SNL2024

OCTOBER 24 – 26, 2024
BRISBANE, AUSTRALIA

SNL2024

Program

Society for the Neurobiology of Language

SNL 2024 Annual Meeting, October 24-26, 2024

Brisbane Convention & Exhibition Centre, Brisbane, Australia

2024 Annual Meeting Program

Contents

https://www.neurolang.org/2024

2024 Committees & Staff

Founders

Steven Small, University of Texas at Dallas
Pascale Tremblay, Université Laval, Québec

Board of Directors

Chair: **Sophie Scott**, University College London
Treasurer: **Eva Gutierrez-Sigut**, University of Essex
Secretary: **Daniela Sammler**, Max Planck Institute for Empirical Aesthetics, Frankfurt/Main
Program Committee Chair: **William Matchin**, University of South Carolina
Student/Postdoc Rep: **Xin Sun**, University of British Columbia
Chair-Elect: **Jonathan Peelle**, Northeastern University
Treasurer-Elect: **Francesca Branzi**, University of Liverpool
Secretary-Elect: **Simona Mancini**, Basque Center on Cognition, Brain, and Language
Program Committee Chair-Elect: **Katrien Segaert**, University of Birmingham
Past Chair: **Liina Pylkkänen**, New York University
Past Treasurer: **Andrea E. Martin**, Radboud University
Past Secretary: **Yanchao Bi**, Beijing Normal University
Past Program Committee Chair: **Stephen M. Wilson**, University of Queensland

Incoming 2025 Board Members

Chair-Elect: **Beth Jefferies**, University of York
Treasurer-Elect: **Tyler Perrachione**, Boston University
Secretary-Elect: **Nai Ding**, Zhejiang University
Program Committee Chair-Elect: **Valentina Borghesani**, Université de Genève

Program Committee

William Matchin, University of South Carolina, *Chair*
Katrien Segaert, University of Birmingham, *Chair-Elect*
Stephen M. Wilson, University of Queensland, *Past Chair*
Sophie Scott, University College London
Jonathan Peelle, Northeastern University
Eva Gutierrez-Sigut, University of Essex
Daniela Sammler, Max Planck Institute for Empirical Aesthetics, Frankfurt/Main
Xin Sun, University of British Columbia
Greig de Zubicaray, Queensland University of Technology

Local Organizing Committee

Greig de Zubicaray, Queensland University of Technology

Nomination Committee

Clara Martin, BCBL, *chair*
Matt Davis, MRC Cognition and Brain Sciences Unit, Cambridge. *chair-elect*
Emily Myers, University of Connecticut, *past chair*

Review Committee

F.-Xavier Alario
Annika Andersson
Giosue Baggio
Venu Balasubramanian
Marina Bedny
Michal Ben-Shachar
Sara Berentsen Pillay
Anna Beres
Jonathan Berken
Richard Binney

Review Committee continued

Esti Blanco-Elorrieta
Megan Boudewyn
Abbie Bradshaw
Jonathan Brennan
Bradley Buchsbaum
Adam Buchwald
Stefano Cappa
Manuel Carreiras
Qi Cheng
Gregory Cogan
Brendan Costello
Matt Davis
Andrew DeMarco
Dirk den Ouden
Michele Diaz
Nai Ding
Karen Emmorey
Danielle Fahey
Li-Ying Fan
Raphaël Fargier
Evelina Fedorenko
Leonardo Fernandino
Adeen Flinker
Benjamin Gagl
Sara Guediche
Thomas Gunter
Ayse Gürel
Arturo Hernandez
Nicolás Hinrichs
Andreas Højlund
Emma Holmes
Maria Ivanova
Eric Jackson
Rebecca Jackson
Xiaoming Jiang
Karim Johari
Hossein Karimi
Lynsey Keator
Say Young Kim
Denise Klein
Vanja Kljajevic
Robert Kluender
Saloni Krishnan
Sigfus Kristinsson
Vicky Lai
Nicole Landi
Ellen Lau
Laurie Lawyer
Chia-lin Lee
Matt Leonard
Deborah Levy
Jixing Li
Chia-Hsuan Liao
Mairéad MacSweeney
James Magnuson
Simona Mancini
Alec Marantz
Clara Martin
Carolyn McGettigan
Aya Meltzer
Lars Meyer
Monika Molnar
Emily Myers
Yun Nan
Caroline Niziolek
Müge Özker Sertel
Myung-Kwan Park
Andrew Persichetti
Stephen Politzer-Ahles
Liina Pylkkänen
Jana Reifegerste
Ryan Rhodes
Holly Robson
Mathias Scharinger
Cory Shain
Tineke Snijders
Christina Sotiropoulou Drosopoulou
Melissa Stockbridge
Kristof Strijkers
Li-Hai Tan
Pascale Tremblay
Kenny Vaden
Jane Warren
Janina Wilmskoetter
Oscar Woolnough
Xi Yu
Linmin Zhang

Meeting Perfect Staff

Shauney Wilson, Event Director
Kerry Miller, Event Planner
Shawna Lampkin, Event Associate
Lynn Flannery, Event Associate
Jeff Wilson, Event Associate

Schedule Overview

Thursday, October 24, 2024

7:00 am - 5:30 pm	Registration Open	Great Hall Foyer
7:00 - 7:00 pm	Quiet Lounge	Merivales Boardroom 2
7:00 - 7:00 pm	Chill Out Lounge	Mezzanine M1
8:00 - 8:45 am	Coffee Break	Mezzanine Foyer
8:45 - 9:00 am	Opening Remarks	Great Hall 1
9:00 - 10:00 am	Keynote Lecture: Angela Morgan	Great Hall 1
10:00 - 10:30 am	Coffee Break	Great Hall Foyer
10:00 - 11:30 am	Poster Session A - Sandbox Series	Great Hall 4
11:30 am - 1:00 pm	Lunch Break	On Your Own
11:30 am - 1:00 pm	'Lunch with a Professor' Trainee Event	Mezzanine M3
1:00 - 3:00 pm	Symposium 1 - Modeling linguistic processes through experimental and naturalistic designs	Great Hall 1
3:00 - 3:30 pm	Coffee Break	Mezzanine Foyer
3:30 - 4:30 pm	Slide Session A	Great Hall 1
4:30 - 5:30 pm	Keynote Lecture: Rachel Nordlinger	Great Hall 1
5:30 - 7:30 pm	Welcome Reception	Mezzanine Foyer

Friday, October 25, 2024

7:30 am - 6:00 pm	Registration Open	Great Hall Foyer
7:30 - 6:00 pm	Quiet Lounge	Merivales Boardroom 2
7:30 - 6:00 pm	Chill Out Lounge	Mezzanine M1
8:00 - 8:30 am	Coffee Break	Mezzanine Foyer
8:30 - 9:30 am	Keynote Lecture: Patrick C.M. Wong	Great Hall 1
9:30 - 10:00 am	Annual Business Meeting	Great Hall 1
10:00 - 10:30 am	Coffee Break	Great Hall Foyer
10:00 - 11:30 am	Poster Session B	Great Hall 4
11:30 am - 1:00 pm	Lunch Break	On Your Own
1:00 - 3:00 pm	Symposium 2 - Leveraging intracranial recordings for detailed insights into language processing: Bridging gaps and advancing understanding	Great Hall 1
3:00 - 3:30 pm	Coffee Break	Mezzanine Foyer
3:30 - 4:30 pm	Slide Session B	Great Hall 1
4:30 - 6:00 pm	Poster Session C	Great Hall 4

Saturday, October 26, 2024		
8:00 am - 6:00 pm	Registration Open	Great Hall Foyer
8:00 am - 6:00 pm	Coffee Break	Mezzanine Foyer
8:00 am - 6:00 pm	Quiet Lounge	Merivales Boardroom 2
7:30 - 8:00 am	Chill Out Lounge	Mezzanine M1
8:30 - 9:30 am	Keynote Lecture: Russell Gray	Great Hall 1
9:30 - 10:30 am	Slide Session C	Great Hall 1
10:30 - 11:00 am	Coffee Break	Great Hall Foyer
10:30 am - 12:00 pm	Poster Session D	Great Hall 4
12:00 - 1:30 pm	Lunch Break	On Your Own
1:30 - 3:30 pm	Symposium 3 - Towards modern, theory-driven approaches to grammar in aphasia	Great Hall 1
3:30 - 4:00 pm	Coffee Break	Mezzanine Foyer
4:00 - 4:30 pm	Dissertation Award: Katharina Menn	Great Hall 1
4:30 - 4:45 pm	Neurobiology of Language Best Paper Award 2024	Great Hall 1
4:45 - 5:45 pm	Distinguished Career Award: Manuel Carreiras	Great Hall 1
5:45 - 6:00 pm	Closing Remarks and Outlook to SNL 2025	Great Hall 1

Message from the Chief Executive Officer Tourism and Events Queensland, Patricia O'Callaghan

I am thrilled to welcome you to the Society for the Neurobiology of Language (SNL) 16th Annual Meeting in Brisbane.

Brisbane is home to the world's brightest minds, industry-leading research and acclaimed event facilities with natural beauty on its doorstep, making it the perfect destination to hold the SNL 2024 Annual Meeting.

The Queensland Government is proud to support the Society for the Neurobiology of Language 16th Annual Meeting through Tourism and Events Queensland's Business Events funding.

Queensland's expanding business events calendar showcases our state's reputation as a premier destination for world-class conferences and unique corporate experiences.

If you are visiting for the event, I hope you'll make the most of your time here and get out to experience all the wonderful things that Brisbane has to offer.

TOURISM & EVENTS Queensland

Keynote Lecture

Angela Morgan

Murdoch Children's Research Institute & University of Melbourne

Keynote Address

Thursday, October 24, 2024, 9:00 – 10:00 am, Great Hall 1

Chair: Greig de Zubicaray, Queensland University of Technology

Genetic architecture of childhood speech disorders

As early as the 1950s, the familial nature of speech disorders was recognized, implying a genetic basis; but the molecular genetic basis remained unknown. In 2001, investigation of a large three generational family with severe speech disorder, known as childhood apraxia of speech (CAS), revealed the first causative gene; FOXP2. A long hiatus then followed for CAS candidate genes, but in the past three years, genetic analysis of cohorts ascertained for CAS have revealed over 30 causative genes. A total of 36 pathogenic variants have been identified from 122 cases across 3 cohorts in this nascent field. Current findings suggest a remarkable one in three children have a genetic variant that explains their CAS, with significant genetic heterogeneity emerging. Around half of the candidate genes identified have medium (6 genes) to strong (9 genes) evidence supporting the association between the gene and CAS. Despite genetic heterogeneity; many implicated proteins functionally converge on pathways involved in chromatin modification or transcriptional regulation, opening the door to precision diagnosis and therapies. Most of the new candidate genes for CAS are also associated with previously described neurodevelopmental conditions that include intellectual disability, autism and epilepsy; broadening the phenotypic spectrum to a distinctly milder presentation defined by primary speech disorder in the setting of normal intellect. The shared mechanisms implicated by gene discovery for CAS highlight potential new targets for future precision therapies in these rare conditions. But what do these findings mean for speech and language skills at a population level? Insights into the genetic bases of CAS, a severe, rare speech disorder, are yet to robustly translate to understanding the heritability of more common, typically milder forms of speech or language impairment such as stuttering or phonological disorder. These disorders likely follow complex inheritance with polygenic contributions in many cases, rather than the monogenic patterns that underly one-third of patients with CAS. Regardless, to date, single gene contributions remain an accessible and important entry point for unravelling the molecular bases of human communication.

About

Prof. Angela Morgan is an NHMRC Elizabeth Blackburn Fellow and Director of the NHMRC Translational Centre for Speech Disorders at the Murdoch Children's Research Institute in Melbourne Australia and is also a Dame Kate Campbell Fellow at the University of Melbourne, and Director of the Speech Genomics clinic at the RCH, Melbourne. Angela's career has focused on understanding causation, predictors, prognosis and therapies for severe and persistent speech and language disorders in children. Most recently, her team have identified over 30 genes associated with childhood apraxia of speech and a novel gene causative for stuttering. Work by her group is directly translated into international guidelines for clinical management of children with these rare genetic conditions.

The SNL 2024 Keynote Lecture is Sponsored by The MIT Press.

Neurobiology of Language

Keynote Lecture

Rachel Nordlinger *FAHA*

School of Languages and Linguistics, University of Melbourne

Keynote Address

Thursday, October 24, 2024, 4:30 – 5:30 pm, Great Hall 1

Chair: Stephen Wilson, University of Queensland

Australia's Indigenous languages and their implications for theories of language

Australia's Indigenous languages exhibit many interesting and unique linguistic properties that have contributed greatly to our understanding of how humans perceive, categorise and discuss the world around them. These properties have informed theories of grammatical structure and linguistic diversity and raise questions for theories of language processing, many of which are yet to be addressed in psycholinguistic research. In this talk I provide an overview of Australian Indigenous languages, their grammatical diversity and the ways in which they reflect and encode Indigenous knowledges and worldview. I then discuss recent research focussed on sentence production and comprehension that highlights the importance of these languages for models of cross-linguistic processing and our understanding of the nature of language.

About

Rachel Nordlinger *FAHA* is Professor of Linguistics and Director of the Research Unit for Indigenous Language at the University of Melbourne. Rachel's research focusses on the description and documentation of Australia's Indigenous languages, and their implications for our understanding of language structure and use. She has collaborated with many Indigenous communities, especially the Bilinarra, Wambaya, Gudanji, Murrinhpatha and Marri Ngarr communities of the Northern Territory, to record their languages and support their efforts in maintaining and preserving their linguistic and cultural heritage. She has also published on syntactic and morphological theory, and in particular the challenges posed by the unique and complex grammatical structures of Australian Aboriginal languages, and what they can teach us about the nature of language more broadly. In recent work (in collaboration with Prof. Evan Kidd), Rachel has undertaken linguistic processing research on Australian languages, focussing on the effects of grammatical properties such as free word order and polysynthetic verbal structures on sentence planning and comprehension. She is the author of multiple academic articles in international journals, and seven books, including *A Grammar of Wambaya* (Pacific Linguistics, 1998), *Constructive Case: Evidence from Australian languages* (CSLI Publications, 1998), *A Grammar of Bilinarra* (Mouton de Gruyter, 2014 - coauthored with Prof Felicity Meakins) and *Lexical-Functional Grammar: an introduction* (Cambridge University Press, 2019 – co-authored with Prof. Kersti Börjars and Prof. Louisa Sadler). She is editor (with Dr. Harold Koch) of *The Languages and Linguistics of Australia* (Mouton de Gruyter, 2014) and leads (with Assoc Prof. Nick Thieberger) the 50 Words Project (https://50words.online/), which aims to provide community-led recordings of Indigenous languages across Australia to increase public awareness and showcase their diversity. Rachel was a Chief Investigator of the ARC Centre of Excellence for the Dynamics of Language (2014-2022) and was elected to the Australian Academy of the Humanities in 2017.

Keynote Lecture

Patrick C.M. Wong

Brain and Mind Institute, The Chinese University of Hong Kong, Hong Kong SAR, China

Keynote Address

Friday, October 25, 2024, 8:30 – 9:30 am, Great Hall 1

Chair: Eva Gutierrez-Sigut, University of Essex

Forecasting Language Development from Neural Data: From Hypothesis Testing to Model Generalization

Language neuroscience can make important contributions to the broader agenda of precision medicine by capitalizing on what we know about the neurobiology of language learning to improve the precision of detection and intervention of language-related neurodevelopmental conditions. In this presentation, I report findings from a series of studies in which we use neural data (MRI or EEG) collected as early as infancy to construct predictive models to forecast language developmental outcomes at the individual child level. These studies include data from preterm and term-born infants, cochlear implant candidates, and children with a confirmed diagnosis or are at elevated likelihood of autism. Our results show that predictive models using neural data to forecast language developmental outcomes often outperform those that use standard clinical and demographic measures as predictors (e.g., gestational age, birth weight, socioeconomic status, Ages & Stages Questionnaires). In some cases, we have sufficient data to validate the models using unseen data or to evaluate the models' generalization to cross-site and cross-language data. Besides their potential clinical applications, our neural predictive models also provide opportunities to address more basic questions about the neurobiology of language. For example, we ask whether cortical and subcortical development interacts with native and non-native speech processing in infancy, and whether this interaction forms the basis of spoken language development. In children who are hearing impaired, we examine whether brain regions that are resilient to reduced auditory/spoken language input are those that promote spoken language when hearing is facilitated by cochlear implantation. In both typical and atypical populations, we are in the process of testing whether individual-child predictions can inform the design and prescription of different types of early intervention and enhancement strategies so that language development can be optimized for all children.

About

Patrick C.M. Wong conducts research centering on cultural and biological factors that lead to variation in language and cognition across individuals. From imaging the brains of infants and older adults, to perceptual psychophysics, grammar learning, gene sequencing, field research in rural areas, and developing processes to forecast developmental changes, his research is fundamentally interdisciplinary. Wong joined The Chinese University of Hong Kong (CUHK) in 2013 as a professor of linguistics and cognitive neuroscience, after serving on the faculty of Northwestern University for nearly a decade. He is the founding director of CUHK's Brain and Mind Institute. As a teacher and mentor, Wong is a four-time recipient of the Faculty Outstanding Teaching Award at CUHK. In 2021, he was named a Guggenheim Fellow for Humanities. Wong actively seeks to translate his research into clinical and educational solutions. One of his patented inventions was awarded the Gold Medal with Congratulations of the Jury at the 2023 International Exhibition of Inventions Geneva. Wong has been Associate Vice-President (Research) at CUHK since 2023.

The SNL 2024 Keynote Lecture is Sponsored by The MIT Press.

Neurobiology of Language

Keynote Lecture

Russell Gray *FRSNZ*

Max Planck Institute for Evolutionary Anthropology, Leipzig and School of Psychology, University of Auckland

Keynote Address

Saturday, October 26, 2024, 8:30 – 9:30 am, Great Hall 1
Chair: William Matchin, University of South Carolina

Cognitive science and the challenge of linguistic diversity

The diversity of human languages poses a challenge: if language is a cognitive tool for efficient communication and social coordination, why are approximately 7000 mutually unintelligible languages spoken across the globe today? For some cognitive scientists, this diversity is only superficial, while it is a fundamental feature for others. In this talk, I will argue that the current trend of including some token non-European subjects doesn't really meet the challenge of linguistic diversity in a theory-driven way. I will outline how new global linguistic databases such as Lexibank and Grambank can be used to select languages and test claims about putative universals in emotion and grammar in a more principled way. I will describe an analysis of emotion semantics across 2474 spoken languages using "colexification"—a phenomenon in which languages name semantically related concepts with the same word. The study shows significant variation in networks of emotion concept colexification. However, the results also reveal a universal structure, with all families differentiating emotions based on hedonic valence and physiological activation. I will report new analyses using Bayesian phylogenetic methods to test 191 putative grammatical universals. The results show strong statistical support for around one-third of the proposed linguistic universals. This suggests that despite the enormous combinatorial flexibility of language systems, shared cognitive and communicative pressures mean that languages repeatedly evolve toward the same preferred regions of design space. Finally, much of the research on linguistic universals tends to assume that relatively constant neural structures underpin the diversity of languages. I will conclude the talk by reviewing recent evidence that challenges this view and suggests that the languages we speak adaptively change patterns of neural connectivity.

About

Russell Gray completed his Ph.D. at the University of Auckland, New Zealand, in 1990. He spent four years lecturing at the University of Otago in Dunedin, New Zealand, before returning to the School of Psychology at the University of Auckland. From June 2014 Russell Gray was Director at the Max Planck Institute for the Science of Human History in Jena. In June 2020 he moved to the Max Planck Institute for Evolutionary Anthropology in Leipzig. He is a Fellow of the Royal Society of New Zealand and has been awarded several prestigious fellowships, including the inaugural Mason Durie Medal for his contributions to social science. Russell Gray's research spans the areas of linguistics, animal cognition, philosophy of biology and the evolution of human and animal behaviour. He pioneered the application of computational evolutionary methods to questions about linguistic prehistory and cultural evolution. He has published over 150 journal articles and book chapters including ten papers in *Nature* and *Science*. More information can found here.

Dissertation Award

Katharina Menn

Max Planck Institute for Human Cognitive and Brain Sciences

Dissertation Award Lecture

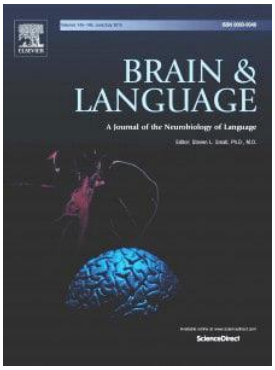
Saturday, October 26, 2024, 4:00 - 4:30 pm, Great Hall 1

Chair: Sophie Scott, University College London

How Early Electrophysiology Shapes First Language Acquisition: A Naturalistic Approach

About Katharina Menn is a postdoctoral researcher in the Max Planck Research Group "Language Cycles" at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. She completed her PhD in Psychology at this institute in March 2024, under the guidance of Dr. Lars Meyer, Dr. Claudia Männel, and Prof. Dr. Dr. Angela D. Friederici. Before her PhD, Katharina earned a Master's degree in Cognitive Neuroscience from the Donders Institute in Nijmegen, The Netherlands, where she completed her thesis in collaboration with the Max Planck Institute for Psycholinguistics. Katharina Menn's dissertation provides a novel framework for language acquisition: It suggests that the ontogenetic trajectory of electrophysiological brain maturation determines the staged pace of language acquisition. The work combines theoretical and empirical approaches to demonstrate that the gradual acceleration of electrophysiological activity predisposes the progression of first language acquisition to proceed from large to small linguistic units. The studies included have been published in Science Advances, Perspectives on Psychological Science, NeuroImage, and Neurobiology of Language. The thesis project was supported by a fellowship from the International Max Planck Research School and it received the Outstanding Dissertation Award by the International Society for Infant Studies.

The Dissertation Award is generously sponsored by *Brain and Language*.



Distinguished Career Award

Manuel Carreiras

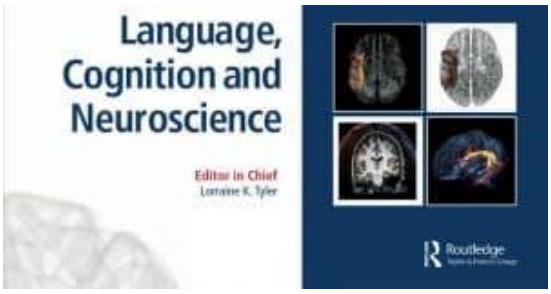
Basque Center on Cognition, Brain and Language

Distinguished Career Award Lecture

Saturday, October 26, 2024, 4:45 - 5:45 pm, Great Hall 1
Chair: Simona Mancini, Basque Center on Cognition, Brain and Language
Introduction by: Arturo Hernandez, University of Houston

About Dr. Manuel Carreiras is a distinguished cognitive neuroscientist and the Scientific Director of the Basque Center on Cognition, Brain, and Language (BCBL) in San Sebastián (Donostia), Spain. Dr. Carreiras has made significant contributions to the fields of psycholinguistics, neuroimaging, reading and bilingualism. His work focuses on understanding the neural mechanisms underlying language processing, with a particular emphasis on bilingualism, reading and dyslexia. In a recent paper in Nature he showed how the brain changes with learning to read testing illiterate members of the Colombian gerilla. Dr. Carreiras early research centered on syntactic processing, with notable publications exploring this area. Among his most intriguing studies is a publication in Nature that highlighted whistling languages, showcasing his innovative approach to language research. Throughout his career, Dr. Carreiras has employed a diverse array of methodologies, including EEG, MEG, MRI eye-tracking, and behavioral techniques, to investigate the complexities of language processing. His research expanded significantly upon his appointment as the founding Scientific Director of the BCBL. Under his leadership, the center has become a one of the leading institutions for the study of the neural bases of language from a multilingual perspective, attracting researchers from around the world. A significant focus of his work has been on the Basque language, a unique non-Indo-European language isolate, providing valuable insights into the cognitive processes involved in multilingualism. His contributions extend beyond research. He has provided extensive service to the field, serving on numerous editorial boards and as a senior editor of the Neurobiology of Language journal. He has also served as the chair of the Society for the Neurobiology of Language and headed multiple summer schools. His commitment to nurturing the next generation of cognitive scientists is reflected in his active participation in various academic societies and his role on the International Scientific Advisory Board of the Max Planck Institute for Psycholinguistics. In recognition of his contributions, Dr. Carreiras has received numerous awards and honors, including the "Premio Euskadi de Investigación en Ciencias Sociales y Humanidades" (Basque Research Award in Social Sciences and Humanities) and the Spanish National Prize for social sciences. He was also awarded the Advanced Grant from the ERC twice , a prestigious award given to leading researchers with a track record of significant research achievements. This grant will support his project on understanding how real-time monitoring of speech can improve language functions through neurofeedback, further underscoring his contributions to the field. Dr. Manuel Carreiras's pioneering research and dedicated service align closely with the mission of the Society for the Neurobiology of Language, and of those who have been given the Distinguished Career Award.

The Distinguished Career Award is generously sponsored by Language, Cognition and Neuroscience.



Sponsors and Exhibitors

The Society for the Neurobiology of Language thanks the following sponsors for their support of our 2024 meeting.

Major Sponsors

National Institutes of Health
The Society for Neurobiology of Language is generously supported by the National Institutes of Health National Institutes of Health (R13 grant #DC011445). The NIH has been supporting SNL meetings by sponsoring travel grants to under-represented minorities, daycare services, sign language interpreting services and more, thus enhancing the accessibility of the meetings to various audiences. We are extremely grateful to the NIH for its generous support of SNL meetings over the years.

Queensland Tourism & Events
Queensland, also known as the Sunshine State, is a vibrant and diverse destination located in Australia. With an area of 1,727,000 square kilometers, Queensland offers a wide range of experiences for travelers. From stunning sandy beaches that stretch for 6,000 kilometers along the coastline to the majestic Great Barrier Reef, Queensland is a paradise for beach lovers and marine enthusiasts. The state is also home to breathtaking natural wonders such as the ancient Wet Tropics and the lush Daintree Rainforest, where you can explore bushwalking tracks and spot unique wildlife like cassowaries. In addition to its natural beauty, Queensland boasts cultural attractions, including the galleries and restaurants in the capital city of Brisbane. With its rich Indigenous history and events, Queensland offers opportunities to learn and engage with Aboriginal culture. So, whether you're seeking adventure, relaxation, or cultural exploration, Queensland has something for everyone to enjoy!

Brisbane Economic Development Agency
Visit Brisbane, from luxury accommodation to award-winning dining and endless adventure, a bustling major events calendar to serene coastlines and hinterland. Find out why Brisbane favours the bold. Take advantage of this chance to go 'Down Under' and explore one of Australia's most dynamic cities. Bring your family and turn your conference trip into a memorable vacation! Enjoy Brisbane's family-friendly attractions, from world-class zoos to beautiful beaches.

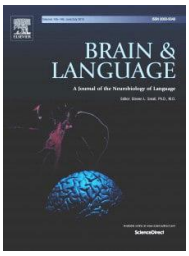
Gold Sponsor

Neurobiology of Language (The MIT Press)
Sponsor of the Angela Morgan Keynote Lecture & Patrick C.M. Wong Keynote Lecture.

The MIT Press commits daily to re-imagining what a university press can be. Known for bold design and creative technology, the Press advances knowledge by publishing significant works from leading scholars and researchers around the globe for the broadest possible access, impact, and audience. Committed to exploring new disciplines and modes of inquiry, the press publishes 220+ new books a year and over 35 journals in a wide range of fields.

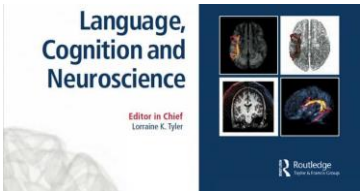
The Press is proud to partner with the Society for the Neurobiology of Language to publish Neurobiology of Language.

Award Sponsors



Brain & Language (Elsevier)
Sponsor of the SNL Early Career Award and the new SNL Dissertation Award.

An interdisciplinary journal, Brain & Language focuses on the neurobiological mechanisms underlying human language. The journal covers the large variety of modern techniques in cognitive neuroscience, including lesion-based approaches as well as functional and structural brain imaging, electrophysiology, cellular and molecular neurobiology, genetics, and computational modeling. All articles must relate to human language and be relevant to an elaboration of its neurobiological basis. Along with an emphasis on neurobiology, journal articles are expected to take into account relevant data and theoretical perspectives from psychology and linguistics.



Language, Cognition & Neuroscience (Routledge)
Sponsor of the SNL Distinguished Career Award.

Language, Cognition & Neuroscience publishes high-quality papers taking an interdisciplinary approach to the study of brain and language, and promotes studies that integrate cognitive theoretical accounts of language and its neural bases. The Journal publishes both high quality, theoretically-motivated cognitive behavioural studies of language function, and papers which integrate cognitive theoretical accounts of language with its neurobiological foundations.

Bronze Sponsor

Rogue Research Inc.

Rogue Research Inc.
Rogue Research Inc. has been your partner in neuroscience research for over 20 years. As developers of the Brainsight® family of neuronavigation systems for non-invasive brain stimulation, we have helped make transcranial magnetic stimulation and now transcranial focused ultrasound (tFUS) more accurate and more reproducible while keeping it simple and effective. Our next-gen Elevate TMS device and companion robot offer better control of the pulse effect and improve reproducibility and efficiency for automated coil placement and mapping. We also offer Veterinary surgical navigation and robotic microsurgery equipment.

artinis

Artinis Medical Systems
Artinis Medical Systems We are an innovative Dutch company providing user-friendly and high-tech functional near-infrared spectroscopy (fNIRS) equipment for easy and unconstrained measurements of brain hemodynamics. We offer integrations with other neuroimaging modalities so that fNIRS can easily be added to your research projects. Please come meet us at our booth for a demonstration of our fNIRS systems, and to get more information.

Frontiers in Language Sciences
Frontiers in Language Sciences is a pioneering open-access journal focused on advancing our understanding of language processing and its impact on the brain and human development. Covering a wide range of topics, the journal features key sections such as Neurobiology of Language, Language Processing, Reading. We invite high-quality submissions exploring language structure, acquisition, comprehension, and production through formal, cognitive, and neurobiological approaches. Committed to open access and interdisciplinary collaboration, Frontiers in Language Sciences remains at the forefront of linguistic research and innovation.

Symposium Sessions

Symposia Session 1

MODELING LINGUISTIC PROCESSES THROUGH EXPERIMENTAL AND NATURALISTIC DESIGNS

Thursday, October 24, 1:00 - 3:00 pm, Great Hall 1

Organizers: Shaonan Wang[1], Jixing Li[2]; [1]Institute of Automation Chinese Academy of Sciences, [2]City University of Hong Kong
Presenters: Nai Ding, Yohei Oseki, Jixing Li, Yanchao Bi, Ping Li, Alona Fyshe

Recent trends in the cognitive neuroscience of language research have been shifting towards the use of naturalistic stimuli, such as story reading or listening. This approach provides more authentic linguistic processes compared to traditional controlled experiments. The relevance of naturalistic design is further amplified in the context of large language models (LLMs), which are trained on naturalistic texts or speech. However, there is also a growing body of research examining LLMs through various linguistic experiments to assess their linguistic competence. In this symposium, we bring together researchers at different career stages and from varied disciplines to explore the benefits and drawbacks of both controlled and naturalistic stimuli. Our objective is to assess the advantages and challenges associated with both controlled and naturalistic stimuli and to discuss the potential of computational models to advance our comprehension of linguistic processes within the human brain, leveraging insights from both research paradigms.

TALK 1: PROBING LINGUISTIC PROCESSING USING HIGHLY CONTROLLED EXPERIMENT DESIGNS

Nai Ding[1]; [1]Zhejiang University

Language comprehension is extremely complicated and involves a large number of highly correlated processes. Highly controlled experiments are often necessary to tease apart these highly correlated processes and can be designed to have high statistical power to test specific hypotheses about how the brain encodes language. Here, I will elaborate on why two unintuitive experimental designs may provide unique insights into how the brain and language models process language. The first paradigm is to study the neural encoding of linguistic constituents using frequency tagging, and the second paradigm is to assess the behavioral sensitivity to linguistic constituents through a word deletion task. I will talk about the advantages and potential clinical applications of these experimental designs, as well as common misunderstandings when generalizing the conclusions from these controlled experiments to natural speech comprehension.

TALK 2: TARGETED AND PSYCHOMETRIC EVALUATION OF LANGUAGE MODELS

Yohei Oseki[1]; [1]University of Tokyo

Language models (LMs) have developed extremely rapidly and outperformed humans in various downstream tasks such as machine translation and question answering. However, despite their super-human performance, whether those LMs process natural language like humans remains to be investigated. In this talk, we evaluate syntactic processing of language models through both controlled and naturalistic designs. Specifically, various LMs like syntactic language models (SLMs) and large language models (LLMs) are assessed via (i) targeted syntactic evaluation (i.e. modeling controlled acceptability judgments) and (ii) human psychometric evaluation (i.e. modeling naturalistic eye movements and brain activities). The results converge on the conclusion that SLMs seem to process natural language like humans, while LLMs are not always human-like, suggesting that controlled and naturalistic designs should be integrated to understand both humans and machines.

TALK 3: ISOLATED AND CONTEXTUALIZED MEANING COMPOSITION

Jixing Li[1]; [1]City University of Hong Kong

Naturalistic paradigms using movies or audiobooks have become increasingly popular in cognitive neuroscience, but connecting them to findings from controlled experiments remains rare. Here, we aim to bridge this gap in the context of semantic composition in language processing, which is typically examined using a "minimal" two-word paradigm. Using magnetoencephalography (MEG), we investigated whether the neural signatures of semantic composition observed in an auditory two-word paradigm can extend to naturalistic story listening, and vice versa. Additionally, we subjected a large language model to the same classification tests. Our results demonstrate consistent differentiation between phrases and single nouns in the left anterior and middle temporal lobe, as well as in LLMs, regardless of the context. This consistency suggests the presence of a unified compositional process underlying both isolated and connected speech comprehension.

TALK 4: INTERFACING LANGUAGE AND VISUAL PERCEPTION: EVIDENCE FROM COMPUTATIONAL AND LESION MODELS

Yanchao Bi[1]; [1]Beijing Normal University

Language and visual perception are intricately related but the underlying neural mechanisms remain elusive. We examine how language experience affects visual object processing by comparing the power of three computer vision models in explaining neural activity patterns in the visual cortex across four fMRI datasets with diverse visual tasks and subjects. These models vary by whether language alignments are introduced in the training—CLIP_ResNet50 (image- text alignment), ResNet50 (image-word labeling), and MoCo v3_ResNet50

(visual only). CLIP_ResNet50 consistently exhibited superior explanatory power compared to the other models in clusters in the visual cortex. Importantly, in patients with brain lesions, we observed a correlation between white matter integrity across language areas and the advantage of CLIP_ResNet50, indicating that the advantage of such language-vision fusion models indeed is driven by the contribution of language processes. These findings highlight the potential role of language in shaping neural computations during object processing in the visual cortex.

TALK 5: MODEL-BRAIN ALIGNMENT FOR DISCOURSE COMPREHENSION

Ping Li[1]; [1]The Hong Kong Polytechnic University

Reading comprehension remains the main medium for students to gain scientific knowledge despite pervasive use of digital platforms. In this talk, I describe the “model-brain alignment” approach that leverages Large Language Models (LLMs) to study naturalistic reading comprehension in both native (L1) and non-native (L2) languages. By training LLM-based encoding models on brain responses to text reading, we can evaluate (a) what computational properties in the model are important to reflect human brain mechanisms in language comprehension, and (b) what model variations best reflect human individual differences during reading comprehension. Our findings show that first, to capture the differences in word-level processing vs. high-level discourse integration, current LLM-based models need to incorporate sentence prediction mechanisms on top of word prediction, and second, variations in model-brain alignment allow us to predict L1 and L2 readers’ sensitivity to text properties, cognitive demand characteristics, and ultimately their reading performance.

TALK 6: EXPLORING TEMPORAL SENSITIVITY IN THE BRAIN USING MULTI-TIMESCALE LANGUAGE MODELS: AN EEG DECODING STUDY

Alona Fyshe[1]; [1]University of Alberta

During language understanding, the brain performs multiple computations at varying timescales, ranging from word understanding to grasping the narrative of a story. Recently, multi-timescale long short-term memory (MT-LSTM) models have been introduced to use temporally-tuned parameters to induce sensitivity to different timescales of language processing. Here, we used an EEG dataset recorded while participants listened to Chapter 1 of "Alice in Wonderland" and trained models to predict the temporally-tuned MT-LSTM embeddings from EEG responses. Our analysis reveals that our models can effectively predict MT-LSTM embeddings across various timescales and windows of time, usually in concordance with the timescale the model is tuned for. However, we also observed that short timescale information is not only processed in the vicinity of word onset but also at distant time points. These observations underscore the parallels and discrepancies between computational models and the neural mechanisms of the brain.

Symposia Session 2

LEVERAGING INTRACRANIAL RECORDINGS FOR DETAILED INSIGHTS INTO LANGUAGE PROCESSING: BRIDGING GAPS AND ADVANCING UNDERSTANDING

Friday, October 25, 1:00 - 3:00 pm, Great Hall 1

Organizer: Jill Kries[1]; [1]Stanford University
Presenters: Matthew Leonard, Gregory Cogan, Stephanie Ries, Anna Mai

Intracranial recordings (iEEG, ECoG) uniquely provide both high spatial and temporal resolution, enabling researchers to study local neural populations at a scale that approaches advances in animal models for behaviors other than language. Such precision is necessary for understanding the complex representations, computations and architecture underlying language processing. Symposium speakers will present recent advances in intracranial research, addressing (1)theoretical psycholinguistic debates, (2)the interface between acoustic/motor encoding and higher-level conceptual and cognitive processing, and (3)muscle-artifact-free speech production data that enable BCI applications. The panel discussion will entail debating future directions, addressing questions like: How can intracranial research contribute to furthering our theoretical understanding of language in ways that no other technique can? How can intracranial language studies support and augment non-invasive research? What promise does intracranial research hold for applications in individuals with language disorders? This symposium will identify future directions for intracranial language research and strengthen integration with non-invasive methods.

TALK 1: SPEECH ENCODING IN SINGLE NEURONS AND NEURAL POPULATIONS IN HUMAN CORTEX

Matthew Leonard[1]; [1]University of California San Francisco

The development of high-resolution direct neural recording techniques in humans has enabled a detailed understanding of how local neural populations and single neurons process spoken input. The emerging picture of speech encoding in the brain is one in which key regions like the superior temporal gyrus (STG) represent multiple phonological, prosodic, and word-level features in parallel. However, we lack an understanding of how these diverse features are integrated into coherent percepts, and how both local and network-level neural codes contribute to listeners’ perceptual experience of speech comprehension. By combining recording techniques (ECoG, Neuropixels, and direct cortical stimulation), naturalistic and controlled stimuli, and both linear and non-linear encoding models, it is now possible to address fundamental questions about the interface between auditory speech input and language comprehension.

TALK 2: MORE IS BETTER: STUDYING THE SPEAKING BRAIN USING MICRO-ECOG

Gregory Cogan[1]; [1]Duke University

Direct brain recordings afforded by neurosurgical patients has provided new insights into how the human brain works. This opportunity has also led to technological advances to record from large areas of the brain with fine spatial detail. These 'high-definition' neural recordings are particularly important for the uniquely human capacity of speech and language. In this talk, I will discuss our recent work using high-density, high channel-count micro-electrocorticography (micro-ECoG) to study the speaking brain. I will show the benefits of increased spatial sampling for speech decoding from neural signals for brain computer interfaces (BCI). I will also show that we can delineate neural sub-processes associated with both the planning and execution of speech. Together, these results highlight opportunities from direct brain recordings that combined with advances in neural recording technologies, will provide new vistas for advancing our ability to understand and treat the human brain.

TALK 3: CORTICAL INTERACTIONS SUPPORTING COGNITIVE CONTROL IN LANGUAGE PRODUCTION

Stephanie Ries[1], Yusheng Wang[1,2], Ashkan Ashrafi[1], Sharona Ben-Haim[2], Jerry Shih[2]; [1]San Diego State University, [2]University of California San Diego

Although producing language seems easy, cognitive control processes help efficiently transform ideas into language output and avoid errors. Prefrontal cortex (PFC) regions in the lateral and medial PFC play critical roles in supporting cognitive control processes in and outside of language. However, little is known about how these regions interact with core language regions to allow us to produce and retrieve words so efficiently as we speak. We used graph signal processing, i.e. graph learning, to analyze intracranial electroencephalography data recorded directly within brain regions of interest as participants were naming pictures. Our results show that distant frontal and temporal brain regions are functionally connected in picture naming. In particular, a higher number of functional connections involve the caudal anterior cingulate cortex compared to the superior temporal gyrus time-locked to vocal onset. This supports the involvement of a domain-general medial PFC conflict monitoring mechanisms during language production and speech monitoring.

Talk 4: Linguistic Structure on Both Sides of the Braincase

Anna Mai[1]; [1]Max Planck Institute for Psycholinguistics

Explaining structured variability within and across languages is a central goal of linguistic research, and the unparalleled spatiotemporal resolution of intracranial recordings is invaluable to explaining this intricate structure at the neural level. In this talk, I will discuss work showcasing how intracranial recordings have enabled such study as well as work highlighting the importance of bridging intracranial work with other neuroimaging literatures. In particular, I will discuss how some recent intracranial work has substantiated long-standing theoretical claims about the structure of phonological contrasts, their relationship to speech acoustics, and their specificity to particular languages (Mai et al. 2024). I will additionally show how aspects of this work have been validated in a less-invasive neuroimaging context and how bandlimited intracranial responses to speech vary across distances in gray and white matter. In this way, this talk will illustrate both the present and future promise of intracranial recordings in language research.

Symposia Session 3

TOWARDS MODERN, THEORY-DRIVEN APPROACHES TO GRAMMAR IN APHASIA

Saturday, October 26, 1:30 - 3:30 pm, Great Hall 1

Organizers: Danielle Fahey[1], Jeremy Yeaton[2]; [1]University of Montana, [2]University of California, Irvine
Presenters: Nicoletta Biondo, Jeremy Yeaton, Laura Giglio, Sladjana Lukic, Alex Krauska

Traditional approaches to grammatical deficits in aphasia harken back to categorical definitions conceived in the 19th century. Though the methodologies have improved, much research has continued to integrate these definitions. We seek to move beyond nebulous characterizations of comprehension and production deficits in aphasia—receptive and expressive agrammatism and paragrammatism—towards theory-driven, modern empirical approaches to understanding what underlies syntactic deficits in aphasia. The investigations presented ask the basic questions of whether there are distinct syndromes of agrammatism and paragrammatism, where in the brain and/or linguistic process deviations arise, whether the deviations are strictly syntactic, and what methodologies will best serve to improve our understanding of these conditions, and how the brain does syntax. Therefore, we draw together researchers examining the issue from diverse theoretical perspectives, disciplines and training backgrounds, and empirical evidence from patients with various diagnoses, etiologies and language experiences.

Talk 1: Bridging the gap: From linguistic theory to psycholinguistics in the assessment of post-stroke comprehension deficits

Nicoletta Biondo[1,2]; [1]Basque Center for Cognition, Brain and Language, [2]University of California, Berkeley

Why are we still debating grammatical deficits in aphasia? In this talk, I argue that this debate stems from a tension between the "applied" needs for swift language tools to assess deficits and guide treatment plans, and the "theoretical" needs for investigating grammar deficits in depth to provide a more reliable formalization of the neurobiology of language. I demonstrate the effects of this tension by first reviewing previous studies that have examined grammar deficits in post-stroke aphasia through lesion symptom mapping analyses. I

then propose a sequential approach, where linguistic theory offers finer-grained analyses, and psycholinguistics provides mechanistic insights into how grammar is affected in aphasia, bridging linguistic concepts with brain mechanisms. Finally, I outline future potential implementations, aiming to contribute both to more reliable formalizations of grammatical processing and improved tools for the assessment of grammatical abilities.

Talk 2: Characterization of expressive grammar deficits in aphasia using SUBA coding

Jeremy Yeaton[1], Danielle Fahey[2]; [1]University of California, Irvine, [2]University of Montana

There are two main types of expressive syntactic deficit in aphasia: agrammatism and paragrammatism. Agrammatism is often characterized by reduction or simplification of morphosyntax, while paragrammatism is characterized by over and misuse of morphosyntax, rather than reductions. Paragrammatism has received less attention than agrammatism with no large-scale structural description available in the literature. We developed novel error coding, the Syntactic Utterance-Based Analysis (SUBA), based on mechanistic accounts of sentence production and focused on capturing breakdowns in morphosyntax and hierarchical structure, analyzing comparable discourse sample transcripts of people with aphasia and healthy controls. Productive errors were used to cluster participants, resulting in several distinct phenotypes. These phenotypes localize to distinct regions of the inferior frontal and posterior temporal cortex. Results highlight the importance of integrating linguistic theory into structural descriptions of disordered output, as well as how that can inform our understanding of the neurobiology of syntax.

Talk 3: Characterizing verb argument structure production in discourse in aphasia

Laura Giglio[1], Julius Fridriksson[1], Dirk B. Den Ouden[1]; [1]University of South Carolina

Verb production and verb argument structure production are often affected in people with aphasia that present with grammatical deficits. Measuring verb argument structure production in spontaneous speech can help characterize grammatical deficits in aphasia, but it usually requires intensive manual coding. I will discuss the use of dependency parsers to automatically extract verb use and argument structure production in controls and people with aphasia. Dependency parsers allow for a fast and use-based quantification of verb choice and use by identifying verbs in sentences and their dependent relations. These automatically-derived measures identify differences across aphasia types classified by the Western Aphasia Battery-Revised diagnosis relative to baseline measures derived from a large control group from AphasiaBank. This approach also captures variability within aphasia types, thus potentially providing a tool to better characterize grammatical behavior from discourse in people with aphasia.

Talk 4: Neural correlates of morphosyntax: evidence from acquired and progressive aphasias

Sladjana Lukic[1]; [1]Florida State University

A longstanding debate in neurolinguistics revolves around understanding how and where the brain integrates morphosyntactic elements to encode and decode language. Morphosyntactic deficits are the defining features of nonfluent subtypes of aphasia, in contrast to fluent subtypes which primarily exhibit lexical retrieval deficits regardless of the etiology of aphasia. Various perspectives challenge this traditional distinction, with some arguing that syntax is inseparable from lexical processing, while others advocate for a "syntax-centric" view. Over the last decade, we observed the flourishing of quantitative linguistic approaches aided by AI tools enabling analysis of morphosyntactic features in speech samples. This talk delves into lesion-mapping and neural disorders, addressing key questions in neurolinguistics: 1) Are there clear functional-anatomical dissociations? 2) What roles do other linguistic and non-linguistic capacities play in morphosyntactic processing? 3)How do task differences and subtypes impact morphosyntax performance? Answers to these inquiries offer a comprehensive framework for understanding the anatomical-functional roles of morphosyntax.

TALK 5: MOVING AWAY FROM LEXICALISM IN APHASIOLOGY

Alex Krauska[1]; [1]University of Maryland

Recent work in non-lexicalist linguistic theory asks for a deep re-thinking of the format of linguistic representations and the kinds of processes which operate over them. This shift has significant implications for how we think about language disorders, given that the aphasia literature is deeply steeped in a tradition where the grammar and the lexicon are fundamentally distinct. Reinterpreting clinical data in a non-lexicalist lens - where elements above and below the “word” level are retrieved and combined via the same mechanisms, where meaning, syntax, and form are fully independent data structures, and where linear order is not fully determined by the syntax - suggests that the surface form of speech errors and language impairments may not transparently reflect the underlying cause. I discuss the issues with lexicalism as they pertain to language production in aphasia, and how a non-lexicalist approach can be useful in the analysis of language disorders.

Slide Sessions

Slide Session A

Thursday, October 24, 3:30 - 4:30 pm, Great Hall 1

Chair: Daniela Sammler, Max Planck Institute for Empirical Aesthetics, Frankfurt/Main

TALK 1: NEURAL ENCODING OF WORD FORMS FROM CONTINUOUS SPEECH IN HUMAN CORTEX

Yizhen Zhang[1], Matthew Leonard[1], Laura Gwilliams[2], Ilina Bhaya-Grossman[1,3], Edward Chang[1]; [1]University of California San Francisco, [2]Stanford University, [3]University of California Berkeley

When listening to speech, our ears receive a continuous stream of sound vibrations, yet our brains perceive a sequence of discrete and meaningful linguistic units - words. Words serve as a crucial link between sound and meaning, however, it remains largely unknown how the speech cortex extracts and represents individual words from natural continuous speech. Here, we recorded high-density electrocorticography (ECoG) responses while participants passively listened to spoken narratives. Our findings revealed the neural encoding of word forms as a distributed and dynamic representation in the human speech cortex. First, we examined neural activity aligned to word boundaries. We found neural populations throughout the superior temporal gyrus (STG) elicited time-locked evoked responses. These responses were distinct from other boundaries like syllables, which are cued with similar acoustic features (i.e., changes in the amplitude envelope). The word-evoked response was multi-phasic, consisting of 1-3 distinct states around each word boundary. To address the functional significance of each phase of the evoked response, we used partial correlation to test the extent to which key speech and language features (e.g., acoustic-phonetic, prosodic, lexical) are encoded at each moment. We found that each part of the response encodes distinct information, with a characteristic temporal sequence: immediately before the boundary, information about the duration of the previous word modulates neural activity, followed by a peak just after the boundary that encodes acoustic-phonetic and prosodic (e.g., vowel length) cues, and finally a peak in the middle of the word that encodes lexical properties like word frequency. This sequence of feature encoding, anchored at word boundaries in continuous speech, is highly robust to the large variation in word length, which is enabled by a population code for relative time. Finally, word extraction and representation spatially overlap with the acoustic-phonetic feature encoding in the mid-STG, with additional neural populations encoding word-level information extending in both anterior and posterior directions along the gyrus. Together, these results suggest that extracting words from continuous speech relies on a distributed neural code, which jointly represents temporal context and speech content to integrate phonological and lexical features within a rapid cycle.

TALK 2: CORTICAL REPRESENTATION OF READING COMPREHENSION IN ENGLISH

Xue Gong[1], Cong Du[1], Catherine Chen[1], Christine Tseng[1], Frederic Theunissen[1], Jack Gallant[1], Fatma Deniz[2]; [1]UC Berkeley, [2]Technische Universität Berlin

Reading comprehension, a specialized form of object recognition, requires extracting meaning from written texts through a set of dynamic and intermediate representations. Previous research indicates that the visual word form area (VWFA) in the left ventral occipitotemporal cortex is crucial for the invariant recognition of written words (Cohen et al, 2000, Dehaene et al, 2010). However, the specifics of how the brain processes reading comprehension remain less understood. To investigate the intermediate representations of reading throughout the human cerebral cortex, we used functional MRI and voxelwise encoding models. We collected BOLD activity when nine participants read over two hours of engaging natural narrative stories. Firstly, we build a voxelwise encoding model using eleven feature spaces based on language statistics (e.g. word rate), visual, phonemic, orthographic, semantic and syntactic information of the story stimuli. Secondly, because visual, orthographic and semantic features can be highly correlated in reading, we used variance-partitioning analysis to determine how much of the variance was uniquely predicted by each feature space and the combination of these features (Gong et al, 2023; de Heer et al, 2017; Lescroart et al., 2015). Lastly, we examined the tuning of visual and orthographic properties in the cerebral cortex by projecting the high dimensional model weights onto a low dimensional and interpretable space using principal component analysis. Our results provide three lines of evidence for representations of reading comprehension. First, visual, orthographic and semantic feature spaces are the three major dimensions in representing reading related information in the cerebral cortex. In particular, the human cerebral cortex does not represent features of reading comprehension in clearly segregated and distinct areas. Instead, various cortical areas simultaneously represent a combination of these features. Secondly, as the cerebral cortex extracts meaning from written words, voxels in early to high-level visual areas gradually become tuned to lower spatial frequencies and higher temporal frequencies. These results suggest a visual processing of increased sensitivity to temporal variation and a progressive integration across spatial areas. Thirdly, we identified the posterior inferior temporal gyrus (pITG) and posterior fusiform gyrus (pFG) to represent orthographic information. The first principal dimension of the orthographic model weights separates linear letters (i, j, l) from curved letters (a, c, s). The second principal dimension separates letters with intersections (x, y, w) from the letters without intersections (o, c, s). This result indicates that the human cerebral cortex represents English letters orthographically according to their curvature and intersections.

TALK 3: WHITE MATTER NETWORKS DIFFERENTIALLY MEDIATE LANGUAGE COGNITION BY SEMANTIC DEMAND AND IMPROVED RESPONSES AFTER TMS NON-INVASIVE BRAIN STIMULATION

Shreya Parchure[1], John Medaglia[2], Denise Harvey[1], Apoorva Kelkar[2], Dani Bassett[1], Roy Hamilton[1]; [1]University of Pennsylvania, [2]Drexel University

Semantic cognition - understanding the context and meaning of words - is critical for language production, and its impairment in aphasia patients profoundly disrupts daily living. Understanding neural mechanisms of semantic processing is key for effective brain stimulation treatments. While singular brain regions underlying language are well-studied, little is known about how their interactions (i.e. white matter tract networks) contribute to speech generation. White matter networks mediate distribution of potential treatments like transcranial magnetic stimulation (TMS), non-invasive neuromodulation that temporarily depresses cortical excitability and influences behavior. Theories of anatomical basis of semantic cognition implicate various tracts: connecting left inferior frontal gyrus (LIFG), dual-stream model in peri-sylvian fissure, to a broad language network comprising nearly entire brain. To elucidate the anatomical basis of semantic cognition, we used network neuroscience models of these theories paired with experiments using focal manipulation by TMS during tasks with varying semantic demands. N=31 English-speaking healthy adults received either active or sham rTMS over LIFG. Before and after stimulation, response times (RTs) were collected for 2 spoken word completion tasks: Verb generation and Sentence completion. Each subject underwent structural MRI, and networks were created of white matter streamlines connecting cortical brain regions. Sub-networks corresponding to theorized language models were constructed for each subject: 1. Left inferior fronto-occipital fasciculus (IFOF), 2. Inferior longitudinal fasciculus (ILF), 3. Uncinate fasciculus (UF), and 4. Peri-sylvian language network (LangNet). Each of their connectivity, measured as network strength, were used as predictors in linear mixed effects regression with log(RTs) as behavioral outcome measure, before and after cTBS. At baseline for Verb generation, IFOF ($p<0.001$) and ILF ($p=0.015$) were significant predictors of RTs. Whereas for Sentence completion, UF ($p=0.004$) and LangNet ($p<0.001$) significantly predict RTs. After rTMS, there was a significant decrease in Sentence completion RTs for active stimulation recipients ($p=0.017$, pairwise t-test) but not in sham ($p=0.59$). For Verb Generation, there was no significant difference from baseline RTs; IFOF ($p=0.007$) and ILF ($p<0.001$) remained significant mediators even after rTMS. Additionally for Sentence Completion, there was a change in white matter predictors: IFOF network strength was newly predictive ($p<0.001$) of the faster post-stimulation RTs, while UF and LangNet were no longer predictive ($p>0.05$). Double dissociation between networks predicting Verb generation (IFOF and ILF) and Sentence completion (UF and LangNet) at baseline, suggests differential recruitment of white matter tracts according to semantic demands of language task. Results also corroborate fMRI studies on the role of IFOF in semantic cognition and syntactic comprehension, and for IFOF and ILF but not UF in Verb generation. These methods are generalizable to many cognitive processes organized in brain networks that contribute to complex human behavior. Further, focal stimulation over LIFG (nearest UF tract) produced faster RTs only for the task which was associated with UF. Change in its significant predictors post-rTMS (from UF to IFOF) suggest Sentence completion RT changes may be mediated by disruption of UF and recruitment of alternate tract IFOF. This work produces novel insight into neural organization of semantic cognition and language dynamics after neuromodulation.

TALK 4: AGE-APPROPRIATE LARGE LANGUAGE MODELS AND EEG ENCODING MODELS REVEAL CONTEXTUAL LEXICAL PROCESSING ACROSS THE FIRST FIVE YEARS OF LIFE

Katharina Menn[1], Claudia Männel[1,2], Florian Scharf[3], Hanna Woloszyn[4], Benjamin Gagl[4], Lars Meyer[1,5]; [1]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]Charité - Universitätsmedizin Berlin, Germany, [3]Universität Kassel, Germany, [4]Universität zu Köln, Germany, [5]University Hospital Münster, Germany

Language acquisition entails rapid learning. Segmentation and comprehension of single words emerge within the first year of life (Bergelson & Swingley, 2012; Jusczyk et al., 1999). While there is also evidence that contextual processing emerges within the second year of life (Friedrich & Friederici, 2005), the earliest stages of contextual lexical processing remain elusive—due to infants' limited attention and restricted response capacities. Here, we combine age-appropriate Large Language Models (LLMs; Schepens et al., 2023) with EEG encoding models (TRFs; Crosse et al., 2015) to reveal contextual lexical processing across the first five years of life, analyzing a quasi-longitudinal developmental dataset of naturalistic speech processing. Our sample consists of n = 51 children (31 female) aged between 3 months and 5 years, with age distributed uniformly across the age range. Each child was assessed twice within a 3-month time window. During each session, we recorded children's EEG while they heard translation-equivalent stories in their native language (German) and an unfamiliar language (French). Children's electrophysiological responses to the individual words in the story were quantified using EEG encoding models. First, we used TRFs to capture word onset responses as a temporal search space for native lexical processing. Electrophysiological responses to words increase with age ($t = 2.34$, $p = .021$) in the native language (German), but not the unfamiliar baseline (French), in three distinct time windows (100–300/300–450/450-600 ms). To estimate whether word onset responses are related to lexical processing, we employed LLMs (GPT-3.5) to generate age-appropriate text corpora and estimate lexical frequencies and contextual lexical predictabilities of the words in our stimuli specifically for German-learning children (Schepens et al., 2023). Mixed-effects modeling demonstrates that all EEG word responses also contain variance that indicates contextual lexical processing: Amplitudes between 100–300 ms increase with word frequency ($t = 3.14$, $p < .001$), an effect attenuated by age ($t = –2.22$, $p = .026$). Amplitudes between 300–450 ms decrease with word frequency ($t = –2.26$, $p = .024$). Between 450–600 ms, amplitudes are modulated by age-appropriate lexical

predictability (t = –4.88, p < .001). Our findings reveal early electrophysiological sensitivity not only to individual words, but to words in context. While our preliminary findings cannot dissociate form– and content-level processing (i.e., the lexical and semantic levels), they suggest that age-appropriate LLMs may be a critical looking glass for studying the early emergence of the mental lexicon and contextual lexical processing with non-invasive electrophysiological recordings.

Slide Session B

Friday, October 25, 3:30 - 4:30 pm, Great Hall 1

Chair: Jonathan Peelle, Northeastern University

TALK 1: RELATIVE ENCODING OF SPEECH INTENSITY IN THE HUMAN TEMPORAL CORTEX

Ilina Bhaya-Grossman[1,2], Yulia Oganian[3], Emily Grabowski[2], Edward Chang[1]; [1]University of California, Berkeley, [2]University of California, San Francisco, [3]University of Tübingen

Lexical stress, or the emphasis placed on syllables within words, critically facilitates word recognition and comprehension processes. For instance, it enables listeners to distinguish between the noun “a present” (PRE-sent) and the verb “to present” (pre-SENT). In English, lexical stress is prominently signaled by relative speech intensity, with the stressed syllable exhibiting the greatest intensity relative to other syllables in the word. Prior work has shown that the human speech cortex on the superior temporal gyrus (STG) encodes speech intensity as a series of discrete acoustic landmarks marking moments of peak intensity change (peakRate). Building on this finding, a key question arises: Is there a neural encoding of relative intensity in the STG that supports the perception of lexical stress? To address this question, we performed intracranial recording (n=9 ECoG patients) while English speaking participants performed two experiments. In Experiment 1, participants performed a forced choice task, identifying whether the first or second syllable was stressed in a set of synthesized two syllable pseudo-words (e.g. hu-ka, ma-lu). The intensity of the first syllable in each pseudo-word varied while the intensity of the second syllable was fixed, allowing us to experimentally test whether neural responses to the second syllable depended on the intensity of the first. We found that a subset of cortical sites on the human STG encoded relative intensity, that is, these sites showed activation in response to the second syllable only when its intensity was greater than that of the first syllable. Critically, we found that cortical sites that encoded relative intensity were distinct from those that encoded peakRate. Neither population encoded which syllable participants perceived as stressed when they were presented with ambiguous pseudo-words, where both syllables had identical intensity. In Experiment 2, we used a passive listening paradigm to extend our findings to a naturalistic speech stimulus. Our results indicate that relative and absolute intensity of speech is encoded in two distinct neural populations on the STG and further, that these populations do not encode stress percepts in cases where the intensity cue to lexical stress is removed. Our results reveal the multiple, distinct neural representations that work in concert give rise to lexical stress perception.

TALK 2: CUEING IMPROVES EXPRESSIVE EMOTIONAL APROSODIA IN ACUTE RIGHT HEMISPHERE STROKE: INVESTIGATING NEURAL AND ACOUSTIC CHARACTERISTICS

Shannon M. Sheppard[1], Gabriel Cler[1], Sona Patel[2], Ji Sook Ahn[2], Lynsey Keator[3], Isidora Diaz-Carr[4], Argye E. Hillis[4-5], Alexandra Zezinka Durfee[6]; [1]University of Washington, Seattle, WA, [2]Seton Hall University, [3]University of Delaware, [4]Johns Hopkins University School of Medicine, [5]Johns Hopkins University, [6]Towson University

Introduction: Right hemisphere (RH) stroke frequently impacts expressive emotional prosody (pitch, rate, loudness, rhythm of speech), resulting in expressive aprosodia. Expressive aprosodia is associated with negative outcomes including reduced social networks (Hewetson et al., 2021), but we still know little about the neural correlates and effective treatments. Expressive aprosodia can arise from impaired motor planning and implementation, or from lack of awareness of the acoustic characteristics that convey specific emotions (e.g., sadness is conveyed with a quiet volume and low pitch). We aimed to 1) identify the specific acoustic features of five emotions (happy, sad, angry, afraid, surprised) that differed between healthy controls and individuals with expressive aprosodia that has not resulted from motor deficits, 2) determine whether aprosodia would improve when providing specific cues (e.g., happy = high pitch, fast rate) for each emotion, and 3) investigate neural correlates. Methods: Patient group: 21 participants with acute RH damage following ischemic stroke and expressive aprosodia were enrolled and tested within five days of hospital admission. Aprosodia diagnosis was confirmed by speech-language pathologists. Control group: 25 healthy age-matched controls. Prosody Testing and Analysis: Speech was recorded while participants completed two tasks: 1) read aloud 20 semantically neutral sentences with a specified emotion (e.g., Happy: “He is going home today.”) without acoustic cues, and 2) read aloud the same sentences with acoustic cues provided (e.g., Happy (Fast Rate, High Pitch). Automated routines in Praat were used to extract acoustic characteristics relevant to each emotion (e.g., fundamental frequency variation, duration) for each sentence. Mixed effects linear models were used to evaluate whether acoustic characteristics of each emotion differed between the control and patient groups, and to determine if cueing improved impaired characteristics of speech. Neuroimaging and Analysis: Acute neuroimaging, including diffusion-weighted Imaging (DWI) was acquired. Areas of ischemia were identified and traced on DWI images using MRICron (Rorden & Brett, 2000).

Lesion volume and proportion of damaged tissue to regions of interest (ROIs) in the JHU atlas were calculated. Mixed effects linear models evaluated whether changes to specific acoustic features were predicted by damage to right hemisphere ROIs. Results: The patient group differed from controls only on emotions with positive valence (happy and surprised). They had significantly lower pitch (surprised: p = 0.009; happy: p < 0.001)

and slower rate (surprised: p = 0.002, happy: p = 0.002). Cueing helped improve speech rate for happy (p = 0.04) and surprised sentences (p < 0.001), and improved pitch in happy (p < 0.001), but not surprised sentences. Lesion mapping analyses revealed damage to the right putamen, external capsule, fronto-occipital fasciculus, and posterior superior temporal gyrus were implicated in expressive aprosodia. Conclusion: Expressive aprosodia primarily impacts the expression of emotions with positive valence, but providing acoustic cues can improve pitch and speech rate. Damage to both right hemisphere cortical and subcortical structures were implicated in expressive aprosodia. These findings have clinical implications for the development of expressive aprosodia treatments, and contribute to neural and cognitive models of prosody expression.

TALK 3: RELATIVE BRAIN AGE AS A BIOMARKER FOR LANGUAGE FUNCTION IN ACUTE APHASIA

Sigfus Kristinsson[1], John Absher[2], Sarah Goncher[2], Roger Newman-Norlund[1], Natalie Hetherington[1], Alex Teghipco[1], Chris Rorden[1], Leonardo Bonilha[1], Julius Fridriksson[1]; [1]University of South Carolina, SC, USA, [2]Prisma Health-Upstate, SC, USA

Introduction Although factors such as lesion location, age, and stroke severity account for variability in language function, long-term prognostication remains problematic in aphasia.1-3 Recently, we found that brain age–a neuroimaging-derived measure of brain atrophy–predicted language function at stroke onset and long-term recovery in a small sample of stroke survivors.4 Here, we examined the extent to which brain age explains variability in language performance in a larger, non-selective sample of acute stroke patients. Methods The current study relies on archival data from 1,794 individuals admitted to the Prisma Health-Upstate facility in Greenville, SC (F/M, 889/901; age, 67.8±15.1y). Participants underwent routine clinical neuroimaging (T1-weighted) and their language performance was assessed by an on-call clinician. After excluding participants with structural brain pathophysiology, MRI data were preprocessed using established procedures and we estimated the brain age of 1,027 participants using the publicly available BrainAgeR analysis pipeline.5,6 To overcome the effects of biased brain age estimates in younger and older individuals, we calculated Relative Brain Age (RBA) as follows6: [RBA = Estimated Brain Age – Expected Brain Age (Estimated Brain Age | Chronological Age)] Estimated Brain Age represents the predicted brain age based on BrainAgeR, whereas Expected Brain Age was calculated by regressing Estimated Brain Age on Chronological Age. Thus, a positive RBA reflects an "older looking brain" and negative RBA a "younger looking brain", given chronological age. Logistic regression models were constructed to examine the association between RBA and presence/absence of aphasia, and regression models to investigate the effect of RBA on the following behavioral outcomes: NIHSS Language (N=478), WAB Auditory Comprehension (N=52), WAB Yes/No Questions (N=87), WAB Naming (N=87), and WAB Repetition (N=290). Models were adjusted for chronological age, lesion size, and affected hemisphere. Results Our primary analyses revealed a significant interaction between RBA and lesion size (β=.001, p<.01) for the prediction of aphasia presence, suggesting that a negative RBA ('younger looking brain') is associated with absence of aphasia in case of relatively small lesions. RBA was not associated with performance on any of the continuous language outcomes. In an effort to scrutinize the relationship between RBA and lesion size, we added a binary term reflecting brain resilience (positive/negative RBA). We observed a significant interaction between brain resilience and lesion size for the NIHSS Language Score (β=.002, p<.05), WAB Yes/No (β=-.002, p<.001), and WAB Naming (β=-.003, p<.01), suggesting that preserved brain resilience is predictive of better language performance in smaller lesions only. We similarly observed a significant interaction between brain resilience and lesion in the right hemisphere for WAB Repetition (β=-.001, p<.05), and brain resilience and lesion in the left hemisphere for WAB Naming (β=-.001, p<.05) and WAB Repetition (β=-.001, p<.001). Discussion Our findings suggest brain age explains variability in language performance not accounted for by lesion characteristics and age. In particular, brain resilience emerged as a prominent predictor of language performance. Although a fine-grained analysis is underway, we are encouraged by the positive findings thus far, and contend that our findings promise to inform prognostication procedures in post-stroke aphasia.

TALK 4: A HIERARCHICAL ENSEMBLE APPROACH TO PREDICTING RESPONSE TO PHONOLOGICAL VERSUS SEMANTIC NAMING INTERVENTION IN APHASIA USING MULTIMODAL DATA

Dirk Den Ouden[1], Alex Teghipco[1], Sigfus Kristinsson[1], Chris Rorden[1], Grant Walker, Julius Fridriksson[1], Leonardo Bonilha[1]; [1]University of South Carolina, [2]University of California, Irvine

Introduction Treatment selection for persons with aphasia (PWA) is aided by improved prediction of treatment response in general, but especially to specific types of intervention. Several studies have attempted to predict response to 'phonological' interventions for lexical production, focused on word-form representations, versus 'semantic' interventions, focused on meaning representations, based on biographical, behavioral or neurological variables in isolation. Here, we tailored treatment-response predictions to individuals by integrating multimodal information while considering multivariate relationships of various complexities. Methods Out of 93 PWA who received both phonological and semantic interventions, 34% exhibited a clinically-meaningful improvement on the Philadelphia Naming Task (>9/175 points), with 9 responding to phonological and 23 to semantic treatment. Response was predicted in a nested leave-one-out cross-validation scheme using a set of 345 baseline biographical, behavioral, and neuroimaging variables. Behavioral variables included latent constructs of impaired domains based on our prior modeling efforts (Walker et al., 2018). Neuroimaging variables spanned measures of lesion load, task-based BOLD-response, cerebral blood flow, fractional anisotropy, medial diffusivity, and functional and structural connectivity. Unilateral variables were expressed in proportion to bilateral counterparts. Given that the factors determining treatment response may differ from those determining response to phonological versus semantic treatment, we adopted a flexible hierarchical modeling approach. We first trained a binary classifier to predict general treatment response. Then, a second

binary classifier was trained on 'responders' to adjudicate between the two interventions. Both classifiers were ensembles of decision trees, boosted using RUSBoost. Model tuning included identification of the most reliably predictive features through stability selection, enhanced by combining multiple complementary algorithms for forming the feature ensemble (Teghipco et al., forthcoming). Results General treatment response was predicted with 77% balanced accuracy and 0.72 AUC ($p<0.0001$). In the correctly predicted responders, a second model achieved 85% balanced accuracy and 0.79 AUC ($p<0.0001$). The combined model had an overall balanced accuracy of 72% and AUC of 0.77 ($p<0.0001$). Different patterns of feature weights drove model performance, and feature importance did not correlate between the two models ($p=0.4$). Nevertheless, some features were influential across both models, highlighting the complex interaction of latent ability estimates and error types, consistency across multiple baseline picture-naming sessions, and whole brain CBF. Non-responders were more strongly predicted by high ventral functional connectivity, inconsistency of picture-naming errors, lesion-load characteristics, low performance on semantic judgment, reduced CBF, and higher stroke severity. Semantic responders were more strongly predicted by high perilesional temporal-lobe BOLD-response, while phonological responders were more strongly predicted by high fractional anisotropy across the brain, but especially in the dorsal stream. No biographical variables were among the top predictors for treatment response. Conclusions The hierarchical multimodal approach we present here applies machine learning to predict whether PWA will respond to impairment-based naming treatment, and whether 'responders' show greater effects of phonologically-focused versus semantically-focused intervention. It yields improved success particularly in the prediction of response to phonological versus semantic intervention. These results can aid in the selection of impairment-based treatment for PWA with naming difficulties.

Slide Session C

Saturday, October 26, 9:30 - 10:30 am, Great Hall 1

Chair: Xin Sun, University of British Columbia

TALK 1: INVESTIGATING THE NEUROBIOLOGY OF HUMAN PROSODY PERCEPTION USING (NEURO)GENOMIC AND CROSS-SPECIES APPROACHES

Srishti Nayak[1], Alyssa Scartozzi[2], Daniel Gustavson[3], Cyrille Magne[4], Nicole Creanza[2], Jennifer Below[1], Reyna Gordon[1]; [1]Vanderbilt University Medical Center, [2]Vanderbilt University, [3]University of Colorado Boulder, [4]Middle Tennessee State University

Exciting advances have been made in the (neuro)genetics of language in the past few years, showing that individual differences in language abilities are substantially driven by genetic factors. This includes genome-wide investigations of word reading, phonemic awareness, nonword repetition, dyslexia, and voice pitch variability amongst others. Currently there is almost a complete lack of behavioral genetics or genomics work on prosody perception, despite its known relevance to reading development, adult literacy, language disorders, and mental health disorders. In fact, prosody is one of the most underrepresented traits in language research more broadly. Prosody is defined as the pattern of stress and intonation in speech and is crucial for both speakers and listeners during human communication. For listeners, speech prosody aids in word boundary identification, the understanding of speaker emotion, distinguishing questions and statements, and parsing syntax. For speakers, speech prosody attracts listener attention to key information for efficient comprehension or conveys intentions (e.g. sarcasm). Individual differences in prosody perception skills are also associated with reading outcomes in both children and adults, and disruptions in prosody are a key feature of certain language and learning disorders (e.g. dyslexia), and mental health conditions (e.g. depression). Understanding the (neuro)genetics and evolutionary history of prosody would allow us to characterize another piece of the puzzle in the neurobiological processes that support human language abilities. Here, we report on the first major effort to investigate the (neuro)genetics of prosody perception. Participants mailed in their saliva for genotyping, and completed a previously validated internet-based prosody test: Test of Prosody via Syllable Emphasis (Nayak et al., 2022; Gustavson et al., 2023). First, we tested associations between prosody perception scores in our sample, and genetic predispositions for word reading (which is known to be behaviorally associated with prosody) in N = 1698. Results showed that individual differences in genetic predispositions for word reading explained significant variability in prosody perception scores ($\beta = 0.109$, p-value = 2.23e-5) controlling for age, sex, and commonly used genetic controls. Next, we conducted the first genome-wide association study (GWAS) of prosody in N = 1501, which revealed that one common genetic variant (SNP) is significantly associated with prosody perception ($p = 8.39e-10$).The SNP occurs in, or genetically upstream of, gene TMEM108, involved in brain and central nervous system development (e.g., neuronal migration; fetal brain development), function (e.g., cellular response to BDNF), and structure (e.g., cerebellum). Last, we investigated the comparative biology of prosody perception in humans and vocal learning in songbirds to explore the evolutionary history of the neurobiology of human prosody abilities. Gene-set enrichment analyses showed that genes expressed in songbird brain Area X (a key song learning brain area homologous to human basal ganglia) were overrepresented in human prosody-related genes ($p < 7.14e-3$). This work highlights a significant step forward in our understanding of the (neuro)genetics of prosody perception traits, which adds to complementary literature from EEG and fMRI studies which have previously revealed details about neural mechanisms of prosody perception states.

TALK 2: A SPEECH NEUROPROSTHESIS THAT CAPTURES PHONEMIC AND PARALINGUISTIC ELEMENTS OF ATTEMPTED SPEECH

Sergey Stavisky[1], Nicholas Card[1], Maitreyee Wairagkar[1], Xianda Hou[1], Aparna Srinivasan[1], Tyler Singer-Clark[1], Carrina Iacobacci[1], Leigh Hochberg[2], David Brandman[1]; [1]University of

California, Davis, [2]Brown University, VA Providence Healthcare, Massachusetts General Hospital

It has historically been rare to study the neurobiology of speech and language at the level of the population activity of individual neurons due to the invasive nature of collecting such measurements. However, ongoing early feasibility studies of speech restoration neuroprostheses represent opportunities to study the cortical basis of speech and language while restoring rapid, accurate, and naturalistic communication to people with paralysis. As part of the BrainGate2 clinical trial (ClinicalTrials.gov identifier: NCT00912041), we enrolled a participant, 'T15', who is a left-handed man in his 40s living with severe dysarthria due to ALS. We chronically placed 64-microelectrode Utah arrays into his left precentral gyrus, with two arrays nominally in ventral premotor cortex (area 6v), one array in primary motor cortex (area 4), and one array in middle precentral gyrus (area 55b). We found that these cortical areas all encoded attempted speech, with the strongest tuning in ventral-most premotor and middle precentral gyrus. We could train machine learning algorithms to decode what words he attempted to say with 97.5% accuracy using a 125,000-word vocabulary ("Brain-to-Text"), with high communication restoration performance persisting for over 300 days as of the time of this abstract submission. The participant has used the neuroprosthesis in his own home to converse with his family and friends, write emails and messages, and video call with colleagues for over 500 cumulative hours, up to 14 hours a day. Device connection and initiation can be performed independently by his care partners. We also were able to synthesize a digital voice instantaneously and directly from neural activity ("Brain-to-Voice"), and to detect paralinguistic features such as added stress of specific words in a sentence, changing a statement into a question, or attempting to speak at different volumes. Examining the neural ensemble dynamics during this attempted speech, we observed that the dynamics strongly reflected the phoneme being produced at each given moment, but that there was also preparatory activity that preceded voice onset which carried both phonemic and paralinguistic information. Lastly, we detected potentially higher-level language-related activity in the form of error signals that occurred after the neuroprosthesis displayed the wrong word. Not only could we decode whether or not the wrong word appeared from this error-related neural modulation, but we could also detect whether the incorrect output was a pseudoword, homophone, one-phoneme different word, or synonym. Altogether, these results indicate that speech neuroprosthesis clinical trials represent a unique and useful opportunity to study the neural basis of speaking – and perhaps even of language – at the resolution of action potentials.

TALK 3: NEURAL CORRELATES OF SPEECH SEGMENTATION IN TYPICAL ADULTS

Panagiotis Boutris[1], Alissa Ferry[2], Perrine Brusini[1]; [1]University of Liverpool, [2]University of Manchester

Words are the building blocks of language, but are not obvious in the speech stream. When learning to segment speech, one needs to integrate both transitional probabilities (TPs; Saffran et al., 1996) and prosodic markers, such as stress (Nazzi et al., 2006). Recent research has explored how these two cues are integrated (Cunillera et al. 2006; 2008). Yet it remains unclear how they are tracked and weighted by the speech-processing system. Here, we aim to capitalize on the brain's ability to synchronize with different speech units (Giraud and Poeppel, 2012; Buiatti et al. 2009) and investigate the neural correlates of TP, stress and their combination. Twenty young adults were presented with artificial language streams, comprised of 6 trisyllabic words, whilst their brain activity was recorded by a high-density EEG net. Six conditions were created: a TP-only stream, following the model of Saffran et al; a stress-only, where all words were concatenated in the same order (TP=1) and stress was placed on the first syllable; two mixed-cue streams where TPs were combined with stress either on the first syllable (a coherent cue for English speakers) or on the last syllable (an incongruent case in English); a random syllable, and a random stress stream, where TP is uninformative (TP=0.2-0.5) and stress is randomly assigned to one of the 3 syllables respectively. Time-frequency analysis was used to extract power and phase at the frequencies of word and syllable onset. At the end of each stream presentation, behavioural responses where collected using a forced-choice task, opposing stream-words, and part-words made from the last syllable of the stream-word and the two first syllables of another. All test stimuli were played without any stress. It is worth noting here that, in the incongruent condition, if English adults rely more on stress than TPs, participants should systematically choose the part-word, as this structure corresponds to the trochaic pattern. In the frequency domain, the power should inform us whether the brain can follow the frequency of occurrence of each unit (word and/or syllable), while the phase should allow us to see if the onset of the units detected by the brain align with the onset of the units in each condition. Behavioural results showed better segmentation and recall for the TP-with-stress-on-1st-syllabe condition, followed by stress-only. TP-only and TP-with-stress-on-3rd-syllable remained at chance. However, power showed a clear online tracking of word onset for all the cues, which did not seem to follow the pattern of our behavioural results. A subsequent look at phase, however, revealed a more nuanced difference between cues: the conditions of TP-with-stress-on-1st-syllable and Stress-only had a much closer-to-zero-degrees phase as compared to TP-only, following, thus, more reliably the behavioural data. In addition, although power at word-onset frequency was significant for the TP-with-stress-on-3rd-syllabe, participants were consistently out of phase, in line with our behavioural results. We conclude that, although power is an important indicator of cortical tracking of word-onset, phase might be a more reliable measurement of more precise and, possibly, altogether better segmentation.

TALK 4: THE NEURAL BASIS OF DECLINE IN WRITTEN PRODUCTION: EVIDENCE FROM CHINESE HANDWRITING

Xufeng Duan[1], Yang Yang[2], Junjun Li[2], Shuyi Wu[1], Zhenguang Cai[1,3]; [1]The Chinese university of Hongkong, [2]Institute of Psychology of the Chinese Academy of Sciences, [3]Brain and Mind Institute, The Chinese university of Hongkong

Background: People sometimes forget how to spell a word (though still being able to recognize it) as a result of attrition in

the orthographic production processes. This phenomenon, known as character amnesia, is particularly common in opaque writing systems such as Chinese, where most characters do not have reliable phonology-to-orthography conversion. However, little is known about the underlying neural time-course of character amnesia and the neural substrates underlying the orthographic attribution. Our study aims to address these issues using EEG and fMRI. Methods: We conducted an EEG experiment to unravel the physiological time course of character amnesia and an fMRI experiment using the same group of participants (30 Chinese-speaking participants, 15 females, 20–24 years) to ensure the consistency of our findings across different neuroimaging modalities. We selected, from two handwriting databases, 360 Chinese characters (120 for fMRI; 240 for EEG), which were shown to be susceptible to character amnesia (amnesia rate mean = 20.9%). Both experiments made use of a writing-to-dictation task, where participants handwrote on a tablet a character according to a dictation prompt (e.g., 雪糕的雪, meaning the character 雪in the word 雪糕) while lying inside the scanner and being able to see their handwriting on a screen. The EEG experiment had a similar task procedure except that participants were instructed to write Chinese characters after a two-second delay following the dictation prompt (to reduce hand movement artefacts). In both experiments, we had two handwriting-outcome-dependent conditions: successful handwriting (i.e., when participants correctly wrote down a character) and character amnesia (i.e., when participants failed to handwrite a character). Results: For the EEG Experiment, time-frequency analyses revealed two distinct cognitive stages in character amnesia compared to successful handwriting. There was a significant increase in total power within the theta and alpha bands (4 -12 Hz) around 400 - 500 ms after handwriting onset, reflecting the difficulty in orthographic retrieval in character amnesia compared to successful handwriting. This was followed by an increase in theta band (4 - 8 Hz) 1000 -1650 ms after handwriting onset, which we argue reflects the continued attempt of orthographic retrieval in the amnesia state. In the fMRI experiment, comparing character amnesia with successful handwriting revealed stronger activations in the left inferior frontal gyrus (IFG; indicating difficulty in orthographic retrieval), left supplementary motor area (SMA; related to motor planning), left superior temporal gyrus (STG; associated with phonological processing), and bilateral cuneus regions (involved in visual processing). We also used the brain clusters activated during the character amnesia condition as ROIs for network connectivity analyses. There was stronger connectivity within language production networks (e.g., the left IFG and bilateral SMA, STG, precentral gyrus, postcentral gyri, and putamen) in character amnesia compared to successful handwriting. Furthermore, there was stronger connectivity between the STG and fusiform gyrus in successful handwriting compared to character amnesia, highlighting its role in retrieving orthographic information. Our study was the first to address the “when” and the “where” questions regarding the neural processes underlying orthographic attrition in handwriting.

Poster Schedule

The first author *must* be present during the entire poster session. If the first author is unable to present, the abstract must be withdrawn or permission must be granted for another author to present.

You may post your materials on the board assigned to you at any time after the "Set-up Begins" time, but all posters must be up before the beginning of the assigned poster session. You must remove your poster promptly–no later than the "Take-down Complete" time. Any posters left up after the "Take-down Complete" time may be discarded.

Session	Date	Location	Setup Begins	Session Hours	Teardown Ends
Poster Session A - *Sandbox Series*	Thursday, October 24	Great Hall 4	9:00 am	10:00 - 11:30 am	7:30 pm
Poster Session B	Friday, October 25	Great Hall 4	8:00 am	10:00 - 11:30 am	1:00 pm
Poster Session C	Friday, October 25	Great Hall 4	1:00 pm	4:30 - 6:00 pm	6:15 pm
Poster Session D	Saturday, October 26	Great Hall 4	8:00 am	10:30 am - 12:00 pm	12:30 pm

Pushpins will be available. Tape, glue and other adhesives are not to be used on the poster boards. Poster boards will be numbered by SNL. No electricity is available onsite.

Poster Session A

Thursday, October 24, 10:00 - 11:30 am, Great Hall 4

A1 *Sandbox Series* - Classifying brain activity during semantic integration of sentences: An ERP study

Toru Egashira[1], Shinri Ohta[1]; [1]Kyushu university

Keywords: ERPs, RNNs, semantic integration, logistic regression analysis This study aims to create a model that uses ERPs to determine how a given text is being interpreted by the listener/reader. For example, a sentence such as "The man saw the boy with the binoculars." is open to multiple interpretations, and the listener/reader can integrate either interpretation when reading it. We made three types of sentences as stimuli, two of which are unambiguous, and we measured brain waves while reading each interpretation of the sentence. We will analyze those data in two ways to create a model that discriminates which interpretation of a sentence is being read by performing a two-class classification. Previous studies have attempted to determine the part of speech of words pronounced in the head, but few have classified sentences in terms of syntax and meaning (Sahil & Nikolaos, 2021). The following three types of sentences written in Japanese were used as stimuli: structurally ambiguous sentences (e.g., apaato-ni sumu kareshi-no oneesan-wa oshitoyakada, a sister of my boyfriend who lives in an apartment is modest; in Japanese, it cannot be distinguished syntactically who lives in an apartment), high attachment sentences (e.g., joshiryo-ni sumu kareshi-no oneesan-wa oshitoyakada, a sister of my boyfriend who lives in a girls' dormitory is modest), and low attachment sentences (e.g., danshiryo-ni sumu kareshi-no oneesan-wa oshitoyakada, a sister of my boyfriend who lives in a boys' dormitory is modest) (40 sentences/term). For ambiguous sentences, the relative clause can modify both nouns (kareshi or oneesan), while in low-attachment and high-attachment sentences, the first and second nouns are modified, respectively. After the sentence presentation, participants answered a sentence comprehension question by pressing buttons to test the participants' interpretation. For the data analysis, we will employ the widely used logistic regression analysis and recurrent neural networks (RNNs) to examine the classification accuracy of sentence comprehension of structurally ambiguous sentences based on the event-related potentials (ERPs). We recruited 13 healthy, right-handed native Japanese speakers (3 females). ERPs were acquired using 32 Ag/AgCl electrodes (actiCAP, Brain Products; Neurofax EEG-1200, Nihon Kohden), and EEG data were analyzed using EEGLAB. P3 and P4 were selected as electrodes of interest. We have already recorded the ERP data, and we will analyze that data as follows. We plan to use the following basic structure, but the details of the hyperparameters will be optimized through future adjustments. The LSTM layer, a key component of our model, will consist of 1 to 3 layers. The number of units in each LSTM layer will range from 50 to 128, and a dropout rate will be implemented to prevent over-learning (e.g., 0.2, 0.5). The dense layer will be added to all coupling layers after LSTM (e.g., 64, 128 units), and we will adopt ReLU (LSTM and Dense layer). We will use grid search or random search to find the optimal hyperparameters, then train the final model based on the optimal hyperparameter settings obtained and analyze the accuracy and other evaluation metrics.

A2 *Sandbox Series* - How Language Shapes Emotion: An fMRI study of Emotion Verbalization in First and Second Languages

Yuto Aki[1], Takumi Uchihara[1], Motoaki Sugiura[2], Hyeonjeong Jeong[1]; [1]Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan, [2]Institute of Development, Aging and Cancer, Tohoku University, Sendai, Japan

[Introduction] Human language goes beyond communication. It has the power to shape and rewire the emotional systems in our minds. The psychological constructionist view of emotion (Barrett, 2017) claims that language actively shapes our emotions by conceptually categorizing sensations of “core affect”, experienced in terms of valence and arousal. Empirical research (Nook et al., 2021; Ortner, 2015) has indeed demonstrated that verbalizing emotions in one’s native language (L1) changes its representation, leading to heightened difficulty in regulation as well increased subjective emotional intensity. However, it remains unknown whether and how similar changes occur when using a late-learned second language (L2) especially from a neural mechanism perspective. Our present fMRI study is the first to explore how verbalizing emotions in the L1 and L2 alters neural emotion representation and subjective emotional intensity. Furthermore, we explore how L2 oral proficiency and daily use contribute to these changes in L2. [Participants] 40 healthy right-handed Japanese L1 speakers will participate, all with intermediate to high proficiency in their L2 English. They will complete a language use questionnaire and an English speaking task. [Stimuli] 120 affective images taken from the Nencki Affective Picture System (NAPS). [Experimental design and procedure] The fMRI experiment consists of two main tasks: an Emotion Naming task and an Object Naming task, performed in either L1 Japanese or L2 English. Both tasks are always performed immediately after the Look task, where participants view affect-evoking images (without verbal activity) and assess their emotional intensity on a scale of -5 (extremely negative) to 5 (extremely positive). In the Emotion Naming task, they see the same images and verbalize their dominant emotion in either L1 or L2 before rating their emotion. In the Object Naming task, the same procedure follows except that participants name an object in the image instead of their emotions. This controls for the effect of word retrieval on emotion representation and the difficulty of word retrieval between L1 and L2. All emotional images are counterbalanced across tasks and languages, ensuring similar valence and arousal levels. [Data Analysis] In the behavioral data analysis, we examine changes in emotion ratings between conditions: [Emotion Naming–Look] and [Object Naming–Look] rating changes between L1 and L2 conditions. In the brain data, we compare brain activity before and after emotion naming and object naming in L1 and L2. In addition, within the L2 condition, we explore correlations between the amount of language use and oral linguistic proficiency with emotion naming effects on ratings and neural activity. [Expected Results] We expect that [Emotion Naming–Look] changes will be larger in the L1 than in the L2 condition. We also crucially predict that Emotion Naming brain activity in L1 will reveal a distinct pattern of neural representation that subserves linguistic emotion compared to the L2. Finally, within the L2 condition, the amount of language use will be more sensitive to emotional ratings in L2 and its neural activation patterns.

A3 *Sandbox Series* - Influence of Unimodal and Association Networks on Language Network Functional Connectivity and Behavior in Aphasia

Mohammad H. Aldabbagh[1], Isaac Falconer[2], Maria Varkanitsa[1], Swathi Kiran[1,3]; [1]Center for Brain Recovery, Boston University, Boston, MA, USA, [2]Chobanian & Avedisian School of Medicine, Boston University, Boston, MA, USA, [3]Department of Speech, Language, and Hearing Sciences, Sargent College of Health and Rehabilitation Sciences, Boston University, Boston, MA, USA

Introduction: Recent studies have suggested that the macro-scale functional connectivity (FC) of the human cerebral cortex is hierarchically organized along a gradient that is anchored at one end by the higher-order (heteromodal) default-mode network (DMN) and at another by lower-order (unimodal) primary sensory areas (Margulies et al., 2016). The language network (LN) is adjacent to two primary areas, namely the tongue motor and auditory regions, and overlaps with the DMN, frontoparietal control (FPN), and salience networks (Braga et al., 2020). Therefore, this makes the LN situated in the middle of this cortical gradient relative to other networks. This research aims to investigate how the FC of unimodal and association networks surrounding the LN in people with aphasia (PWA) influence the FC of the LN, and how are these effects reflected behaviorally. We hypothesize that a lower FC of the LN will be associated with an overall lower FC of its surrounding networks and higher aphasia severity since FC predicts language deficits (Siegel et al., 2016). However, the FC influences of unimodal compared to heteromodal regions on the LN will not be equal since they are not traditionally known to share similar patterns of FC. Methods: 40 PWA with left hemisphere lesions and 42 controls were administered structural scans, resting-state functional magnetic resonance imaging (rs-fMRI) scans, and language localizer tasks that contrast reading intelligible sentences versus a list of nonwords. Individualized LNs are defined by FC overlapping with regions activated during the task. Additionally, PWA were administered an aphasia severity behavioral measure (WAB-R). Analysis concerning our research question will be conducted and planned as follows. All FC values will use our rs-fMRI data, preprocessed using CONN pipelines, analyzed using seed-based connectivity approaches from CONN, and projected onto the cortical parcellations from Schaefer et al. (2018). The FC of the LN will be measured using our individualized LN regions of interest (ROIs) defined by the language localizer task. To get all other networks’ FC values, seed vertices will be placed at canonical regions resembling the unimodal and association networks: auditory network (primary auditory cortex), DMN (left lateral prefrontal cortex), FPN (frontal eye fields), etc. For our statistical analysis, we will run mixed effects models. Our models will test the within-network FC of each unimodal and heteromodal network against the within-network FC of the LN. The FC of each unimodal and association network will make our independent variables. The FC of the LN will be our dependent variable, and aphasia severity (WAB-AQ) will be a covariate in our models. These models will help us understand the FC influences of unimodal and association networks on the FC of the LN in PWA. Anticipated Results: We anticipate that weak FC of tongue motor and auditory regions will be associated with FC in the LN and low WAB-AQ scores (high aphasia severity). Summary: Understanding these results will give us an understanding of how the FC of the LN in PWA is influenced by the FC of the unimodal and association networks along the macro-scale cortical organization.

A4 *Sandbox Series* - A large and scalable semantic brain decoding framework as a precursor for artificial speech restoration in aphasia?

Andrew Anderson[1], Bill Gross, Leo Fernandino, Jeffrey Binder, Hernan Rey; [1]Medical College of Wisconsin

Aphasia is stroke-related language disorder that impacts approximately 1/250 people from 20 y/o+. In cases of severe stroke damage to middle cerebral artery territory, individuals remain intellectually intact, can understand language and even mentalize the meaning of things they'd like to say, but they cannot verbalize this as spoken, written or typed words. This is socially devastating, and because the prospects of verbal recovery are often limited, new interventions are needed. Fueled by advances in deep-learning, one possibility might be to develop Brain Computer Interfaces (BCI) to synthesize words by decoding meaning from undamaged brain regions during (attempted) language production. Indeed, following training on many hours of data recent BCIs that decode the semantics of inner speech from fMRI scans healthy adults now make this prospect seem approachable. However, for the grand goal of restoring conversational speech production in aphasia, fMRI cannot be a complete solution because fMRI is not portable and hemodynamic fMRI responses are delayed ~4s post neural firing. Invasive electrophysiological brain implants could potentially resolve both issues and would provide a way to accumulate the "personalized big brain data" that is probably essential to train decoding models. However, there is currently little hard evidence that practically effective semantic decoders can be built with current invasive technologies that unlike fMRI typically sample from small cortical regions. This leaves little to warrant the health risks associated with trialing semantic decoding implants in aphasia. With the overarching goal of discovering whether accurate semantic decoding from invasive electrodes is a possibility, we assert that: (1) Contemporary Encoder-Decoder artificial neural network models may already provide the requisite framework to accurately decode continuous electrophysiological brain recordings to words – if only there were the data to train them. (2) Data is key. Compiling a large, annotated dataset of high-quality signal recordings of brains in conversation with broad cortical coverage may be essential for training an accurate decoding model. (3) Pre-surgical evaluation for epilepsy could prove invaluable for accumulating such a big dataset. Here stereotactic electroencephalograms (sEEG) are recorded continuously for week-long periods, during which time bed-bound patients engage in many face-to-face conversations. We present the early steps of an effort to produce a standardized framework for acquiring and annotating and open-sourcing large scale conversational sEEG data. We consider challenges surrounding: (1) Speech recognition and speaker diarization, and the application of opensource models to transcribe audio data recorded in an sEEG hospital environment. (2) De-identifying people in conversational audio data. (3) Overcoming sparse individual sEEG electrode coverage (where 100 or so depth electrodes are positioned to spot the focus of epileptic seizures, often in semantic zones). (4) Developing a cross-participant decoding model, potentially as a centralized open access resource, for scalable update with cross-site data.

A5 *Sandbox Series* - Distributional analysis differentiates cognitive control processes supporting lexical retrieval: an intracranial electroencephalography study

Katherine Andrade[1], Elizabeth Anderson[1], Charles Dickey[2,3], Sophie Kajfez[4], Burke Rosen[2], Carrie R. McDonald[5], David Lee[5], Leena Kansal[5], June Yoshii-Contreras[5], Jerry J. Shih[5], Sharona Ben-Haim[5], Eric Halgren[5], Stephanie K. Riès[4,6]; [1]Joint Doctoral Program in Language and Communicative Disorders, San Diego State University/University of California San Diego, San Diego, CA, USA, [2]Neurosciences Graduate Program, University of California San Diego, La Jolla, CA, USA, [3]Medical Scientist Training Program, University of California San Diego, La Jolla, CA, USA, [4]School of Speech, Language, and Hearing Sciences, San Diego State University, San Diego, CA, USA, [5]University of California San Diego, La Jolla, CA, USA, [6]Center for Clinical and Cognitive Neuroscience, San Diego State University, San Diego, CA, USA

The ability to anticipate and resolve conflict are key subprocesses of cognitive control that enable speakers to communicate efficiently. Prior work investigating the temporal dynamics of cognitive control create a distinction between two operating processes: proactive and reactive control. Proactive control is initiated prior to the occurrence of conflict, while reactive control is recruited after conflict is detected. Despite the significance of this processes, the neurobiological mechanisms contributing to cognitive control in language production are unclear. In this study distributional analysis of reaction times were implemented to investigate when conflict between competing linguistic representations is resolved within the language system and to determine which general cognitive control skills are employed in resolving conflict. Stereotactic electroencephalography (SEEG) was acquired from thirteen patients (7M; mean age = 29.5 yrs; SD= 8.1yrs) undergoing clinical monitoring for intractable epilepsy; eight individuals (5M; mean age = 29.4yrs; SD=7.9yrs) had sufficiently available intracranial data to be included in the electrophysiological analysis. In a picture-word interference task, participants named pictures superimposed with to-be-ignored distractor words that are either semantically-related (R), semantically-unrelated (UR), or identical (ID) to the picture name. There was a main effect of condition on reaction time ($X^2(2,7) = 36.18$, $p < .001$). Response times were found to be significantly longer for related compared to unrelated conditions ($\beta\_raw = 5.932x10^{-05}$, $t=5.91$, $p<0.01$) and fastest for identity compared to unrelated conditions ($\beta\_raw = 8.476x10^{-05}$, $t=4.08$, $p=.002$). Distributional analysis of reaction times revealed a significant interaction effect between conditions and quantiles ($X^2(1,18) = 66.54$, $p<.001$). A significant interference effect (RvsUR) emerged from the 6th to the 10th quantiles ($\beta\_raws > -36.77$, $ps<.04$). A significant facilitation effect (IDvsUR) emerged earlier at the 5th quantile onward ($\beta\_raws > -35.11$, $ps<.05$). SEEG results reveal a main effect of condition ($X^2(1,1) = 4.24$, $p < .05$), electrode location ($X^2(1,24) = 60.71$, $p < .001$), and window ($X^2(1,4) = 22.27$, $p < .001$). The UR condition elicited significantly greater activity than the related condition in three brain regions: the caudal anterior cingulate cortex, insula, and superior frontal gyrus. This effect occurred in the 550 - 750 ms post-stimulus time-window in the dorsal anterior cingulate cortex (dACC; $\beta\_raw = -144251.4$

, SE = 68698.9, t = -2.10, p = .036), in the 800 - 1000 ms post-stimulus time-window in the insula, and in the superior frontal gyrus (SFG). Additional participants are needed to interpret the interplay between facilitation and interference effects on cognitive control processes across brain regions. However, these preliminary behavioral results suggest that reactive control was initiated after conflict was detected to resolve interference as seen in slower responses.

A6 *Sandbox Series* - Prosody production after stroke: acoustic features analysis on a longitudinal speech corpus

Giada Antonicelli[1,2], Karen Arellano[1,2], Monike Egia[2], Simona Mancini[1,3]; [1]Basque Center on Cognition Brain and Language, [2]University of the Basque Country, [3]Ikerbasque, Basque Foundation for Science

Prosody is the complex of acoustic phenomena in speech. Neurotypical speakers can effectively use it to convey and interpret both linguistic and emotional meanings. Pathological populations, however, often experience a disruption in prosody processing. Studies analyzing speech production observed reduced pitch and envelope variability following brain damage but it remains unclear whether lesions to either hemisphere can differentially affect expressive prosody. In this ongoing study, we examine spontaneous speech recorded from stroke survivors and healthy individuals. We ask (1) which acoustic features best discriminate among groups; (2) what is the effect of lesion and lesion lateralization on prosody; and (3) whether stroke survivors show recovery over time. We analyzed recordings from 3 groups of participants, one with right-hemisphere damage (RHD, N=38; 16 F; Mage = 66.7; SD = 10.6; range = 42-85), one with left-hemisphere damage (LHD, N=48; 18 F; Mage = 68; SD = 10.9; range: 44-89), and a control group with no brain damage, matched in age, sex and education with the two clinical groups (N=15; 4 F; Mage = 59.1; SD = 8.1; range: 39-71). Twenty-four stroke survivors (13 RHD and 11 LHD) were followed up longitudinally at four different time points (TPs): 1) in the acute phase (~1 week post-stroke); 2) in the early subacute phase (3-4 weeks post-stroke); 3) in the later subacute phase (3 months post-stroke), and 4) in the chronic phase (3-6 months after stroke). To allow for a direct comparison, the control group was also tested at four time points following the same timeline as the clinical groups. After preprocessing the audios, we extracted mean pitch (Hz), pitch slope (Hz/s), pitch standard deviation, mean envelope, and envelope standard deviation. We used Kruskal-Wallis and Wilkoxon tests for cross-sectional analyses at TP1 and aligned rank transform models for longitudinal analyses. At TP1, we found an effect of group. Pitch-related measures were higher in the control group relative to both LHD and RHD but no differences between the two clinical groups were found. No statistically significant effect of group was found in envelope-related parameters. Similarly, longitudinal analyses revealed an effect of group for pitch- but not for envelope-related parameters. Finally, no effect of timepoint emerged, although LHD and RHD displayed a positive trend in all features except for mean envelope. These results suggest that clinical and control groups can be effectively teased apart based on speech acoustics such as pitch-related parameters. Acoustic features extraction has therefore the potential to detect prosodic deficits in non-neurotypical populations. However, a larger data set that includes speakers with more severe language and prosodic impairment is necessary to increase its diagnostic power, and to detect potential differences between RHD and LHD speakers, both in the acute and in subsequent stages of post-stroke recovery. Data collection is currently ongoing. We conclude that acoustic analysis of speech can be a quick, sensitive, and objective way to screen prosody after stroke.

A7 *Sandbox Series* - Using intracranial EEG to study the effect of prosody on attention and linguistic encoding during naturalistic listening.

Eleonora Beier[1], Laura Gwilliams[2]; [1]University of California, Davis, [2]Stanford University

One of the primary goals of language is to exchange information. The amount of information varies over the course of an utterance – some moments are very informative, while others are less informative. Prosody is an important cue to informativity: words carrying novel, essential information are focused through greater prosodic prominence (e.g., higher vowel intensity and duration) and through pitch accents. Previous studies suggest that listeners track prosodic structure over time, pre-allocating attention and processing resources to the predicted timing of focused information. However, most previous literature has employed constrained psycholinguistic paradigms. It is unclear to what extent listeners track prosodic features to predict the timing of upcoming focused words during naturalistic listening, and the underlying neurocognitive mechanisms are not well understood. In this ongoing study, we overcome these limitations through the analysis of a rich intracranial EEG (iEEG) dataset from neurosurgical patients listening to naturalistic stories. Patients listen to 12 snippets of audiobooks, for a total duration of ~1 hour, while iEEG is collected via depth electrodes. We annotate the speech samples for a variety of linguistic features, including the timing of pitch accents indicating prosodic focus, and continuous measures of prosodic prominence (e.g., intensity). We train a classifier to decode the presence or absence of a pitch accent based on the continuous prosodic features of the preceding speech; based on the results of the classifier, we identify pitch accents whose presence and timing was highly predictable from preceding prosody (resulting in high decodability) from those that were not predictable (resulting in low decodability). We then compare neural activity over a time window leading up to predictable vs unpredictable pitch accents. First, we expect to find greater attention pre-allocation leading up to predictable, compared to unpredictable pitch accents, measured through modulations in the power of alpha oscillations. Second, we test whether this greater attention results in deeper encoding of linguistic features. Neural representations of linguistic units (e.g., phonemes, syntactic category) can be decoded from high-gamma (70-150 Hz) neural activity. We hypothesize that linguistic units at different levels of processing are more decodable for words focused through pitch accents, and even more so for pitch accents predictable from the preceding prosodic context. Overall, this study takes a novel approach to the study of prosodic focus, addressing the neural mechanisms by which listeners prepare to process more

informative moments during naturalistic language comprehension.

A8 *Sandbox Series* - Linguistic and non-linguistic time comprehension after stroke

Nicoletta Biondo[1,2], Eleonora Ghiraldini[3], Vera J. Wheatley[2], Alexis L. Pracar[2], Maria V. Ivanova[2], Simona Mancini[1], Nina F. Dronkers[2,4]; [1]BCBL, Spain, [2]UC Berkeley, USA, [3]Florida State University, USA, [4]UC Davis, USA

People with aphasia often produce incorrectly tensed verbs, and their time comprehension abilities, albeit less investigated, can also be impaired (Clahsen & Ali, 2009; Faroqi-Shah & Dickey, 2009; Jonkers & de Bruin, 2009; Fyndanis et al., 2013). Interestingly, the source of time impairment seems to be related to time reference and the ability to access discourse (Bastiaanse et al., 2011; Bos et al., 2014), rather than morphological complexity (Faroqi-Shah & Thompson, 2007). Discourse operates by rules that go beyond the level of the sentence (Avrutin, 2006; Druks, 2017). Therefore, an open question is whether this time impairment is purely linguistic or more domain-general. In this project, we are carrying out a systematic investigation of time processing in post-stroke survivors by addressing two questions: (i) which aspects of time comprehension are impaired? (ii) Is this impairment purely linguistic? The project currently involves English speakers with left hemisphere lesions, ≥ 6 months post-stroke, and adequate hearing/vision/motor skills to complete the tasks, as well as controls. To address (i), we designed two tasks to test Event Location (e.g., “The boy peeled the banana”, task: select one of the three dots representing past/present/future on a timeline) and Temporal Concord (e.g., “Tomorrow the boy peeled the banana”, task: acceptability judgment with two buttons: good or bad) in the same pool of participants. To address (ii), we designed a non-linguistic version of the Event Location task, where the events were represented through colored line drawings rather than sentences. Preliminary results (N = 13 stroke survivors; N = 34 controls) of logit mixed-effect model analyses showed that: (i) Both Event Location and Temporal Concord abilities are significantly impaired in stroke survivors compared to controls (Event Location: $z=-4.44$, $p<.0001$; Temporal Concord: $z=-4.16$, $p<.0001$). Interestingly, locating events in the past is harder than locating events in the present ($z=-4.1$, $p<.0001$), while locating events in the future is only numerically but not significantly harder than locating events in the present ($z=-1.79$, $p=.07$), both for stroke survivors and controls. Conversely, judging the temporal concord between a verb and a preceding mis/matching adverb did not significantly change as a function of the past/future tense of the verb ($z=-0.76$, $p=.45$). These results are currently consistent with accounts suggesting that past is more difficult to process compared to present and future (Past Discourse Linking Hypothesis, Bastiaanse et al., 2013). (ii) Compared to the control group, stroke survivors struggle in locating events on a timeline, even when temporal information is conveyed non-linguistically ($z=-2.18$, $p<.05$). Moreover, locating an event outside of the present, either in the past ($z=-3.59$, $p<.001$) or in the future ($z=-2.30$, $p<.05$) is more difficult in the non-linguistic task, for both groups. These preliminary findings suggest that the time impairment may not be solely language-specific. The recruitment of Spanish stroke survivors in the second phase of the project will help us tease apart whether the past-future dissociation found in the linguistic and non-linguistic data is due to linguistic strategies related to the different realization of past/future verb morphology in English.

A9 *Sandbox Series* - Neural correlates of speech segmentation in atypical-language adults

Panagiotis Boutris[1], Alissa Ferry[2], Perrine Brusini[1]; [1]University of Liverpool, [2]University of Manchester

Speech is processed sequentially and in chunks, i.e. words. Before language learners start acquiring other linguistic aspects (e.g. syntax, see Brusini et al. 2021), they must discover the words. Newborns can start immediately segmenting the speech they hear (Ferry et al., 2016; Fló et al., 2019), utilising a variety of cues. However, it is not clear what drives individual differences in speech-processing and, subsequently, language acquisition, in cases where language is impaired (e.g. dyslexia, SLI/DLD, ASD etc.). There is evidence of “poor segmenters” in dyslexics (Leong & Goswami, 2014), with SLI/DLD (Mainela-Arnold et al. 2014; Marshall, 2009; Obeid et al., 2016) or with ASD (Paul et al, 2005), linked to inability to process cues, such as stress and transisional probabilities (TPs). Although a temporal-sampling issue has been proposed as the underlying factor of poor segmentational skills for dyslexia (see Goswami, 2011), our understanding of the neural and perceptual mechanisms that “fault” in language impairments is still very incomplete. Here, we propose an investigation of the ability of atypical-language adults to use TPs and stress, and their combination, to segment artificial speech. We invited young adults diagnosed with either dyslexia, SLI/DLD and/or ASD to take part in a passive-listening word-learning task while we recorded their EEG. Note that data collection is still ongoing. The stimuli comprised of artificial streams of 6 trisyllabic words. The conditions were: 1) a TP-only stream (Saffran et al); 2) a stress-only, where words were in fixed order (TP=1) and stress was placed on the first syllable; 3) two mixed-cue streams with TPs and stress either on the first syllable or 4) on the last syllable; 5) a random-syllable, and 6) a random-stress stream, where TP was low (TP=0.2-0.5) and stress was randomly assigned to one of the 3 syllables respectively. After listening to each stream, participants performed in a forced-choice task, where they chose between an unstressed stream-word, and an unstressed part-word constructed from the last syllable of a stream-word and the two first syllables of another. To more fully understand any shortcomings of speech tracking, we opted in extracting both power and phase at the frequencies of word- and syllable-onset. Power can inform us whether the brain can follow the frequency of occurrence of each unit (word/syllable); however, we hypothesise that phase might capture more subtle differences of brain alignment to the onset of the units of speech in each condition. Our preliminary results suggest a difficulty in processing mixed cue information; behavioural results revealed a trend towards better performance in the Stress-only condition. Power seems to show word-onset tracking for all cue conditions; in contrast, phase seems to be more precise in the Stress-only and TP-only conditions, suggesting an inability to integrate both

cues to extract word-boundary information. As our preliminary results suggest, phase might be a better link between poor language performance and the underlying inability of cue integration; furthermore, language impairement is possibly guided by a more fractured speech-processing, where a variety of cues cannot be used all at once.

A10 *Sandbox Series* - Neural Mapping of Language Knowledge Representations in Phrases

Feizhen Cao[1,2], Nan Li[1,3], Wenjia Zhang[4], Suiping Wang[1,2]; [1]Philosophy and Social Science Laboratory of Reading and Development in Children and Adolescents (South China Normal University), Ministry of Education, Guangzhou, China, [2]School of Psychology, South China Normal University, Guangzhou, Guangdong, China, [3]School of Foreign Studies, South China Normal University, Guangzhou, China, [4]Key Laboratory for Artificial Intelligence and Cognitive Neuroscience of Language, Xi’an International Studies University, Xi’an, China

The core of the human language function architecture involves knowledge representations, including comprehension of individual words/constructions/expressions and the combinatorial processes for forming compound words, phrases, and sentences. Investigating the neural correlates of these knowledge representations has long been a major challenge in the field of the neurobiology of language. In this study, we used functional magnetic resonance imaging (fMRI) to record brain activity of participants while they read Chinese phrases composed of two consecutive two-character words. Participants were asked to perform semantic judgment and composition relations judgment tasks on these phrases, with approximately one week between the tasks. We combined representational similarity analysis (RSA) techniques and a Bayesian hierarchical partial pooling model to explore the mapping of knowledge representations related to words and phrases in the human brain. Additionally, we used computational linguistics methods to calculate semantic vectors and attempted to quantify semantics using multiple models. This approach allowed us to further investigate the neural mapping of word- and phrase-level knowledge representations and their semantics. The results indicate that the neural representation strength of word grammatical classes and phrase composition relations in the brain can be flexibly adjusted according to different tasks. Under the composition relations judgment task, robust representations of word grammatical classes and phrase composition relations were observed. Specifically, at the word-level, only the grammatical classes of the second two-character word in a phrase could be represented in specific brain regions, whereas no such regions were found for the grammatical classes of the first two-character word. Similar results were observed during the semantic judgment task only using ROI analysis. Thus, evidence for the brain representation of the second two-character word's grammatical class aligns with the combinatorial view, which posits that word grammatical class information is represented only when words are combined into larger linguistic units. At the phrase-level, in the explicit composition relations judgment task, the representation of compositional relations involved the superior parietal lobule and extended to the angular gyrus. Similar results were observed in the semantic judgment task only when ROI analysis was used. Incorporating semantic vectors, the analysis revealed that even when we further controlled for semantic effects, evidence for the brain representation of both phrase composition relations and word grammatical classes was still observable. This indicates that these knowledge representations are mapped in the brain at least partially independent of semantics. Finally, results of the effective connectivity analysis indicated that brain regions representing composition relations receive information from regions representing word grammatical classes, and simultaneously influence the processing of word class information. Overall, these results partially reveal how the human brain supports language processing through the dynamic interaction among multiple brain regions.

A11 *Sandbox Series* - Sentence Predictability Shapes the Encoding of Phonetic Detail

Will Chih-Chao Chang[1], Jiaxuan Li[1], Xin Xie[1]; [1]University of California, Irvine

It is well established that listeners utilize subtle phonetic detail (e.g., voice onset time, VOT) to distinguish between words in isolation (e.g., GOLD vs. COLD; McMurray et al., 2002). However, when given a constraining sentence context, how top-down predictions from prior contexts affect the encoding of phonetic detail remains unclear. Some studies found listeners encode phonetic detail of words less accurately in high-predictability sentence contexts compared to low-predictability ones (Manker, 2019), while others found high-predictability sentence contexts enhance acoustic-phonetic processing (Broderick et al., 2019). Furthermore, most studies presented target words in isolation or at sentence end, leaving open how phonetic encoding and prior prediction interact during ongoing speech. Our study investigates whether listeners dynamically adjust the precision with which they encode phonetic detail as speech unfolds. Specifically, we examine how sentence predictability affects the phonetic encoding of English word-initial voiced stops (e.g., /g/ in GOLD). VOT is manipulated to create auditory voiced targets with three levels of phonetic ambiguity, which would gradiently activate voiced targets and their voiceless competitors (e.g., GOLD 100%-COLD 0%, GOLD 75%-COLD 25%, GOLD-50%-COLD 50%). The auditory voiced targets appear in the middle of sentences with high-predictability (e.g., The treasure hunter found a gold necklace) or low-predictability (e.g., The young man found a gold necklace) contexts. To obtain a fine-grained predictability measure, we further calculated the word surprisal (negative log probability) of the voiced targets given the preceding sentence context using large language model GPT2 (Radford et al., 2019). Participants listen to auditory sentences containing the voiced targets while performing a lexical decision task, where visual strings appear at the offset of target words. There are 72 critical trials where three types of visual strings are presented: identical voiced targets (e.g., GOLD), their voiceless competitors (e.g., COLD), or controls (e.g, ANT), along with 144 filler trials paired with controls or non-words. Participants continue listening to the sentences while responding. Probe trials, where listeners answer comprehension questions, will be randomly interleaved to ensure attention to the auditory sentences. The encoding precision of phonetic detail in the VOT of auditory voiced targets is hypothesized to affect the reaction

times (RTs) in the lexical decision task. GLMM models will be fit to the RTs data, with phonetic ambiguity, sentence predictability, visual string type and their interactions as the fixed effects. We predict more accurate encoding of phonetic detail in unpredictable context, as evidenced by a three-way interaction: increased phonetic ambiguity of VOT slows RTs for visual voiced targets but speeds RTs for voiceless competitors, with a stronger effect in low- than high-predictability sentences. We also expect a stronger VOT effect on RTs as word surprisal increases, suggesting phonetic encoding is sensitive to fine-grained changes in sentence predictability. In the future, we will use fMRI to investigate neural correlates underlying the encoding of phonetic detail in STG, and how STG activation interacts with the cortical regions sensitive to word surprisal. These findings will further elucidate the dynamics of bottom-up and top-down processing within the bilateral fronto-temporo-parietal network during speech comprehension.

A12 *Sandbox Series* - An investigation of the functional neuroanatomy of lexical tone encoding in overt Mandarin word production with functional near-infrared spectroscopy (fNIRS)

Xiaocong Chen[1], Tai Yuan[1], Fumo Huang[1], Caicai Zhang[1]; [1]The Hong Kong Polytechnic University

Introduction: Current psycholinguistic models of Chinese word production assume that the encoding of lexical tone mainly consists of two stages: the retrieval of the tonal information (either as independent segments or as part of the metrical or word-shape frame), and the tone-to-syllable mapping/integration process (i.e., assigning the lexical tone to the syllabic or segmental contents) (Alderete et al., 2019; J. Chen, 1999; O'Seaghdha et al., 2010; Roelofs, 2015), which was supported by our recent EEG study (Chen & Zhang, submitted). But the functional neuroanatomy of these subprocesses prior to articulation is largely unknown. Thus, we aimed to investigate the neural bases of lexical tonal encoding during overt Mandarin word production using functional near-infrared spectroscopy (fNIRS), which has reasonable tolerance of head motion and spatial resolution. Based on previous neuroimaging studies on phonological encoding of speech production (e.g., Chang et al., 2014; Liu et al., 2006; Indefrey, 2011), we hypothesized that the tonal encoding may involve several brain regions, including superior temporal gyrus, inferior parietal lobe, inferior frontal gyrus and motor areas. Methods: Forty-nine native Mandarin speakers (25 females, aged 19-32) completed a phonologically primed picture naming task, where they produced a disyllabic name upon seeing an object picture, with their naming latencies and fNIRS signals recorded. Each picture was preceded by a monosyllabic visual prime, which was presented simultaneously with its spoken form auditorily. To disentangle the two tonal encoding sub-processes (tonal retrieval and tone-to-syllable integration), we orthogonally manipulated the tonal relatedness and syllabic relatedness of the primes to the first syllable of the target picture names (e.g., 鹦鹉, ying1-wu3, 'parrot'). This created four conditions of primes: a homophonous prime with both syllabic and tonal overlap (e.g., 英, ying1), a syllabic prime with only syllabic overlap and no tonal overlap (e.g., 硬, ying4), a tonal prime with only tonal overlap and without segmental overlap (e.g., 滋, zi1), and an unrelated control prime without any tonal and syllabic overlap (e.g., 志, zhi4). Preliminary results: The behavioral data (naming latencies) revealed significant main effects of tonal relatedness and syllabic relatedness and a significant interaction effect. Specifically, the tonal relatedness effect was modulated by syllabic relatedness, as there was a tonal facilitation effect when the syllable was shared between the prime and the target word, but a tonal interference effect when the syllable was different. This showed that the lexical tonal overlap could not be planned in advance, but only when the lexical tone and syllable were both available, the production could be facilitated, which indicated there was a tone-to-syllable integration process. The fNIRS data analysis is currently in progress. If a significant main effect of tonal relatedness with an absence of a significant interaction between tonal and syllabic relatedness is found in a channel, this will indicate the tonal retrieval process. If a significant interaction effect between tonal and syllabic relatedness is found in a channel, especially if the tonal relatedness effect is modulated by the syllabic relatedness as in the behavioral data, this will indicate the tone-to-syllable integration process.

A13 *Sandbox Series* - A longitudinal investigation of social cognition impairments and their neural correlates in the non-semantic variants of Primary Progressive Aphasia

Natacha Cordonier[1,2], Ramón Landin-Romero[2,3], Olivier Piguet[2,4]; [1]University of Neuchâtel, Neuchâtel, Switzerland, [2]Brain and Mind Centre, The University of Sydney, Sydney, Australia, [3]School of Health Sciences, The University of Sydney, Sydney, Australia, [4]School of Psychology, The University of Sydney, Sydney, Australia

Introduction. Primary progressive aphasia (PPA) encompasses a spectrum of neurodegenerative disorders characterized by progressive language decline. Current diagnostic methods often struggle to accurately diagnose the logopenic variant of PPA (lvPPA) and differentiate it from the non-fluent variant (nfvPPA) due to overlapping language features (Harris et al., 2019). Integrating assessments of nonlinguistic cognitive functions, especially socio-cognitive measures, has emerged as a promising avenue for refining diagnostic accuracy (Piguet et al., 2015; Van Den Stock et al., 2022). Despite this potential, studies focusing on social cognition in lvPPA and nfvPPA remain scarce, with a notable lack of longitudinal studies (De la Sablonnière et al., 2021; Fittipaldi et al., 2019). Understanding the nuances of social cognition deficits, their interplay with language disorders, and their neural correlates in lvPPA and nfvPPA across different disease stages seems essential for improving detection and diagnostic accuracy in these variants of dementia. This Sandbox Series poster, therefore, presents a research project aimed at investigating social cognition in lvPPA and nfvPPA during the early stages of the disease and longitudinally tracking changes by combining behavioral and neuroimaging data. Methods. Retrospective longitudinal data from the FRONTIER database, comprising 80 lvPPA, 80 nfvPPA, and 120 healthy controls (HC), will be analyzed. These datasets include behavioral (language and social cognition test scores - empathy, theory of mind, and emotion recognition) and

neuroimaging data collected at multiple appointments one year apart. Statistical analyses will involve univariate ANOVA on baseline behavioral data to compare groups in the disease's early stages, with multiple linear regressions to examine the relationships between language and social cognition. Repeated-measures ANOVA, accounting for social cognition, groups, and time interactions, will assess longitudinal changes. An annual rate of decline will also be calculated. Additionally, vertex-wise (cortical thickness) and fixel-based (fiber bundle integrity) whole-brain general linear models, along with spatiotemporal linear mixed effects whole-brain models, will be fitted to examine grey matter and white matter atrophy and their correlations with social cognition at baseline and throughout disease progression. Expected Results. In the early stages of the disease, lvPPA and nfvPPA participants are expected to exhibit poorer performance in empathy, facial emotion recognition, and theory of mind compared to HC, with potentially better preservation of empathy in lvPPA than in nfvPPA participants (Van Langenhove et al., 2016). These socio-cognitive deficits should be related to language impairment in both PPA variants (Fittipaldi et al., 2019). Over the disease course, socio-cognitive deficits are hypothesized to worsen, particularly in lvPPA, in line with the faster cognitive decline observed in this variant (Foxe et al., 2021). These impairments are likely to be associated with specific brain regions, such as the temporoparietal junction in lvPPA and the prefrontal cortex and insula in nfvPPA. Longitudinally, lvPPA is expected to show different patterns of brain atrophy correlated with more severe social cognition impairments (Tu et al., 2015). Ultimately, these findings should deepen our understanding of socio-cognitive deficits in PPA, their progression over time, their relationship to language, and their neural underpinnings, with implications for diagnosis and intervention strategies.

A14 *Sandbox Series* - Do grammatical similarities in syntactic structure between Japanese and Chinese affect brain activity related to second language processing?

Yaxin Cui[1], Shinri Ohta[2]; [1]Kyushu University

Experimental linguists have focused on the neural patterns of bilingual individuals when processing second languages (L2). It is common for L2 learners to find syntactic similarities between their first language (L1) and L2. Previous studies have verified that cross-language grammatical similarity can be an essential factor influencing L2 syntactic processing (Tolentino, L. C., & Tokowicz, N., 2011). However, most studies have primarily focused on Indo-European languages such as English and Spanish, leaving research on non-Western languages like Chinese and Japanese underexplored. It is widely known that Japanese is an agglutinative language and Chinese is an isolating language, both of which are similar in terms of some vocabulary and the use of characters (kanji) but differ significantly in word order. Except for the predicate that appears at the end of a sentence, the word order in Japanese sentences is relatively flexible. In contrast, in Chinese, word order is closely related to grammatical relations, and changes in word order directly affect the semantics and pragmatics of sentences. Do these differences in grammatical constructions affect the brain activity of bilingual individuals, and if there is an effect, in what form does it present? These questions remind us that the neural patterns of Japanese-Chinese bilinguals when processing sentences with different word orders require further experimental investigations. The present study concerns the brain activity of Chinese learners of Japanese and native Japanese speakers. We use violated and unviolated Japanese sentences with varying degrees of syntactic similarity to Chinese as stimulus materials. For instance, (1) 綺麗な花-kirei na hana (ZH: 美丽的花, měi lì de huā; EN: beautiful flower)→花綺麗-hana kirei (* flower beautiful); (2) 女の子はリンゴを食べた。-onnanoko ha ringo wo tabeta (ZH: 女孩吃了苹果, nǚ hái chī le píng guǒ; EN: The girl ate the apple)→女の子は食べたリンゴ--onnanoko ha tabeta ringo (* The apple the girl ate) The two materials in the first set have more similar word order and thus higher syntactic similarity. The event-related potentials (ERPs), such as N400, left anterior negativity (LAN), and P600, will be collected to detect the brainwave characteristics of participants as they perform Japanese sentence judgment tasks. This study can identify similarities and differences in the brain activity of Chinese learners of Japanese and native speakers of Japanese when processing Japanese sentences with high and low similarity in syntactic structure to Chinese. We hypothesize that the more the word order of a Japanese sentence aligns with its corresponding Chinese sentence, the more similar ERP patterns of Chinese learners of Japanese will be to those of native Japanese speakers during sentence processing. Specifically, we predict that a strong P600 effect will be found in violated syntactically similar structures and a weaker P600 in violated syntactically dissimilar structures. Moreover, we expect the LAN will be more prominent in native speakers than in L2 learners.

A15 *Sandbox Series* - A hierarchical categorical structure of abstract concepts

Rutvik Desai[1], Nandish Chokshi[2], Sidney Crouse[1], Fereshteh Kavandi[1], Parth Desai[3], Sophie Arheix-Parras[1]; [1]University of South Carolina, [2]BITS Pilani, Goa, India, [3]University of California, Berkeley

Categories of concepts are classically divided into superordinate, basic level, and subordinate categories. Most work on conceptual categories is based on concrete concepts. It is not clear if similar hierarchical structure exists for abstract concepts, and if so, what the categories are. A few studies have examined this question using a relatively small number of abstract concepts that are typically restricted to nouns. Here, we used distributional vector embeddings to derive categories and hierarchical structure for a large, comprehensive set of abstract concepts across grammatical categories. A common characteristic of popular distributional embeddings such as GloVe or Word2Vec is that they assign high similarity to concepts that are thematically associated, such as cow-milk or dog-bone. Since we are interested in taxonomic similarity, this represents a confound. Here, we used embeddings that were developed to highlight taxonomic similarity. In these representations, taxonomically similar concepts (e.g., dog-wolf) receive greater similarity than associated concepts (dog-bone). We used approximately 10,000 abstract words for this study from the Brysbaert et al. concreteness rating database. One-

third of the words with the lowest rating were selected to represent abstract words. Similarly, 1/3 of the words with the highest concreteness rating were selected as concrete words. We submitted taxonomic vectors corresponding to each word to hierarchical clustering, for both abstract and concrete sets independently. Words in categories at each level were then submitted to a Large Language Model (ChatGPT 4.0) to facilitate generation of labels for each category, which were then manually examined and edited. The results reveled hierarchical structure for abstract concepts with 27 levels. After broad top-level classes, several major categories were revealed. These included emotional and social concepts (morality, humanism, fraud, treason), qualities and states (persistence, insight, skill, democracy), emotional actions and states (tempt, flaunt, frustrate, obsess), neutral actions and states (devise, govern, develop, exist), thinking and communication (allege, explain, doubt, predict), intensifiers (fiercely, richly, gloriously, shockingly), properties (original, opulent, secret, decent), qualifiers (adaptive, invasive, fiscal, proven), manner or degree adverbs (willfully, negatively, poetically, profitably), and negative traits or beliefs (cheapness, obviousness, radicalism, imprecision). These large categories were further subdivided into multiple other categories of increasing specificity. Surprisingly, closed class words (are, with) did not form a separate category, but were included in various other categories. As a comparison and 'sanity check,' the concrete words also revealed an extensive hierarchy that matched many of the intuitive and known categories such as animals, tools, food items, and musical instruments. These results provide hypotheses regarding possible organization of abstract concepts in the mind and brain. We hope to test these hypotheses using behavioral methods such as masked priming, and with neuroimaging methods. The categories generated by these taxonomic embeddings can be compared against those generated with other distributional models, or with manually created multi-dimensional representations such as experiential ratings, and validated through behavioral and neuroimaging methods. Such large scale studies can provide a more comprehensive picture of representation and organization of abstract and even concrete concepts that goes beyond superordinate, basic level, and subordinate categories.

A16 *Sandbox Series* - Identifying EEG activity related to the linguistic processing of natural language.

Jin Dou[1], Andrew J. Anderson[2], Aaron R. Nidiffer[1], Aisling E. O'Sullivan[3], Jens Hjortkjær[4,5], Alain De Cheveigné[6,7], Edmund C. Lalor[1]; [1]University of Rochester, Rochester, United States of America, [2]Medical College of Wisconsin, Milwaukee, United States of America, [3]Trinity College, Dublin, Ireland, [4]Technical University of Denmark, Kgs. Lyngby, Denmark, [5]Copenhagen University Hospital - Amager and Hvidovre, Copenhagen, Denmark, [6]Laboratoire des Systèmes Perceptifs, Paris, France, [7]Ecole Normale Supérieure, Paris, France

Speech is central to human life. An enormous amount of research has been conducted on the neurobiology of spoken language. In recent years, this has included significant effort aimed at modeling brain responses to natural speech based on different acoustic and linguistic features of that speech. In the case of EEG research, one major unresolved issue centers on how to determine the success of these models. More specifically, it is unknown how much variance in EEG responses to speech derives from the linguistic processing of that speech rather than the obligatory sensory processing of the speech acoustics. Indeed, given the low spatial resolution of EEG, activity related to acoustic and linguistic processing is typically mixed into the same EEG recordings channels. The goal of the present project was to distinguish EEG activity related to linguistic processing from EEG activity related to low-level stimulus feature processing. We did this based on the hypothesis that activity in language processing regions will be similar for reading and listening, while activity in sensory (i.e., auditory and visual) regions will be different across those two conditions. Specifically, we recorded EEG from 10 participants who were presented with segments of a book in both audio and text format with their orders balanced across participants. Crucially, the text presentation was controlled to have the same timing as the audiobook. As a result, we could directly relate EEG data from the reading and listening conditions in an effort to identify any common activity that – by hypothesis – should necessarily be related to language processing. To identify common signals across all 10 participants and 2 modalities, we used multi-way canonical correlation analysis (MCCA). To avoid learning correlations between low-level activity in auditory and visual cortices across channels (based on common timing), we used MCCA to extract a single canonical component (CC) shared across all subjects and modalities for each EEG channel separately. However, including a range of time lags in the analysis allowed us to do this while accounting for any differences in the temporal profile of EEG responses between participants or modalities. We then conducted a series of additional analyses to validate if the CCs extracted for individual channels reflected linguistic processing. We found that: 1) comparing the spatial distribution of pairs of CCs from the two modalities revealed common activity around centro-parietal scalp; 2) the average of all CCs for each channel, predicted EEG most accurately also around the centro-parietal scalp; and 3) the strong activation around centro-parietal scalp remained even after regressing out EEG activity related to lexical surprisal. The fact that distribution of common activity across reading and listening is strongest over scalp regions that have been implicated in linguistic processing in previous research, leads us to conclude that we have successfully isolated linguistic processing from lower-level sensory processing in reading and listening. Notably, the variance of this EEG activity is not fully explained by lexical surprisal – which is a linguistic feature that has been strongly linked with EEG responses to natural language.

A17 *Sandbox Series* - Towards the single-neuron correlates of verbal and non-verbal working memory: insights from a case study of stroke-induced aphasia

Paolo Favero[1,2], Laura Schiffl[1,2], Beste Tasci[1,2], Göktug Alkan[1,2], Lisa M. Held[1,2], Hongbiao Chen[1,2], Arthur Wagner[2], Bernhard Meyer[2], Jens Gempt[3], Simon N. Jacob[1,2]; [1]Translational Neurotechnology Laboratory, Department of Neurosurgery, Klinikum rechts der Isar, Technical University of Munich, Munich, Germany, [2]Department of Neurosurgery, Klinikum

rechts der Isar, Technical University of Munich, Munich, Germany, [3]Department of Neurosurgery, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany

Impairments in verbal working memory have often been reported in individuals with aphasia, especially in the non-fluent variant. However, whether such impairments reflect language-specific or domain-general cognitive deficits is still debated. Are the same neuronal circuits and mechanisms responsible for storing and processing linguistic and non-linguistic information in working memory? In this study, we present a unique case of large-scale extracellular microelectrode recordings with single-neuron resolution from the prefrontal and parietal association cortex of an individual with stroke-induced non-fluent aphasia but largely intact language comprehension and domain-general cognitive functions. Neuronal data was acquired from four areas in the right hemisphere involved in working memory and semantic processing: the middle frontal gyrus, the inferior frontal gyrus, the supramarginal gyrus, and the angular gyrus. Two delayed-match-to-sample working memory tasks were designed to investigate the contribution of these regions in processing verbal and non-verbal information. In both tasks, we used non-linguistic stimuli, i.e., visually presented icons drawn from eight semantic categories, and linguistic stimuli, i.e., written or spoken words matching the pictorial stimuli. In the perceptual matching task (PM), the participant had to judge if a test stimulus was perceptually identical to a preceding sample. Therefore, semantic processing of the stimuli was not enforced. In the semantic matching task (SM), the participant judged whether the test stimulus belonged to the same semantic category as a preceding sample (e.g., “cat” and “lion”), thus enforcing semantic processing. A total of 22 sessions were performed by the participant, each consisting of two consecutive blocks (one per task). The order of the blocks was pseudo-randomized. The participant’s ceiling performance in PM demonstrated preserved non-verbal working memory, which was only mildly modulated by working memory load (decreased accuracy with increasing number of samples). The higher complexity of the SM task resulted in lower accuracy. Nevertheless, the participant reached an average accuracy of 87% for one sample (icons 93%, written words 88%, spoken words 81%) and 76% for two samples (icons 85%, written words 76%, spoken words 66%). These behavioral results suggest that semantic knowledge, lexical access, and verbal working memory are largely preserved. Ongoing analyses are directed at exploring the single-neuron and neuronal population correlates of verbal and non-verbal working memory in the right hemisphere. For example, we will investigate whether the same neuronal ensembles encode working memory content across different reference levels (iconic and symbolic) and whether these networks exhibit persistent or dynamic working memory coding. This study will generate profound insights into the neuronal foundations of human linguistic and non-linguistic cognition.

A18 *Sandbox Series* - Reanalysis of Five fMRI language datasets using Representational Similarity Analysis

James Fodor[1]; [1]The University of Melbourne

Recent years have seen rapid progress in the development of distributed semantic representations, in which the meaning of a word, sentence, or passage is encoded as a vector of numbers in an underlying semantic space. Neuroimaging studies using naturalistic linguistic stimuli have begun to investigate the extent to which such models reflect the representation of semantic information in the brain. The resulting patterns of BOLD activation are typically compared to the corresponding distributional semantics embeddings using an encoding paradigm, where a regression model is trained for each voxel to predict the activity using the semantic embeddings. Studies have found that distributed semantics models can predict BOLD activity across a range of brain regions, with embeddings extracted from state-of-the-art transformer models significantly outperforming older word embedding models. However, several methodological challenges hinder the interpretation of such findings. First, training a separate regression model for each voxel can lead to overfitting, and does not readily enable direct comparisons of the representational spaces of brain and model. Second, paradigms using naturalistic narrative stimuli have not always adequately controlled for confounds arising from the temporal autocorrelation of the BOLD signal. Third, methodological heterogeneity reduces comparability between studies, making it difficult to determine how robust these findings are to different types of language stimuli. In line with the philosophy of ‘scan once, analyse many’ (Madan, 2021), here we aim to mitigate some of these limitations by applying a consistent pipeline to reanalyse publicly available neuroimaging datasets. We reanalyse five distinct datasets with a total of 74 participants, covering a range of stimuli including written sentences (Pereira, et al., 2018, Anderson et al., 2017), written narratives (Wehbe, et al., 2014), and audio narratives (Y. Zhang et al., 2020, Bhattasali et al. 2020). To control for the autocorrelation of the BOLD signal, we segment narrative stimuli into individual sentences, which enables fitting of a general linear regression model to the BOLD data in the same way as studies using discrete sentences. To avoid the limitations of voxel-wise encoding models, we utilise representational similarity analysis (RSA) to compare the similarity structure of brain representations to the similarity structure of the distributed representations from computational models. Applying our uniform pipeline to all five datasets, we find small but robust correlations between brain and model RSA matrices of between 2-10 percent regardless of stimulus modality. We also find that transformer models typically outperform simpler average-word embeddings, though the magnitude of this effect is smaller than reported in several previous studies, potentially due to this effect being inflated by autocorrelation of the BOLD signal. Conversely, we find little systematic pattern regarding which transformer models performs best, raising questions about the robustness of such differences reported in previous studies. We conclude by highlighting the limitations of existing datasets for the purpose of model comparison, and suggesting how future work can more effectively evaluate what distributional semantics models can tell us about semantic representation in the brain.

A19 *Sandbox Series* - Developing a Model of Dyslexia in Neurotypical Adults: A Transcranial Temporal Interference Stimulation Study

Daniel Gallagher[1], Zian Huang[1], Shinri Ohta[1]; [1]Kyushu University, Fukuoka, Japan

Developmental dyslexia (DD) is a hereditary and multifactorial neurodevelopmental disorder affecting fundamental literacy skills (reading, writing, spelling) independently of general intelligence and educational opportunities. DD is estimated to affect around 7% of individuals (Yang et al., 2022), making it one of the most prevalent learning disabilities. In past decades, much of dyslexia research has focused on phonological deficits (Smirni et al., 2020) with a more recent trend towards integrating other causal factors such as visual deficits, visual attention, and epigenetic factors (e.g., Antzaka et al., 2017; Share, 2021; Theodoridou et al., 2021; Werth, 2021; Zoccolotti, 2022). While the mechanism of DD is not fully understood, certain studies have shown that DD is associated with reduced activation in the left ventral occipito-temporal (vOT) cortex, which corresponds to the visual word form area (VWFA) (Brem et al., 2020; Conant et al., 2020). We therefore propose that by modulating neural activation in the VWFA, we can replicate the expression of DD in neurotypical participants, thereby opening new avenues for research into therapeutic interventions for individuals with DD. In order to manipulate neural activation, we will employ non-invasive brain stimulation, which uses magnetic fields or electric currents to non-invasively stimulate a targeted region of the brain. Traditional methods face a trade-off: they can either be precise but unable to reach deep brain areas or reach deep brain areas but with less spatial precision. This trade-off is resolved by a novel technique called transcranial temporal interference stimulation (tTIS). Unlike other methods, tTIS uses two (or more) interfering high-frequency alternating currents (> 1 kHz) to achieve low-frequency stimulation precisely at any depth in the brain. This is advantageous for stimulating the VWFA, since conventional methods have limited efficacy targeting regions on the ventro-medial regions of the brain due to the need to avoid stimulating overlying cortical areas. Additionally, by co-registering electroencephalography (EEG) data during behavioral tasks, we can observe the neurophysiological effects induced by tTIS, as has been done in previous tES-EEG co-registration studies (e.g., Gallagher et al., 2023). By using tTIS to downregulate activity in the VWFA, we expect to inhibit cognitive performance on literacy tasks, resulting in poorer reading comprehension and slower reading times. EEG data measured during tasks will reveal the neurophysiological effects induced by tTIS. Since ERP research has shown that individuals with DD do not exhibit certain ERPs such as the N170 and N320 (Premeti, Bucci, & Isel, 2022), we can empirically assess the efficacy of our DD model. We hope that by creating a model for DD in neurotypical individuals, we will help elucidate the neural basis of DD while facilitating investigation into novel therapeutical interventions for DD, which will in turn hasten their implementation in clinical settings. Finally, by demonstrating the efficacy of tTIS here, we will enable future investigations into various deep brain regions and their roles in language processing.

A20 *Sandbox Series* - Individual differences in brain network organization during taboo word perception

Annette Glotfelty[1], Jeremy I. Skipper[2], Steven L. Small[1]; [1]The University of Texas at Dallas, [2]University College London

Individual differences in brain activity, in response to the same or similar stimuli, represent a way to explore reliability and generalizability of research findings in many areas of brain and behavior, including the neurobiology of language. Individual data also provide the means to link idiosyncratic brain responses to trait-level phenotypes, a feature increasingly exploited to enable personalized medicine and education. Taboo words (i.e., 'expletives,' 'curse words,' 'swear words,' 'obscenities,' 'profanity,' etc.) are a unique subset of words, both biologically – they have distinctive presentations in neurological disorders – and behaviorally, by virtue of their relationship to human cognition, psychology, and social interactions. Researchers interested in taboo words have argued that swear word processing is particularly affected by individual differences such as personality or past experience (e.g., the severity of sanctions imposed from use of these words). Despite this interest, the role of individual differences in behavior has not been substantiated through brain imaging experiments. Evidence from neuroimaging studies of individual differences in affective neuroscience has shown that highly emotional stimuli result in more synchronized brain activity across participants, and behavioral studies of taboo words suggest that expletives are imbued with their tabooness due to their strong emotionality. This leads to the questions of the current study: (1) Does taboo word perception produce subject-level variability in processing? And (2) Is functional brain network organization mediated by trait-level differences? To answer these questions, we plan to use a subset of our publicly available Naturalistic Neuroimaging Database (NNDb), which includes BOLD MRI imaging of individuals watching full length movies as well as cognitive, emotional, and social tests of these participants from the NIH Toolbox (n = 56, 27F/29M, aged 18 – 55, each watching 1 of 7 films). Our study will compare functional brain activity for perception of curse words to that of generic content words during movie watching, and investigate which trait-level factors are most strongly correlated with individual differences in brain activity. We expect to find more individual differences for perception of swear words than for generic words, and that trait-level differences in social cognition will be more strongly correlated with our results, than differences in cognitive or psychological domains. Further, we expect that the most significant individual differences will be driven by regions associated with the putative default mode network (e.g., precuneus, angular gyrus, posterior cingulate cortex, medial prefrontal cortex), which have been consistently implicated in social processing, particularly thinking about others' motivations and emotions.

A21 *Sandbox Series* - When listening to real-life code-switches, neural oscillations do not differ from unilingual processing

Leah Gosselin[1], Laura Sabourin[1]; [1]University of Ottawa

In many communities, code-switching (i.e., using more than one language during a single communication event) is common in-group behaviour. Although some bilinguals state that code-

switching is the "most comfortable" way to speak, electrophysiological (EEG/ERP) studies consistently reveal that the comprehension of code-switched sentences is cognitively effortful. Some question the ecological validity of these findings, noting that previous studies almost exclusively utilize lab-made stimuli, and usually test participants in the visual modality (i.e., reading switches). The goal of the present pilot experiment was to examine the processing of authentic auditory code-switches. We examined the neural oscillations of participants listening to genuine conversations from real-life bilingual pairs. In a precursor study, 19 pairs of French-English bilinguals (couples, friends, siblings, etc.) completed a series of speech elicitation activities, giving rise to the FEBLO-Corpus (Gosselin & Sabourin, in prep). Forty passages of unstructured discussion (M=23.5 seconds, SD=4.1) were selected from FEBLOC: twenty excerpts with code-switches and twenty unilingual excerpts (ten French, ten English). The code-switched and unilingual passages did not differ in terms of length, number of utterances, amount of turn-taking, speaker age or gender, disfluencies, or rated intelligibility (all ps>.17). Nine newly recruited French-English bilinguals (M=37 years, SD=15 years; 5 women, 3 men, 1 non-binary) passively listened to the naturalistic excerpts while their continuous EEG was recorded. Resting-state brainwaves (r-EEGs) were also collected. Following pre-processing, the signal for each excerpt (item) was split into 2 second segments (50% overlap) and a Fast Fourier transform was applied to the data. The average power density for theta (4-7 Hz), alpha (8-12 Hz), lower beta (15-18 Hz), upper beta (20-30 Hz) and lower gamma (30-40 Hz) bands were extracted for each item and participant. As a preliminary analysis, mixed models were performed on each independent frequency band; they included Type (Switch vs. Unilingual), Laterality (left, middle, right) and Longitude (frontal, central, posterior) as fixed factors, as well as subject and item as random factors. Code-switched and unilingual passages did not differ in terms of elicited power density for any frequency band (no main effect of Type or interaction with topography: all ps>.34). However, a comparison of r-EEGs and passive listening EEGs (without by-item random effects) showed consistent differences across all frequency bands (theta, alpha, lower beta: ps<.0001; upper beta, lower gamma: ps<.05). In the alpha band, several self-reported participant characteristics modulated the passive listening EEGs (more so than r-EEGs). For instance, increased language entropy and more frequent switching into the majority language was related to lower alpha density (Fs>3.2, ps<.05); by contrast, switching into the minority language was linked to increased alpha density (F=3.9, p=.02). These results suggest that processing real-life code-switches is not inherently cognitively costly—rather, bilinguals' experiential traits regulate the processing of speech, whether unilingual or code-switched. However, this can only be said about the global level of auditory processing. The novel analyses methods (i.e., applying r-EEG segmenting to auditory passages) may not have been granular enough to detect condition differences at the local switching point.

A22 *Sandbox Series* - Automatic Processing of Morpheme Semantic Relations in Chinese Compounds: A Fast Periodic Visual Stimulation EEG Study

Fengyun Hou[1], Nina Kazanina[1,2]; [1]University of Bristol, [2]University of Geneva

Understanding a sentence means that the listener is able to extract information about the entities involved and relations between them. In language, relations are often encoded using a combination of explicit lexical means and syntactic configuration, such as prepositional phrase modifying a certain noun (e.g. “an apple in the basket” where the spatial relation is conveyed via the preposition “in”). However, relational encoding in language can also be implicit. A notable case is exemplified by compounds, in which diverse semantic relations between the constituent morphemes may be represented in the absence of any overt morphological makers. Chinese is a language in which approximately 72% of words are compounds consisting of two free morphemes (Lexicon of Common Words in Contemporary Chinese, 2008). In light of its rich and varied semantic relations between morphemes, Chinese provides a window for investigating relational encoding in language. For instance, in 酒瓶 (/jiǔpíng/, wine bottle), the morpheme 酒 (/jiǔ/, wine) modifies the function of the head noun 瓶 (/píng /, bottle), yielding the meaning ‘a bottle for wine’. In contrast, in 羊皮 (/yángpí/, sheepskin) there is a possession relation between 羊 (/yáng/, sheep) and 皮 (/pí/, skin), i.e. ‘the skin of a sheep’. Previous studies using the relation-priming paradigm have shown that different relations influence the processing of compounds (e.g. Gagné, 2002; Spalding and Gagné, 2011). However, it remains an open question how these different semantic relations are processed by our brain, in particular, how automatically the brain extracts and processes relations. To address these questions, we investigated processing of relations within Chinese compounds in an EEG experiment using an oddball paradigm combined with fast periodic visual stimulation. We examined five types of Chinese compounds, including three types of noun compounds (1)-(3), a verb-noun compounds (4) and a pseudo-compound with no relation between morphemes: (1) modification-function (X for Y): 酒瓶 (/jiǔpíng/, wine bottle); (2) modification-possession (X of Y): 羊皮 (/yángpí/, sheepskin); (3) coordination (X and Y): 花草 (/huācǎo/, flowers and grass); (4) action (V+N): 弹琴 (/tánqín/, play instrument); (5) pseudo-compound (P-C): 头柴 (/tóuchái/, head firewood). Five stimulation sequences in which the stimuli appeared isochronously at the rate of 6 Hz were constructed. In all sequences, stimuli such as (1) were used as a frequent standard stimulus (i.e. base stimuli), with each of compound types (1)-(5) used as an infrequent stimulus (presented as every 5th stimulus, 1.2 Hz, i.e. oddballs). For example, the stimulation sequence in which (1) served as a base stimulus and (2) as an oddball was as follows: 酒瓶 (/jiǔpíng/, wine bottle) —衣架 (/yījià/, clothes hanger) — 笔筒 (/bǐtǒng/, pen holder) — 信箱 (/xìnxiāng/, mailbox) — 羊皮 (/yángpí/, sheepskin). We hypothesised that periodic EEG responses would be observed at oddball frequency and its harmonics in four sequences where the base and oddball compounds reflected different conditions, i.e. with (2)-(5) as the oddball, but not when they represented the same condition, i.e. with (1) as the oddball. Such findings would indicate that the brain automatically and spontaneously

processes semantic relations between constituent morphemes of Chinese compounds.

A23 *Sandbox Series* - Revisiting human language and speech production network: a meta-analytic connectivity modeling study

Chun-Wei Hsu[1], Chih-Chin Heather Hsu[1], Yanchao Bi[2], Ovid Jyh-Lang Tzeng[3], Chu-Chung Huang[4], Ching-Po Lin[5]; [1]National Yang Ming Chiao Tung University, Taipei, Taiwan, [2]Beijing Normal University, Beijing 100875, China, [3]Institute of Linguistics, Academia Sinica, Taipei, Taiwan, [4]East China Normal University, Shanghai, China, [5]Taipei City Hospital, Taipei, Taiwan

In recent decades, converging evidence has reached a consensus that human speech production is carried out by large-scale hierarchical network comprising both language-selective and domain-general systems. However, it remains unclear how these systems interact during speech production and the relative specific contributions of component regions. By utilizing a series of meta-analytic approaches based on various language tasks, we dissociated four major systems, including domain-general, high-level language, motor-perception, and speech-control systems in this study. Using meta-analytic connectivity modeling, we found while the domain-general system is coactivated with high-level language regions and speech-control networks, only the speech-control network at the ventral precentral gyrus is coactivated with other systems during different speech-related tasks, including motor perception. In summary, this study revisits the previously proposed language models using meta-analytic approaches and highlights the contribution of the speech-control network to the process of speech production independent of articulatory motor.

A24 *Sandbox Series* - How emotion influences prediction dynamics during sentence reading: Evidence from brain potentials

Jing-Yi Huang[1], Yi-Chun Ko[1], Joshua Oon Soo Goh[1], Chia-Lin Lee[1]; [1]National Taiwan University

Emotions shape human experiences and interpersonal communication. In language comprehension, emotional context can heighten attention allocation and elaborate re-evaluation of incoming stimuli. Prior research indicated that more positive amplitudes were elicited in unexpected plausible neutral continuations following emotional contexts than emotionally predicted endings in young adults. This effect is frontally distributed and post-N400, thus is reminiscent of the anterior positivity (AP) effect in response to violations of strong predictions in language comprehension studies that did not systematically manipulate emotion. These results thus indicate a possibility that emotional contexts may enhance predictive processing during sentence reading. The present study aims to further elucidate the nature of this anterior effect following emotional contexts. As these prior findings only used emotionally unexpected endings in moderately strong constraint conditions, the anterior response differences can alternatively be due to anterior negativity (AN) to emotionally expected predictions compared to emotionally unexpected endings, which is not yoked to predictions. To elucidate these possibilities of the anterior effect in an emotional context, we manipulated Sentence Constraint (strong: 85% vs. weak: 20%), Ending Word Expectedness (expected: 20-85% vs. unexpected: 0%), and Context Valence (emotional: 2.2 vs. neutral: 0.4, mean differences from the midpoint 5 on a 1-9 scale). Emotional contexts included equal numbers of positive and negative scenarios. All unexpected sentence-final words were neutral and all sentences were plausible. Target words were controlled for familiarity, concreteness, and length. 480 sentences were arranged into 2 lists, with each condition consisting of 30 sentences. Each participant is assigned to 1 list and reads each sentence context only once. Participants will include 30 young native Taiwan Mandarin speakers. Each read sentences word-by-word on a computer monitor while Event-Related Potentials (ERPs) were recorded. Sentence recognition questions will be posed intermittently to ensure engagement. We hypothesize validation of expectancy and constraint manipulations through graded N400 effects, with unexpected words producing the most negative N400s and expected words showing a graded reduction, more so for strongly constraining sentences than weakly constraining ones. We expect to replicate AP effects with neutral contexts: unexpected words in the strong constraint condition should elicit more pronounced AP compared to expected words in strong constraint condition, along with both expected and unexpected words in weak constraint conditions. Our critical analysis focuses on emotional sentences to determine if unexpected endings in strong constraint conditions elicit the AP effect or if strong expected endings in strong constraint elicit the AN compared to the other three emotion conditions. With this design, this study aims to elucidate these possibilities of the anterior effect in an emotional context and the interaction between emotion and language processing, highlighting the potential role of emotion in enhancing predictive language comprehension.

A25 *Sandbox Series* - Investigating the Neural Substrate of Developmental Dyslexia: A Multimodal Parcellation Study

Zian Huang[1], Daniel Gallagher[1], Shinri Ohta[1]; [1]Kyushu University

Dyslexia, a neurodevelopmental disorder affecting reading and writing abilities, presents a complex challenge in understanding its neural mechanisms because the ability to process written language involves the interplay of multiple brain regions for visual, language, and auditory processing (Dehaene et al., 2015). It is reported that congenital dyslexia is estimated to be up to 7% of the world population, irrespective of language background (Yang et al. 2022). People suffering from dyslexia experience many difficulties in their daily lives, so it is critical to provide proper education and intervention for patients. This study aims to identify the brain regions associated with dyslexia by utilizing functional and structural magnetic resonance imaging (MRI) data from the OpenNeuro repository. By employing multimodal parcellation (Glasser et al. 2018), we can achieve a more precise and detailed examination of brain regions associated with dyslexia. This detailed mapping will serve as a solid foundation for our future studies, where we will modulate the activity of these brain regions through non-invasive brain stimulation methods, thereby providing a

fundamental basis for developing effective interventions for treating dyslexia in the future. The study utilizes functional and structural MRI data of dyslexic children in the OpenNeuro (Banfi et al. 2022) so that we can investigate the differences in brain function between dyslexic and typically developed children. Multimodal parcellation allows for the subdivision of the brain into distinct regions of interest (ROIs), facilitating a fine-grained analysis of functional/anatomical differences. In addition, we will examine structural differences associated with dyslexia using voxel-based/surface-based morphometry (VBM/SBM) (Ashburner et al. 2000, Dale et al. 1999, Fischl et al. 1999). Through these analyses, enhanced by the precision of multimodal parcellation, we aim to identify the whole brain networks associated with dyslexia more accurately. Through the study, we expect to find clear differences in brain structure and network activity between children with dyslexia and healthy individuals. We further expect to observe altered functional connectivity, which may act in two ways. One is reduced connectivity in language-related regions, such as the left temporoparietal region, Broca's area, and the left occipitotemporal cortex, crucial for phonological processing, word recognition, and reading fluency. The other one is increased connectivity in compensatory regions like right hemisphere homologs of the traditional left hemisphere language areas. As to structural differences, we will focus on the cortical thickness and surface area; for example, dyslexic children may exhibit a thinner cortex in the left occipitotemporal cortex. By elucidating functional and structural brain differences with multimodal parcellation, we will pinpoint specific brain areas and networks involved, contributing to a deeper understanding of the neural basis of dyslexia. We aim to contribute to the growing body of research on dyslexia, ultimately improving the lives of those affected by this condition.

A26 *Sandbox Series* - Cross-linguistic syntactic priming in Chinese-Japanese bilinguals during sentence production: an fMRI study

Qiang Huang[1], Yuto Aki[1], Daiko Takahashi[1], Motoaki Sugiura[2], Hyeonjeong Jeong[1]; [1]Graduate School of International Cultural Studies, Tohoku University, [2]Institute of Development, Aging and Cancer, Tohoku University

Most studies support the shared-syntax account for bilingual sentence production, particularly among Indo-European languages with similar Subject-Verb-Object (SVO) word orders. This indicates that bilinguals share syntactic representations, including fundamental grammatical principles, across their languages (e.g., Hartsuiker et al., 2004). However, the debate intensifies when investigating bilinguals who speak languages with different word orders. Early studies found no evidence of cross-linguistic syntactic priming between languages with different word orders such as German (SOV) and English (SVO), suggesting the separate-syntax account (e.g., Loebell & Bock, 2003). In contrast, recent studies on Korean (SOV) – English (SVO) bilinguals suggest that even languages with different surface word orders share abstract syntactic representation (e.g., Hwang et al., 2018). This controversy raises the question of whether shared syntax originates from surface word order or abstract syntactic representations across languages. To address this issue, this ongoing study will conduct an fMRI experiment to observe the repetition suppression effect, which is manifested in decreased brain activation following syntactic priming in syntax-related networks—specifically, the pars opercularis of inferior frontal gyrus (IFG) for syntactic processing and anterior superior temporal gyrus (STG) for word order processing (cf. Grodzinsky & Friederici, 2006). Thirty Chinese-Japanese bilingual participants will be recruited to complete picture-description tasks. Participants will initially listen to a sentence in Chinese as L1 priming, and then orally describe an image in L2 Japanese. To investigate whether bilinguals share syntactic representations in sentence production, we manipulate the surface word order and abstract structure between the priming L1 Chinese (Ba structure active SOV; active SVO; passive SOV) and the target L2 Japanese (active and passive: both SOV) and create three comparisons: sharing both word order and abstract structure (Passive-Passive vs. Active-Passive), sharing only abstract structure (Passive-Passive vs. Ba-Passive), and sharing only surface word orders (Ba-Passive vs. Active-Passive). First, to explore the effects of combining surface word order and abstract structure, we will compare the same word order with priming conditions to different word order without priming conditions: Passive-Passive vs. Active-Passive. Second, to investigate the effect of abstract structure on sentence priming, we will compare the priming and no-priming conditions in the same word order: Passive-Passive vs. Ba-Passive. Finally, to examine the effect of surface word order, we will compare the same word order condition with a different one: Ba-Passive vs. Active-Passive. Regarding the expectations, if the shared-syntax account involves processing both surface word order and abstract structure, we expect the strongest repetition suppression effects in comparison: Passive-Passive > Active-Passive, in both pars opercularis of IFG and anterior STG. Alternatively, if the shared-syntax account only involves surface word order or abstract structure, then the comparisons: Passive-Passive > Ba-Passive and Ba-Passive > Active-Passive will show repetition suppression effects in the corresponding brain regions, the pars opercularis of IFG or the anterior STG, and these effects will be weaker than those in the former comparison. We hope these findings will enhance our understanding of the neural mechanisms in bilingual sentence production by exploring the interaction between surface word order and abstract structures in the brain.

A27 *Sandbox Series* - The neurobiology of phonological interference and facilitation effects in spoken production

Lydia Z. Huang[1], Katie L. McMahon[2,3], Greig I. de Zubicaray[1], Angelique Volfart[1]; [1]School of Psychology and Counselling, Faculty of Health, Queensland University of Technology, [2]Herston Imaging Research Facility, Royal Brisbane & Women’s Hospital, [3]School of Clinical Sciences, Centre for Biomedical Technologies, Queensland University of Technology

Phonological interference (slower reaction times) and facilitation (faster reaction times) effects in spoken word production have been reported in the literature; however, their neural mechanisms are yet to be properly studied. While no

neuroimaging studies have investigated the interference effect, those that studied the facilitation effect have reported highly heterogeneous activation patterns, and over half of them failed to observe a behavioural effect (see Arrigoni et al., 2024; de Zubicaray & Piai, 2019). Together, a paradigm that robustly elicits both the interference and facilitation effects in the scanner is needed to understand the neural bases of these effects in language production. We will conduct 2 fMRI experiments using the blocked cyclic naming paradigm to investigate both effect types. Imaging will be performed on a 3T PRISMA system (Siemens Healthineers, Erlangen) at Herston Imaging Research Facility. Participants (N = 24) will attend 2 sessions (3-4 days apart) and task order (interference or facilitation) will be counterbalanced across participants. Each task will use a different stimulus set containing 36 pictures with monosyllabic names, organized into a 6-by-6 matrix. Each row represents homogeneous blocks (i.e., sharing phonemes) and each column represents heterogeneous blocks. The block order (homogeneous or heterogeneous) will be counterbalanced across participants using Latin Square design. Each block, participants will name the 6 pictures 6 times in a different order as quickly as possible. For the interference task, each homogeneous block will contain pictures with distributed phonemic overlap (e.g., cat mat cot cap map mop, same as Breining et al., 2016). For the facilitation task, the phonemic overlap will be at the same position within the word (e.g., moth mug moon mask match maze). The heterogenous block in both tasks will consist of pictures with no phonological, semantic, or visual relationship. Before each task, participants will be familiarized with the pictures. The activation patterns associated with each effect will be extracted by contrasting homogeneous with heterogeneous blocks, and the areas correlating with behavioural changes will be highlighted. The activation patterns of the two experiments will be contrasted to show brain activity specific to each effect type (interference or facilitation). We hypothesize that typical production-related brain areas will be activated in both experiments, including, for example, the left middle temporal gyrus, left posterior superior temporal gyrus (LpSTG), left supramarginal gyrus (LSMG), left inferior frontal gyrus, and bilateral sensorimotor cortices. Furthermore, we hypothesize that the LSMG will be associated with the interference effect, considering its role in speech repetition and sequencing (Hickok et al., 2023), and that the LpSTG will be correlated with the facilitation effect based on previous fMRI studies (de Zubicaray & McMahon, 2009). The results of our study will reveal the neural mechanisms of phonological interference and facilitation effects, which is crucial for understanding the functional roles of the brain areas involved in output phonological processes.

A28 *Sandbox Series* - Effects of Disconfirmed Linguistic Predictions on Memory in Bilinguals

Elaina jahanfard[1,2], Tamara Swaab[1,2]; [1]UC Davis, [2]Center for Mind and Brain

Research on prediction during language processing has mainly focused on its immediate effects, both in monolingual and bilingual individuals. Recent studies have examined the downstream consequences of unmet predictions in monolinguals, showing that they not only impact language processing but also memory for text. Prior research suggests that when predictions are disconfirmed, they can lead to false memories for words that were predicted but never actually encountered (Rommers & Federmeier, 2018; Hubbard et al., 2024). Haeuser & Kray (2022) showed that these false memories were restricted to words that were semantically related to the disconfirmed predictions (e.g., clown – circus), but were not found for words that were phonologically related (e.g., clown – cloud). However, previous research indicates that the mental lexicon in bilingual individuals is organized more according to phonological relations than semantic relatedness, compared to monolinguals. This suggests that bilinguals are more likely to activate phonologically similar words during sentence processing, thereby increasing the proportion of phonological prediction errors and the likelihood of false memory for unmet phonological predictions. The present study aims to investigate how unmet phonological and semantic predictions affect the susceptibility to false memories in bilingual individuals. We will measure heritage Spanish-English bilingual participants' ERPs to predictable and unpredictable sentence-final words in moderately constraining contexts and ask them to indicate whether they had accurately predicted the sentence-final word. Participants' prediction accuracy will be recorded via button press after each trial to determine whether they correctly anticipated the final word. We will compare ERPs to successfully predicted words against unsuccessfully predicted words for which the context was equally supportive. Additionally, we will compare responses to two types of unsuccessfully predicted words: those that were contextually supported but not predicted, and those that were contextually unsupported. The experiment will be divided into encoding and retrieval test blocks. After each encoding block, participants will complete a memory test with a confidence scale involving old words, new words, semantic lures, and phonological lures. This study will enable us to test our hypotheses regarding bilinguals' susceptibility to phonological versus semantic false memories for unmet predictions during encoding. The results will provide insights into how bilingualism influences the cognitive processes underlying prediction error and memory.

A29 *Sandbox Series* - Influence of speech rate on auditory neural tracking and neural processing of sentence predictability

Minhong Jeong[1], Minjeong Kim[1], Jieun Song[1]; [1]Korea Advanced Institute of Science and Technology

The act of speaking slowly to the other person reflects the general notion that slower speech would be helpful for the listener, which is indeed supported by previous studies. For instance, older adults with normal hearing could take advantage of additional processing time provided by a slower speaking rate in noisy environments (Adams et al., 2012), or listening effort was reduced for individuals with cochlear implant when speech was slower, partly because they can better utilize contextual information (Winn & Teece, 2021). A recent finding also reported that neural tracking of semantic features increased with decreasing speech rates (Verschueren et al., 2022). However, our recent behavioral study on listening effort with different speech rates, conducted with young normal hearing adults,

demonstrated that not only slow speeds were cognitively challenging, but speech comprehension was also impaired at slower rates. As a follow-up, we aim to investigate how neural processing of speech is affected by different speech rates at multiple levels (auditory, lexical-semantic). To this end, we measured electroencephalography responses of normal hearing young adults listening to sentences from Korean Speech Recognition Sentence Corpus (Song et al., 2023) with varying degrees of semantic predictability of the final word (predictable, neutral, anomalous). We time-compressed and expanded sentences of the KSR corpus by 25% each, resulting in three different speed conditions (fast, normal, slow). 10 subjects listened to the stimuli, where they were asked to respond with a key press whenever they heard an incongruent final word in the sentence (i.e., anomalous sentence). Auditory neural tracking of the amplitude envelopes of the sentences was examined using Multivariate Temporal Response Functions (Crosse et al., 2016). The results showed that the degree of neural tracking of the speech envelope increased in the faster condition likely because more acoustic information was processed at an auditory level in a given time (Verschueren et al., 2022). The behavioral results were more unexpected; the accuracy was lower in the slow condition than in the normal rate condition. The N400 response to the final word of each sentence showed that there was a tendency of delayed N400 in the slow condition. A significant interaction was also found between speed and sentence type for N400 amplitudes; they were larger when sentences were presented more slowly compared to the normal speed when subjects were listening to neutral sentences. These preliminary results suggest that speech rate affects both neural and behavioral responses to spoken language, where moderately fast speech like the one used in this study may be facilitating neural efficiency at least at an auditory level, whereas slower speech could be disrupting the natural flow of semantic processing, requiring more cognitive demand. In light of the current findings, we expect to see more elaborated results on whether the brain optimizes the neural mechanisms under higher temporal demands with varying speech rates.

A30 *Sandbox Series* - Whisps and whisp-ers in the Brain: A crossmodal investigation into amodal representations in English morphological processing using HD-EEG

Tyson Jordan[1], Dustin Chacón[2,1], Donald Dunagan[1]; [1]University of Georgia, [2]University of California, Santa Cruz

[INTRODUCTION] How does the brain process novel combination of morphemes? One key idea is that complex word forms are 'decomposed' into their parts. MEG signals from visual word form area (VWFA) show greater activity for morphologically complex forms ('baker' = 'bake-er') compared to form-matched simple forms ('winter') (e.g., Zweig & Pylkkänen 2009). Other evidence shows that morphological decomposition overapplies: 'brother' decomposes into 'broth-er' (Gwilliams & Marantz 2018; Rastle et al. 2004), suggesting form-based decomposition. Our question is: If morphologically complex forms like 'baker' involve reaccessing 'bake', then can we detect shared patterns of activity for 'bake'-'baker', indicating a shared representation? What about pseudocomplex words, like 'hung'-'hunger'? We also ask: are these shared representations detectable across modalities (e.g. reading vs. speech)? We present preliminary, 'sand-box' findings in reading only. [METHODS] [Materials] We prepared 90 words in three key conditions: Complex ('baker'), Pseudocomplex:ExistingStem ('hunger'), and Pseudocomplex:NoStem ('winter'). We also included their 1-syllable (pseudo)stems ('bake', 'hung', 'wint'). Filler items consisted of two- and one-syllable (pseudo)words (50% grammatical, total: 360 words). Key stimuli were controlled for length, whole-word and stem frequency, and phonological and orthographic neighborhood density. Stimuli were prepared as text and audio+video recordings of a speaker producing the word. [Procedure] Participants (N = 4) conducted lexical decision tasks in 4 modalities: text, audio, audio+video, and silent video (order counterbalanced). [RESULTS] [Behavioral] Participants performed near ceiling, with no detectable difference in accuracy (ps > 0.50) or response time (ps > 0.50) in key conditions. [EEG] Spatio-temporal cluster-based permutation tests with 1-factor ANOVAs (Complex, Pseudocomplex:ExistingStem, Pseudocomplex:NoStem) identified a cluster from 267–362ms (p = 0.14) in left parietal and posterior sensors, showing distinct EEG activity for Complex, Pseudocomplex:ExistingStem, and Pseudocomplex:NoStem words. We then conducted representational similarity analysis (RSA) to determine whether there are shared representations for stem-complex word pairs ('sing-'singer'). We subsetted the data to the Complex and Pseudocomplex stimuli, and their monomorphemic (pseudo)stems. Then, we fit representational similarity matrices (RSMs), one treating Complex words and their stems as similar (Morphological Identity; F(bake, baker) = 1.0, F(hung, hunger) = 0.0), and one treating Complex and Pseudocomplex words as similar to their (pseudo)stems (Orthographic Identity; F'(bake, baker) = 1.0, F'(hung, hunger) = 1.0). We used a searchlight RSA procedure (50ms, 30mm) to compute correlations between EEG data and the RSMs per subject. We conducted group-level t-tests to determine whether these correlations differed from zero. We found a correlation between Morphological Identity in left frontal sensors 182–400ms (p=0.2), but no correlation for Orthographic Identity. [CONCLUSION] Models of morphological decomposition hold that morphologically complex forms ('baker') involve decomposition into and activation of the stem ('bake'). These processes may only apply to morphologically complex words, or they may overapply in pseudocomplex cases. Here, we presented preliminary RSA suggesting that pairs like 'bake'-'baker' involve accessing similar representations in reading ~200–400ms, but not pseudocomplex pairs like 'hung'-'hunger'. Conference presentation will also describe results across 4 modalities, plus preliminary source space equivalences.

A31 *Sandbox Series* - Exploring Brain Activity and Multimodal Input: Effects on First and Second Language Learning and the Role of Working Memory

Mayumi Kajiura[1], Chunlin Liu[2], Diego Dardon[3], Motoaki Sugiura[2], Hyeonjeong Jeong[2]; [1]Nagoya City University, [2]Tohoku University, [3]Miyagi University of Education

[Introduction] In second language (L2) learning, multimodal input—such as information from video captions and audio—

Can mitigate prediction errors through the richness of information, thereby enhancing comprehension and acquisition (Perez, 2020). However, due to the non-automated nature of L2 processing, it can also strain the limited capacity of working memory (WM), causing difficulties in simultaneously processing information and splitting attention (Pociask & Morrison, 2004), which may hinder learning. The processing of multimodal input in the automated first language (L1) may differ significantly from L2. For instance, reading speeds are typically faster than human speech speeds (Brysbaert, 2019), implying suppression of audio input in multimodal situation. This fMRI study aims to elucidate the brain mechanisms associated with processing multimodal input in both L1 and L2, and to identify effective input presentation methods for L2 acquisition by considering individual factors that influence their effectiveness. [Method] Thirty-one Japanese university students learning English participated in this study. The participants completed a semantic judgment task, (e.g., "It is true that rabbits usually have two ears." Participants judged the truthfulness of the statement) in both their L1 (Japanese: 2 sessions, 72 trials) and L2 (English: 2 sessions, 72 trials) under three conditions: audio-only (A), visual (text)-only (V), and simultaneous-audio-and-visual (AV) presentation. Participants also took Oxford listening and reading tests to assess English proficiency, a digit span test for WM capacity, and an anti-saccade task to assess their ability to suppress attention to stimuli. [Data Analysis] Behavioral data, including accuracy and response time, and brain activities in the semantic judgment tasks under the conditions above were compared. To isolate specific brain activity related to the AV condition, brain activity in (AV - (A + V)) will be calculated in both L1 and L2 conditions. Correlations between individual English proficiency, WM, attention-inhibition abilities, and the behavioral data (accuracy and response time), as well as brain activity for each condition, were also examined. [Expected Results] According to Kajiura et al. (2021), the superior temporal gyrus (STG) and angular gyrus (AG) are involved in integrating auditory input and prior knowledge through reading transcripts. While audio might aid reading comprehension in L2, leading to integration of the two types of information, it might interfere in L1 since reading speeds surpass audio speeds. We hypothesized that in the AV condition, participants with higher attention-inhibition abilities would show increased activity in brain areas involved in attention suppression (e.g., caudate nucleus) in L1, whereas participants with higher WM would exhibit increased activity in the STG and AG due to the integration of auditory and visual information in L2. If this hypothesis is confirmed, it suggests that integrating information from multiple modalities can enhance comprehension in non-automated languages like L2, with learners possessing higher WM benefiting more significantly. Conversely, focusing on a single modality's information might be more efficient for automated languages like L1, with learners exhibiting higher attention-inhibition abilities achieving better outcomes. Thus, the effectiveness of multimodal input may vary depending on the type of stimuli presented and the characteristics of the learners.

A32 *Sandbox Series* - Neural Pathways of Vocal Pitch Modulation: An fMRI Study

Minkyu Kim[1], Gregory Hickok[1]; [1]University of California, Irvine

While human communication extensively depends on vocal pitch modulation, the neural mechanisms governing pitch control and perception are poorly understood. This research aims to elucidate these mechanisms using functional magnetic resonance imaging (fMRI) to enhance our understanding of vocal pitch coordination and its evolution in human communication. Two fMRI experimental approaches have been developed for this purpose. The first experiment focuses on identifying the neural circuits involved in pitch modulation within the speech production network. It compares neural activations during speech repetition tasks (Hickok et al., 2009, J. Neurophysiol.; Rong et al., 2018, PLoS ONE) under two conditions: one involving complete rehearsal and the other limited to humming the prosodic patterns of the auditory stimulus. The second experiment aims to distinguish pitch-specific pathways from general speech coordination networks by analyzing neural responses to speech repetition tasks under conditions of Altered Auditory Feedback (AAF; Tourville et al., 2008, Neuroimage; Niziolek & Guenther, 2013, J. Neurosci.). Both experiments seek to delineate the specific neural circuits activated by pitch changes. Preliminary findings suggest a consistent neural connection between pitch variations and specific areas of the premotor cortex, particularly area 55b (Glasser et al., 2016, Nature), and a more posterior-lateral planum temporal region, while the non-pitch variations such as voicing and vowel formants tend to be more correlated with an anatomically distinct region that is posterior to area 44. Further analyses are currently being conducted using the representational similarity analysis (RSA) technique. These observations may support the hypothesized pitch-related functions of this region as independently proposed by Silva et al. (2022, J. Neurosci.) and Hickok et al. (2022, Brain). This work is expected to not only advance our understanding of the neural basis of vocal pitch and human language but also have potential implications for clinical interventions in speech and language disorders.

A33 *Sandbox Series* - Bilingual child and adult processing of syntactically ambiguous sentences

Claire Kong-Johnson[1], V. Andrew Stenger[1], Jonas Vibell[1,2], Kamil Deen[1]; [1]University of Hawaii at Manoa, [2]John A. Burns School of Medicine

Language is full of ambiguity, from word-level ambiguity (e.g., ‘play’ can be what children often do, or it can be a theatrical performance) to sentence-level ambiguity (e.g., “the man saw the woman with binoculars” can have two meanings, depending on who has the binoculars). When we hear an ambiguous sentence and unintentionally get the wrong meaning, it requires that we revise our interpretation. That revision is cognitively demanding and requires a great deal of cognitive resources (Pozzan & Trueswell, 2016; Trueswell et al., 1999). On top of this, bilinguals must also deal with potential cross-language interference due to parallel activation of both languages. This has led to the proposal that bilingual brains are adapted to handle conflict more efficiently than monolingual brains (Green & Abutalebi, 2013). We aim to test this proposal by having Hawaiian-English bilingual children (ages 5-10) and adults perform two syntactic ambiguity resolution tasks while in an MR scanner. The sentences will be presented auditorily and, in one

task, the participant must indicate if the action they witness on the screen matches the sentence they heard, and in the other task, which of two pictures better matches the sentence. In addition to the fMRI scans, we will be collecting structural and diffusion weighted images to address the following broad goals: 1) have bilingual children acquired the ability to successfully resolve syntactic ambiguities at an earlier age than their monolingual counterparts, 2) are the brain networks that bilingual children and adults recruit different, and possibly less widespread, than monolinguals, and 3) do bilinguals show differences in white matter diffusivity and gray matter volume in the conflict resolution network. In adults, we expect to see an interaction between ambiguity and bilingualism in conflict resolution and integration networks, like LIFG, ACC, dlPFC and their connections, in the form of less widespread activation for bilinguals when dealing with ambiguity. Further, we expect that bilingual children will exhibit more adult-like activation of this network at an earlier age compared to age-matched monolinguals. Therefore, in this sandbox series poster, we will present behavioral results from three syntactic ambiguity tasks as well as pilot fMRI data from two syntactic ambiguity tasks. These preliminary data will be discussed within theories of syntactic ambiguity resolution as well as bilingual language processing. Our interest in Hawaiian-English bilinguals is a conscious effort to broaden our understanding about different types of bilinguals and highlight an understudied and endangered language to contribute to its revitalization. Our hope is that the results of this research will encourage parents in Hawai'i to commit to raising their children bilingual. The power of English is so overwhelming that unless there is deep commitment from both parents (and their extended family and support network), children invariably end up being English-dominant. Therefore, we would like to show families that if they decide to contribute to Hawaiian revitalization by raising their children bilingual in Hawaiian, their hard work will be worth it.

A34 *Sandbox Series* - Using EEG to Examine Action Semantics in Primary Progressive Aphasia

Amy Lebkuecher[1,2], Laurel Buxbaum[2], Chia-Lin Lee[3], Kristen Li[1], Branch Coslett[1]; [1]Laboratory for Cognition and Neural Stimulation, University of Pennsylvania, Philadelphia, PA, USA, [2]Cognition and Action Laboratory, Moss Rehabilitation Research Institute, Philadelphia, PA, USA, [3]Graduate Institute of Linguistics, Department of Psychology, Graduate Institute of Brain and Mind Sciences, and Neurobiology and Cognitive Neuroscience Center National Taiwan University, Taipei, Taiwan

The current study uses EEG to explore the role of action semantics in the comprehension of nouns and verbs in Primary Progressive Aphasia (PPA). PPA refers to a group of neurodegenerative diseases characterized by frank language deficits early in disease progression (Gorno-Tempini et al., 2011). Sensorimotor disruption has been proposed to explain action-related language deficits observed in other neurodegenerative disorders such as Parkinson's Disease (see Bak, 2013 for a review), but there is little research examining action semantics in PPA. For the purposes of the current project, action semantics is defined as semantic information about actions (e.g., manual gestures) that is accessible to language and during the execution, observation, and mental simulation of actions. Specifically, this project focuses on whether there is neurophysiological and behavioral evidence that the observation of gestures facilitates language comprehension in at least some individuals with PPA. Meaningful gestures facilitate language comprehension in neurotypical individuals (Gunter, Weinbrenner, & Holle, 2015; Kelly, Özyürek, & Maris, 2010; Wu & Coulson, 2007), but this facilitation has not yet been assessed in PPA. There is an on-going theoretical debate surrounding the extent to which gesture and language access a common repository of semantic representations or separate stores of semantic knowledge (e.g., Leshinskaya & Caramazza, 2016). Studying the connection between gesture and language comprehension in PPA will further inform this debate. Our experiment uses an event-related paradigm to investigate whether observing a related manual gesture facilitates the comprehension of an auditorily presented noun or verb across 10 individuals with PPA as well as 10 age-matched neurotypical controls. To examine whether sensorimotor disruption affects this facilitation in PPA, we are evaluating event-related desynchronization of the β oscillation and μ rhythm as indicators of sensorimotor aspects of action semantics (e.g., Schaller et al., 2017). If the sensorimotor aspect of action semantics is intact, we expect to observe greater event-related desynchronization of the β oscillation or μ rhythm in response to a matching gestural prime and target word. If this desynchronization is reduced or absent, then this would suggest sensorimotor disruption may contribute to any observed action semantics deficits in PPA. We examine the N400 as an index of semantic priming across gesture and target word, as well as how this effect relates to behavioral evidence for priming (e.g., faster response time to matching gestural primes and target words). Individuals with impaired comprehension should exhibit a reduced response time benefit for trials where a matching gesture precedes the target word and a reduced or absent N400 effect in response to mismatches. Here we present preliminary findings for the project as data collection is still in progress.

A35 *Sandbox Series* - Aspects of syntactic production represented in inferior frontal gyrus

Tianhao Lei[1], Prashanth Prakash[2], Crispin Foli[4], Joshua Glaser[1], A. Bolu Ajiboye[4,5], Marc Slutzky[1,2,3]; [1]Department of Neurology, Northwestern University, IL, [2]Department of Biomedical Engineering, Northwestern University, IL, [3]Department of Physical Medicine & Rehabilitation, Northwestern University, IL, [4]Department of Biomedical Engineering, School of Medicine, Case Western Reserve University, OH, [5]FES Ctr of Excellence, Rehab. R&D Service, Louis Stokes Cleveland Dept of Veterans Affairs Medical Center,OH

Inferior frontal gyrus (IFG) is thought to be an important node in the human language network. Lesions in this area, especially neurodegenerative, can lead to expressive language deficits including omission of grammatical elements and simplified sentence structure (agrammatism). Grammatical syntax provides words with context that highlight differences in time (e.g., tense), grammatical number (singular vs. plural) or

semantics. Some imaging studies have reported an association between damage to IFG and syntax comprehension. Evoked responses in IFG, mainly in pars triangularis, Brodmann's area 45, showed some modulation with tense processing (Sahin et al, Science 2009). However, IFG's (in particular area 44's) role in grammatical processing remains unclear. Particularly unclear is the type of processing in which IFG participates and the amount of information it contains about syntax on the neuronal scale. Here, we recorded intracortical activity from a human participant as part of the Reconnecting the Hand and Arm to the Brain (ReHAB) clinical trial. We recorded broadband (30 kHz sampling rate) signals with a 64-channel microelectrode array placed on the anterior border of areas 44 and 6v. The participant was instructed to read a sentence that had one verb missing displayed on a monitor. This was followed by the display of a root verb that the participant was asked to conjugate, in agreement with the grammatical context of the sentence. We used two types of verb inflection: grammatical number (e.g. kicks vs. kick) and tense (e.g. kicked vs. kick). After a go cue, the participant spoke the conjugated word aloud. We extracted spike band power (300 Hz – 5 kHz) and binned it at 50ms and aligned all the trials to voice onset time for further analysis. We observed in trial-averaged data that some of the electrodes demonstrated early modulation 500 ms prior to voice onset, while some others showed activity after voice onset. For each type of syntax decoding, we built a supported vector machine decoder with a nonlinear kernel at each time step. We used 10 causal bins of history to construct the neural features, resulting in 640 features per time step. A small set of trials were reserved as a test set. To prevent overfitting, we used the first 10 principal components as features. We observed significantly above-chance accuracy starting approximately 450 ms prior to voice onset for grammatical number decoding, and 200 ms prior to voice onset for tense decoding. These results suggest that IFG may play a role in processing syntax for speech production.

A36 *Sandbox Series* - The Systematic Variability of Individual Differences in Neural Representations across Tasks within Large-Scale Brain Networks

Liu Linyan[1], Ding Guosheng[1]; [1]Beijing normal university

The current functional magnetic resonance imaging (fMRI) research is shifting from the traditional focus on the average effects at the group level to the recognition of individual-level differences. However, most studies have not controlled for individual genetic differences, and the characterization of individual differences using small samples and single tasks has severe limitations. This study utilized the Human Connectome Project dataset to compare the neural representation similarity between monozygotic twins across various cognitive tasks (such as language task, emotion task and decision-making task). Furthermore, the study explored the distribution and topological structure in individual differences of neural representation in large-scale brain networks across different cognitive tasks. The results showed that the individual differences in neural representations between monozygotic twins exhibited strong flexibility across different cognitive tasks. In language and mathematical operations tasks that requiring higher-order cognition, the individual differences in neural representations within the default network decreased (i.e., representation similarity increased). However, when cognitive processing relied more on external stimuli, the individual differences in neural representations within the default network increased, while the individual differences in somato-motor networks decreased. Across different cognitive tasks, the individual differences in neural representations within the default network strongly and positively modulated the individual differences in transmodal networks (language, fronto-parietal, orbito-affective networks), while negatively modulating the individual differences in unimodal networks (visual, somato-motor and attention networks). That is, the greater the individual differences in the default network, the greater the individual differences in the language, fronto-parietal, and orbito-affective networks, and vice versa for the unimodal networks. These results suggest that individual differences in cognitive representations are flexibly adjusted across different tasks, especially in tasks involving higher-level cognitive processing such as language, the default network is believed to play a core role in this regulation.

A37 *Sandbox Series* - Does Segmentation Disrupt Dependency Processing? A Frequency-Tagging and ERP Study on Natural Language

Chia-Wen Lo[1], Lars Meyer[1,2]; [1]Max Planck Institute for Human Cognition and Brain Sciences, [2]University Clinic Münster

INTRODUCTION Humans need to link the words and morphemes of a sentence to comprehend it. However, this ability is constrained in time by the capacity of our working memory. Recently, it has also been suggested that the length of the underlying neural processing time windows also poses a constraint. In particular, cycles of neural oscillations in the delta band (< 4 Hertz) have been discussed to serve and constrain the formation of multi-word chunks (Henke & Meyer 2021; Henke & Meyer 2023; Lo et al. 2023). But if we sample and process speech chunk by chunk, how can we link words and morphemes that belong to separate chunks? That is, how can we establish dependencies across different memory units or different processing cycles? METHODS During EEG recording, native German speakers listen to trials consisting of six 10-syllable sentences that contain an agreement dependency. Eight conditions were created by manipulating three factors: (i) whether there is gender agreement or not (i.e., agreement violation); (ii) gender (female/male); and (iii) agreement within a single chunk or across a chunk boundary. We employed a frequency-tagging paradigm to assess neural segmentation. In addition, we analyzed ERPs to the second element of the dependency. PREDICTION Data collection is still in progress. We expect a peak at the rate of sentences in both the within-chunk and across-chunk conditions in the power spectrum, suggesting the active segmentation of continuous speech into multi-word memory chunks. Additionally, if dependency processing across chunks is more difficult, the difference between the agreement and violation conditions will be smaller in the across-chunk condition than in the within-chunk condition. The results help us better understand how we integrate the time-constrained chunk-by-chunk sampling of speech and the processing of non-adjacent dependencies and whether the

sampling of chunks in some way blocks the formation of non-adjacent dependencies in natural language comprehension.

A38 *Sandbox Series* - Modelling the late frontal positivity: an investigation into the relationship between prediction failure and semantic learning

Yiming Lu[1]; [1]University of California, Irvine

Background: prediction is widely acknowledged as a fundamental mechanism in language comprehension. Yet, the consequences of prediction failures remain debated. Prediction failures leave electrophysiological traces in the brain. When an unexpected but plausible word disconfirms comprehenders` prediction, a post-N400 frontal positivity (short for frontal PNP) signal has been elicited by various studies (DeLong et al., 2014; Federmeier et al., 2007; Kutas, 1993; Moreno et al., 2002; Quante et al., 2018). Many proposals have been advanced to explain the underlying cognitive processes, including prediction error detection (Delong et al., 2011; Thornhill & Van Petten, 2012), inhibition of the expected words (Federmeier et al., 2007; Kutas, 1993; Ness & Meltzer-Asscher, 2018), as well as the memory enhancement of the unexpected words (Lai et al., 2021). However, the above hypotheses have been overshadowed by subsequent experiments, and the nature of frontal PNP remains elusive. In this proposed study, we hypothesize that frontal PNP reflects the updating of the probabilistic distribution of words in contexts (Rommers, 2022). Furthermore, we propose that different thematic roles modulate the updating process differentially, such that core thematic components of an event will have a larger frontal PNP reduction than non-essential ones. Methods: we use repetition priming to examine these hypotheses. 40 monolingual English speakers will be recruited. Two studies will be conducted. Contexts are biased towards an instrument in Study 1 and a manner in Study 2. All stimuli will be examined in a cloze probability test to make sure all sentence contexts are highly constraining (>70% cloze probability). Unexpected but plausible continuations are created for qualified sentences, which are subjected to plausibility judgments (5-point Likert scale, rating > 1.5). Participants read a sentence with prediction disconfirmation (e.g., the boy swept the floor with a robot, biased for instruments), which was followed by filler sentences. Then comes the critical sentence that differs from the initial sentence only in the final word. The critical sentences contain three conditions: same word/expected role (robot), different word/expected role (rag), and different word/unexpected role (smile). A linear mixed model with by-subject and by-item intercepts and slopes will be constructed for frontal PNP. Predictions: Regarding hypothesis 1, we predict that frontal PNP will be lower if the unexpected word is repeated in the second presentation (i.e., robot), compared with violations seen for the first time (i.e., rag and smile). This means that frontal PNP is sensitive to repetition priming and potentially, the perturbation of the local statistical distributions. However, if the opposite is borne out, the hypothesis is likely wrong. Regarding hypothesis 2, we predict that frontal PNP is sensitive to thematic roles. If contexts suggest a core thematic role, like instruments, the PNP amplitude for another unexpected instrument (i.e., rag) should be lower than the unexpected role (i.e., smile). This suggests that the belief updating for word association is differential depending on the kind of information encoded. However, if there is no significant difference between instrument and role, PNP is likely insensitive towards thematic roles.

A39 *Sandbox Series* - Methodological Insights into Declarative Memory Assessment: Investigating the Impact of Familiarity and Visual Complexity in Picture Recognition Tests

Jiayi Lu[1], Jueyao Lin[1], Xiaocong Chen[1], Lu Li[1], Fumo Huang[1], Caicai Zhang[1]; [1]The Hong Kong Polytechnic University

INTRODUCTION: Declarative memory, crucial in language-related studies due to its link with vocabulary abilities (Hamrick et al., 2018), involves storing and recalling facts and events. Recognition tests, commonly used to evaluate this memory, present participants with a mix of previously studied (target) and new (distractor) items, asking them to identify the studied items after a delay. This method assesses declarative memory using signal detection theory and evaluates its retention by testing at different delays. Both verbal (e.g., words) and non-verbal (e.g., pictures) stimuli can be used, with pictures preferred to minimize verbal influences (Ullman, 2020). Controlling confounding factors is essential for valid test results. In picture-based recognition tests, familiarity and visual complexity are key factors, with familiarity negatively and complexity positively correlated with memory performance according to a previous study (Brodeur et al., 2017). The effects of these two variables on memory performance across different contexts (e.g., target vs. distractor pictures, short vs. long delays) and their potential interactions remain unclear. This research aims to clarify these questions, in order to enhance declarative memory assessment and inform future methodologies. METHODS: Eighty scene pictures were rated on familiarity and complexity by 20 native Cantonese-speaking adults (mean age: 22.3 ± 3.79 years; 10 female) using a 1 to 5 scale. These pictures were then used in recognition tests with a different group of 28 native Cantonese-speaking adults (mean age: 22.96 ± 3.54 years; 16 female). Participants studied 40 pictures and were tested with 20 studied pictures and 20 distractors after 10 minutes (immediate test) and with the remaining 20 studied pictures and 20 new distractors after 24 hours (overnight test). Each picture was tested in all four contexts (immediate-studied, immediate-distractor, overnight-studied, overnight-distractor) with seven participants per context. Recognition accuracy was analyzed using a logistic mixed-effects model, examining main effects and interactions of picture familiarity, complexity, target vs. distractor status, and test delay, with gender and age as control variables, and random effects for subjects and picture items. FINDINGS: An interaction between picture familiarity and complexity ($p = 0.026$) shows that accuracy improves with increased familiarity at high complexity (complexity = 3.66). This trend weakens (complexity = 2.91) or reverses (complexity = 2.15) as complexity decreases. This finding aligns with the study showing a negative correlation between familiarity and memory accuracy for low-complexity object pictures (Brodeur et al., 2017). The interaction is more pronounced in immediate tests but absent in overnight tests, as revealed by a marginal three-way interaction with test delay ($p = 0.075$). The model also predicts larger accuracy variations at extreme familiarity and complexity levels. Accuracy is higher in immediate tests ($p < 0.001$) due to memory decay, and distractor pictures show higher accuracy ($p = 0.077$), likely due to decision biases. DISCUSSION: These findings necessitate the careful selection of pictures with moderate

familiarity and complexity, and the rigorous balancing of interactions between familiarity and complexity for both target and distractor pictures in short-delayed recognition tests. These strategies could enhance the accuracy of declarative memory assessments and support language-related studies.

A40 *Sandbox Series* - Dissociate language selective region from domain general region using functional near-infrared spectroscopy: an individual functional channel of interest analysis approach

Haolun LUO[1], Qun LI[2], Li SHENG[1]; [1]Hong Kong Polytechnic University, [2]West China Hospital of Sichuan University

Many cognitive operations in language comprehension are domain-general, suggesting that the "multiple demand" (MD) brain network, associated with domain-general executive functions, may perform these operations (Fedorenko & Shain, 2021). However, recent evidence suggested that the language and MD network are dissociable (Fedorenko et al., 2024). Language-selective regions likely implement these computations locally. Defining functional region of interest is a valid method to dissociate language processing from other cognition in fMRI studies. In this study, we extend this method to fNIRS. Sixteen university students participated in three tasks: an auditory language localizer task (adapted from Scott et al. 2017), a spatial working memory task (adapted from Fedorenko et al. 2011) and listening to a 5-minute narrative recording. In the localizer task, participants listened to intact and degraded audio clips. Each run consisted of two 18s blocks of the intact and degraded audio type, with a 10s fixation at the beginning of each block. In the spatial working memory task, participants tracked four (easy) or eight (hard) locations on a 3 × 4 grid and then chose the correct grid in a two-choice question. The fNIRS measurements were recorded with a 79-channel system. Data were then preprocessed using the HomER3 (Huppert et al., 2009). We first took the standard fixed array analysis for different condition contrasts with Bonferroni correction. Then, in fCOI analysis, we defined the fCOI within participants using a leave-one-run-out procedure (Liu et al., 2022). Specifically, for each participant, one run of data from the localizer task is left out iteratively while the remaining runs are used to define the fCOI. The fCOI identified was used to extract a response for each condition from the left-out run. For each participant, the extracted response were averaged for each condition. We used a linear mixed-effects (LME) analysis on these averaged values to account for individual differences in global signal strength: full model = channel HbO data ~ condition + (1 + 1|subject). We then extracted the HbO time courses when listening to the narrative from the language and MD fCOI. For each participant and fCOI, we computed the intersubject correlation (ISC, Blank & Fedorenko., 2024). We tested whether the average ISCs differed between the language and MD fCOI using LME model: full model = ISCs ~ fCOI + (1 + 1 | subject). For the selected language fCOIs, the mean HbO2 concentration in the left-out data was significantly higher for the intact audio trials than that for the degraded audio (β = -5.20e-7, SE = 2.32e-7, p=0.032). Also, the selected language fCOIs tracked the linguistic input more closely than the MD (β = -0.28, SE = 0.13, p=0.027). However, language fCOI did not show a significant difference between the hard and the easy conditions in the spatial working memory task (β = 9.71e-8, SE = 1.35e-8, p=0.47). In the fixed-array analysis, none of the channels exhibited significantly higher HbO2 concentration in language localizer task. This study establishes the feasibility of identifying language-responsive channels at the individual level by fNIRS with better sensitivity.

A41 *Sandbox Series* - Why do we mind-wander when we read? Insights from reading an unfamiliar language.

Lidon Marin Marin[1,2], Chen Chen[1,2], Katya Krieger-Redwood[1,2], Elizabeth Jefferies[1,2]; [1]Department of Psychology, University of York, [2]York Neuroimaging Centre

Common experience shows that it can be difficult to keep our focus on the task we want to be engaged with - for example, when trying to get some work done in a café, we might get distracted by overhearing a conversation near us, and its content might elicit our own personal thoughts that also distract us from work. However, the extent to which we get distracted depends on several factors – e.g., if the conversation is in a language that is not familiar for us, it will probably be less distracting. The phenomenon of drifting attention away from task-related information to task-unrelated thoughts is called mind-wandering, and not many studies have investigated its neural correlates yet. Previous evidence suggests that the default mode network (DMN) may be especially relevant for mind-wandering when reading: it has been shown to be more decoupled from medial visual regions in participants who mind-wander more frequently when reading (1) and to be more functionally coupled to visual cortex when focus is stronger for the task, i.e., there is less mind-wandering (2). However, to the best of our knowledge, the neural basis of mind-wandering when reading has never been explored using linguistic stimuli in languages that are non-native or unfamiliar for participants. We have recently started an investigation – acquisition of functional MRI is still ongoing – inspired in the procedure used in a previous study (2). Specifically, we ask participants either to engage with personal thoughts (elicited by a thought-probe such as ‘Easter holiday’) while ignoring sentences on the screen (“recall” condition); or to suppress personal thoughts while engaging with the sentences on-screen (“comprehend” condition). After each sentence’s presentation, we ask participants to rate their focus on the corresponding task. Sentences are written in English (native language of our participants) or Spanish (non-native, unfamiliar language with the same alphabet). We hypothesise that semantic engagement drives distraction because personal thoughts and language processing both require this resource. We also hypothesise that familiar language inputs access meaning more automatically than unfamiliar language, even if both languages share alphabet and cognates are present. Therefore, we expect less mind-wandering when reading sentences while trying to ignore personal thoughts in English than in Spanish; but more mind-wandering when engaging with personal thoughts while trying to ignore sentences in English as compared to Spanish. Based on previous evidence (1,2), we expect the DMN to be more coupled with visual regions when engaging with reading sentences and successfully ignoring personal thoughts, and more decoupled when mind-wandering while trying to read sentences. We also expect the anterior temporal lobe to be decoupled from visual input and coupled with the core DMN when successfully

engaging with personal thoughts and ignoring sentences, but to show the opposite pattern when getting distracted from personal thoughts by on-screen sentences. Our investigation will further contribute to unveiling the neural mechanisms of mind-wandering. It is also especially relevant in the context of a multilingual world and could have potential implications for language learning and communication practices.

A42 *Sandbox Series* - Preliminary findings from functional Near Infrared Spectroscopy-based adaptive language mapping in people with post-stroke aphasia and neurologically healthy controls

Erin Meier[1], Veronica Fletcher[1], Esprit Ange Andraos[1], Lauren Rauert[1], Isabelle Cotenoff[1], Leanna Ugent[1], Gengchen Wei[1]; [1]Northeastern University

Introduction: Longstanding questions remain unanswered about the nature of beneficial functional reorganization of language in people with post-stroke aphasia (PWA), particularly the roles of left versus right hemisphere regions and the recruitment of the multiple demand (MD) network in recovery. Previous studies in aphasia have not sufficiently controlled for task difficulty, which may have contributed to mixed findings. Reliance on fMRI as the lead imaging modality for studying aphasia recovery also creates barriers to participation for some participants (due to e.g., MR contraindications), which further limits generalizability of findings. Therefore, in this sandbox presentation, we will present preliminary results from a functional Near-Infrared Spectroscopy (fNIRS) study in which participants with aphasia and age-matched healthy controls completed the Adaptive Language Mapping (ALM) Semantic Matching (Wilson et al., 2018) and Rhyme Judgment (Yen et al., 2019) tasks. The overarching aim is to determine the extent to which PWA and controls recruit language versus MD regions when task difficulty at the subject level is controlled. Method: Twenty PWA and 20 neurologically healthy adults will participate. The ALM fNIRS tasks follow an AB design with alternating blocks of experimental trials (semantic or rhyme judgment) and control trials (letter strings matching). Data are acquired with two daisy-chained 8x8 NIRx NIRSport2 devices with 16 sources and 16 detectors. The bilaterally symmetrical 44 long- and 8 short-channel montage covers classic language regions (split into inferior frontal gyrus (IFG) and temporal regions of interest [ROIs]) and portions of the bilateral MD network (including parts of rostrolateral (RLPFC) and dorsolateral (DLPFC) prefrontal cortices) (Fedorenko & Thompson-Schill, 2014). For both tasks, data processing will be done in Homer3 (Huppert et al., 2009) and activity in MD versus language regions (broadly defined based on Fedorenko et al., 2010) will be compared between groups. Preliminary Results: Thus far, Semantic Matching behavioral and fNIRS data have been collected and analyzed for 14 PWA and eight healthy controls. As expected for an adaptive task, accuracy did not differ between groups (t= 0.679, p= 0.507) but controls were significantly faster than PWA (t=14.51,p<0.001). At a group level, PWA and controls exhibited activity across channels within bilateral frontal and temporal language ROIs. Activity in the MD regions was observed for some participants, resulting in significant activity at the group level for PWA but not controls. Counter to predictions, PWA exhibited greater activity in language ROIs (bilaterally) than controls, but these findings may reflect reduced power with the current small sample of controls. Discussion: The overarching motivation for this study is to address a central methodological limitation of previous functional imaging studies in PWA (i.e., task difficulty confounds) using a promising imaging modality, fNIRS. The preliminary findings suggest that PWA activate MD regions, even when task difficulty is controlled for at a single subject level. Next steps include analysis of the complete dataset and investigation of relationships between fNIRS activity and language task data. During the sandbox presentation, feedback from attendees about important methodological (e.g., fNIRS modeling) and theoretical issues will be elicited.

A43 *Sandbox Series* - Investigating semantic representations with varying context during language comprehension

Anuja Negi[1,2], Fatma Deniz[1,2]; [1]Institute of Software Engineering and Theoretical Computer Science, Technische Universität Berlin, Berlin, Germany, [2]Bernstein Center for Computational Neuroscience Berlin, Berlin, Germany

Semantic representations are affected by the amount of context. Increasing the amount of context in the stimulus increases the representation of semantic information across the human cerebral cortex (Deniz & Tseng, et al. 2023). In their work, Deniz & Tseng et al. used static embeddings to capture the semantic properties of individual words. However, static embeddings do not account for different word senses or contexts. In this study, we extend their work by comprehensively comparing voxelwise encoding models based on both static and contextual embeddings. We used functional magnetic resonance imaging (fMRI) to record human brain responses. Each participant read words under four conditions that varied in context: narratives, isolated sentences, blocks of semantically similar words, and isolated words. Stimuli for all four conditions were generated from 11 spoken stories from The Moth Radio Hour (previously used by Huth et al., 2016). We then used a voxelwise encoding modeling (VM) approach to compare how different semantic models integrate contextual semantic information differently across the four conditions. We first extracted low-level linguistic embeddings, and several semantic embeddings (static and contextual) from the stimulus words in each condition separately. The low-level linguistic embeddings were phoneme count, number of words, number of letters, letters, and word length variation per TR. Traditional static vectors such as GloVe were used to get the static embeddings. Layer-by-layer representations from large language models such as BERT, GPT and Llama, were used to extract contextual semantic embeddings. Banded ridge regression (Nunez-Elizalde et al., 2019) was used to determine how each embedding is represented in each voxel (Wu et al. 2006, Naselaris et al. 2011). Prediction accuracy was quantified by calculating the Pearson correlation coefficient (r) between predicted and recorded BOLD responses. Separate datasets were used for model estimation and evaluation to estimate prediction accuracy. A separate voxelwise encoding model was fit for each voxel, participant, and stimulus condition. Our preliminary findings indicate that both static and contextual embeddings predicted brain responses more accurately when the stimulus included more context. A comparison between static and contextual embeddings suggests that the difference in predic-

-tion accuracy is more pronounced in stimuli with greater context.

A44 *Sandbox Series* - Neurotechnological Innovations for Multilingual Communication: Challenges and Future Directions for Low-Resourced Languages

Abigail Oppong[1]; [1]Independent Researcher

Recent breakthroughs in Brain-Computer Interface (BCI) technology have enabled individuals with various neurological conditions to communicate using neural signals decoded by implanted devices. These advancements are critical for improving the quality of life for individuals with severe motor impairments, speech disorders, and other conditions affecting communication abilities. Currently, these breakthroughs have worked in two languages: English and Spanish. This project aims to expand BCI communication capabilities to include low-resourced languages, addressing a significant gap in neurotechnological research. Ensuring multilingual inclusivity is vital for developing equitable neurotechnological solutions, as it allows for the evaluation of cross-linguistic generality and the exploration of neural mechanisms specific to diverse languages (Malik-Moraleda, Ayyash et al., 2022). This work seeks to leverage the successful implementation of brain implants in individuals with neurological conditions to enable multilingual communication through neural signal decoding as a case study to advocate for language inclusivity in BCI communication capabilities. The implant, consisting of electrodes placed on the sensorimotor cortex, captured brain activity as participants thought of specific words and phrases. This captured neural data was processed using artificial intelligence (AI) algorithms to translate thoughts into coherent speech across multiple languages. To ensure the robustness and inclusivity of the BCI system, this study highlights the need to incorporate several innovative methodologies, including biological and environmental diversity, by including languages of populations from diverse demographic backgrounds, accounting for age, gender, and environmental influences on brain activity. Using the state of the art techniques, neural signals processed using state-of-the-art AI techniques, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and transformers, will be finetuned to handle the complexity and variability in neural signals associated with different languages. In enhancing multilingual Models, the AI algorithms will be fine-tuned using transfer learning from pre-trained models on high-resource languages and augmented with data from low-resourced languages. This ensures accurate decoding of neural signals into multiple languages, including those with limited linguistic resources. Comprehensive ethical protocols will be in place to address privacy and data security concerns, ensuring informed consent and mitigating biases in AI models. This study also seeks to expand on the need to collect neural data from speakers of various low-resourced languages and Data Augmentation to enhance data diversity through synthetic data generation and related language data. Leveraging pre-trained models on high-resource languages, fine-tuning with low-resourced language data, and Incorporating robust language models (e.g., GPT, BERT) for understanding linguistic structures.

A45 *Sandbox Series* - Changes in white matter microstructural integrity across the early subacute, late subacute and chronic stages of stroke recovery: a longitudinal diffusion-weighted MRI study

Viktoriia Pozdniakova[1,2], Stephen Wilson[1], Katie McMahon[3,4], David Copland[1,2], Sonia Brownsett[1,2]; [1]School of Health and Rehabilitation Sciences, The University of Queensland, [2]Queensland Aphasia Research Centre, The University of Queensland, [3]Herston Imaging Research Facility, [4]School of Clinical Sciences, Queensland University of Technology

In aphasia rehabilitation, it is widely accepted that the most significant improvements occur within the first three months following a stroke. After this period, recovery becomes less pronounced and depends on various factors, including lesion site and size, and initial impairment severity [1]. Reduced microstructural integrity of the white-matter tracts involved in language processing is commonly observed in post-stroke aphasia. However, findings regarding changes in white matter connectivity across the course of aphasia recovery have been inconsistent [e.g., 2,3]. In this sandbox series presentation, we describe our project in progress aiming to evaluate changes in structural connectivity across the stroke recovery trajectory. We are conducting a longitudinal diffusion-weighted MRI study with a cohort of stroke survivors. In total, 34 participants have been recruited (28.4 ± 9.3 days post-onset), 18 of whom underwent follow-up screening and imaging at the late subacute stage (96.8 ± 8.8 days post-onset), and 29 at the chronic stage (205.7 ± 17.4 days post-onset). We also recruited a control group of 39 age- and sex-matched healthy participants. Tracts of interest will be mapped with an automatic fibre-tracking algorithm in DSI Studio [4]. The following metrics of microstructural integrity will be derived: quantitative anisotropy (QA), i.e., the degree of anisotropy of water diffusion in the tract; axial diffusivity (AD), i.e., the magnitude of diffusion parallel to the tract; radial diffusivity (RD), i.e., the magnitude of diffusion perpendicular to the tract; and the mean diffusion (MD), i.e., the mean amount of diffusion in a voxel. We will evaluate: (1) these metrics in the clinical group, in comparison to the control group; (2) differences between the diffusion metrics in the left hemisphere, compared to the intact right hemisphere; and (3) changes in diffusion metrics across the early subacute to late subacute to chronic stages of stroke rehabilitation. We hypothesise that: (1) at the early subacute stage, QA values will be decreased in the left hemisphere tracts of those with post-stroke aphasia compared to healthy controls, due to the stroke-induced disruption of white matter integrity; (2) QA values will be decreased in left hemisphere tracts compared to the intact right hemisphere; and (3) the differences in diffusion metrics observed between groups and hemispheres will change over the course of recovery, reflecting axonal degeneration along with potential neuroplastic changes. Our findings will contribute to a better understanding of the mechanisms and time course of structural connectivity changes in recovery from aphasia after stroke. References 1. Pedersen et al., Ann Neurol 1995;38(4):659–666. 2. Bae et al., Neurorehabil Neural Repair 2022;36(9):633–644. 3. van Hees et al., Neurorehabil Neural Repair 2014;28(4):325–334. 4. Yeh, DSI Studio (2021) [Computer software]. Zenodo.

A46 *Sandbox Series* - The bilingual language processor: A separate or shared system?

Laura Sabourin[1], Melanie Knezevic[1], Gabrielle Manning[2], Shuzhen Wang[1], Yubin Xing[1]; [1]U. of Ottawa, [2]U. de Montréal

During language use, speakers apply grammatical rules that are represented in an internal language system to convey their message. In bilingualism research, it is debated whether this system is language specific (i.e., a separate grammar for each language) or shared (i.e., one grammar for both languages). Previous research has shown that the answer is not clearly one or the other and that how multiple grammars are represented is likely due to the involvement of various linguistic and environmental factors. Depending on the similarity between languages, a large degree of redundant information in the linguistic system may not be an efficient method of storage. On the other hand, grammatical systems may be shared, which would result in a more efficient storage system resulting in cross-linguistic interference. The debate of shared vs. separate grammars has previously been investigated making use of structural priming in which it has been found that speakers show a tendency to produce or more easily process a sentence that is structurally similar to a previous sentence (e.g., Bock, 1986). Further, cross-linguistic structural priming in second language (L2) speakers has shown that, for languages with identical sentence structures, priming occurs between languages, suggesting a shared system (e.g., Hartsuiker et al., 2004; Loebell & Bock, 2003). It is less clear if priming effects manifest when grammatical structures are similar but not identical across languages (Ahn et al., 2021; van Gompel & Arai, 2018). In our proposed research we aim to investigate the English-French bilingual grammar system of simultaneous bilinguals, sequential bilinguals and L2 learners by testing two linguistic structures (grammatical gender and adverb placement). Specifically, this will allow us to evaluate the bilingual processing of 1) a feature that is present in one language and absent in the other (grammatical gender) and 2) a structure that is similar but not identical in its word order (adverb placement). We aim to discuss our methodological plans and our hypotheses for our electrophysiological data. More specifically, we hope to get feedback about our participant groups and we hope to discuss the ERP components of interest. While our goal is to ultimately compare late bilinguals and L2 learners, we will also discuss what this means for the typical “monolingual” control group.

A47 *Sandbox Series* - Modulation of speech production network in picture naming and word read-aloud: A graph signal processing analysis of electrocorticography data

Hiromu Sakai[1], Jion Tominaga[1], Ji-Hyun Park[1], Yuichi Kubota[2], Takafumi Inoue[1]; [1]Waseda University, [2]Tokyo Women’s Medical University

Introduction: In spoken word production, the same sensorimotor output can be produced from the cortical network for speech production depending on the tasks. Picture naming and word read-aloud are good examples that produce the same output (for instance the sound “apple”) by performing two distinct tasks (naming the apple images or reading the letter string A-P-P-L-E). Previous research (Wu et al., 2011) reported that, though these tasks both activated left frontal-temporal language networks, picture naming elicited greater neural activation in the left dorsolateral premotor-prefrontal areas and word read-aloud elicited greater activation in the left ventral occipital-temporal areas. However, little is known about how these regions interact to produce the same output when performing different tasks. In this study, we use graph signal processing methods to examine the functional connectivity among regions in the analysis of electrocorticography (ECoG) recording data when the subject performed picture naming and word read-aloud tasks. Participant: A 68-year-old right-handed native Japanese speaker diagnosed as having a glioma in the left frontal region participated in this research. The patient was scheduled for surgery to remove the affected area at the Department of Neurosurgery at Tokyo Women’s Medical University Adachi Medical Center. Subdual electrodes were placed for pre-surgical examination 5 days before the experiment. Stimuli Presentation: 32 picture images and matching words in Japanese “katakana” fonts were presented on a 19-inch LCD monitor about 60 cm in front of the patient. Each stimulus was randomly presented 8 times during two experimental sessions. Each trial consists of 500 ms fixation and 500 ms stimulus presentation, followed by another 500 ms fixation. Interstimulus intervals were varied between 700 to 1300 ms. Data Acquisition: 36 grid-electrodes and 6 deep-electrodes were surgically implanted covering the left inferior to middle frontal and superior temporal to occipital-temporal areas. ECoG signals were recorded at 1,000 Hz sampling frequency by Nihon Kohden Neurofax 1200 Digital System. Analysis: Preprocessing was performed using MNE-Python analysis tools. 1,000 ms epochs were extracted from the recording data and baseline-corrected relative to 100 ms before the onset. Event-related potentials (ERPs) were calculated by averaging high frequency band activities extracted from each epoch using a band-pass filter between 65 to 155 Hz. As an in-progress analysis, Linear Predictive Coding (LPC) coefficients are obtained and use for Graph Learning (GL) to infer the underlying functional connectivity in the speech production network (Ries et al., 2020). A GL algorithm will take the entire connectivity map consisted of ECoG electrodes as graph vertices and decide the connection weights that best explain the LPC coefficients (Tavildar et al., 2019). Preliminary and Expected Results: Amplitude modulation of ERPs was observed at the electrodes placed in the left inferior frontal and temporal areas in both conditions. Picture naming elicited stronger activation at the electrodes located in the left ventrolateral frontal areas. Word read-aloud elicited stronger activation at the electrodes in the left temporal-parietal areas. GL algorithms are expected to show stronger connectivity in the dorsolateral areas for picture naming whereas in the ventral occipital-temporal areas for word read-aloud.

A48 *Sandbox Series* - Cerebro-cerebellar interactions during narrative comprehension in Chinese-English bilinguals

Chan Tang[1], Guosheng Ding[#]; [1]Beijing Normal University

Bilinguals utilize shared but not perfectly same brain regions when processing different languages. While previous research indicated that both the cerebrum and cerebellum were engaged in bilingual language processing, less research investigate the cerebro-cerebellar interaction and whether the interaction profile were flexibly adjusted in bilingual brain. Here we focus on cerebro-cerebellar interaction during oral narrative comprehension, trying to reveal the interaction profile during the first and the second language processing in Chinese-English bilinguals. Further, we explore the neural encoding and decoding mechanisms for different stories with cerebro-cerebellar interaction patterns. Twenty-eight highly proficient Chinese-English bilinguals were included in the experiment (all females, 22.9 ± 2.8 yrs). All subjects listened to eight 60 s-long stories in both Chinese version and English version. Before scanning, all the participants completed the General English Test, fluency test, English speaking and comprehension assessment as well as the Language History Questionnaire(LBQ). Imaging data were acquired on a Siemens 3-T Trio scanner. Univariate analysis and functional connectivity analysis were performed first after controlling for AoA and proficiency. Network analysis was then carried out to draw a whole picture of brain organization during bilingual narrative processing. In order to further illustrate the role of cerebro-cerebellar interactions during narrative comprehension, we complete a multivariate analysis in which individual cerebellar voxel to the whole cerebrum connectivity pattern were extracted and used to decode different story using Representational similarity analysis. Results show that both the cerebellum and the cerebrum were recruited in the narrative processing, with similar activation pattern across languages (peak cerebellum activation in Right Crus2, located in (11,-85,-42)). Whole-brain connectivity analysis reveals that the cerebro-cerebellar connections show a L1 preference in which stronger cross-brain coupling during L1 narrative processing compared to L2 narrative processing. Network analysis further confirms that L1 processing shows higher Characteristic path length ($t(27) = 2.17$, $p = 0.039$), which indicates a higher functional integration of brain network. In addition, RSA based on multivariate cerebro-cerebellar connectivity pattern shows that distributed cerebellar voxels' connectivity pattern could decode different story meaning, which mostly located similarly at bilateral posterior cerebellum including region Ⅶ, Ⅷ, crus Ⅰ and Ⅱ in both languages. While wider range of cerebellar voxel' could represent different narrative meaning using connectivity pattern during L1 processing(725 voxels in L1 and 389 voxels in L2, FDR $p<0.05$), voxels in right Ⅵ can represent story meaning only based on L2 connectivity pattern, which indicate a more extensive representation of story meaning in cerebellum during L1 narrative processing and a special role of right Ⅵ in story meaning decoding during L2 narrative processing. Our results provide important insights as to how the cerebellum is engaged in language processing and deepen our understanding of the cerebro-cerebellar interaction mechanism in bilingual narrative processing.

A49 *Sandbox Series* - Spatiotemporal characteristics of semantic facilitation and interference: An MEG study using the cyclic picture-naming task

Jion Tominaga[1], Kai Nakajima[1], Dmitry Patashov[1], Manabu Tanifuji[1], Keita Tanaka[2], Akihiko Tsukahara[3], Hiroki Miyanaga[4], Shoji Tsunematsu[4], Takafumi Inoue[1], Hiromu Sakai[1]; [1]Graduate School of Advanced Science and Engineering, Waseda University, [2]Graduate School of Electronic and Mechanical Engineering, Tokyo Denki University, [3]School of Science and Engineering, Tokyo Denki University, [4]4. Sumitomo Heavy Industries, Ltd.

[INTRODUCTION] Word retrieval in speech production recruit complex mechanisms to overcome semantic interference from competing words. In this study, we aim to further clarify the spatiotemporal characteristics responsible for the interference effect. Using MEG, we measured the neural activities of participants while they performed a blocked-cyclic picture naming task (Kroll and Stewart, 1994) to induce either contextualized or non-contextualized semantic memory recall. Preliminary results of MEG amplitude comparisons between the two conditions are consistent with the interference account and contradict the facilitation account of the previous finding (Dirani and Pylkkänen, 2020). [METHOD] Eleven native Japanese speakers underwent MEG recording (whole-head 64-channel MEG system, Sumitomo Heavy Industries Ltd.) while performing a picture-naming task. Stimuli (picture images or line drawings) were projected onto a screen within the MEG through a prism glass. The tasks were divided into contextualized and decontextualized conditions: a homogeneous block where concepts from the same category were presented consecutively and a heterogeneous block where concepts from different categories were presented randomly. Each trial consisted of a fixation cross for 500 ms followed by the presentation of an image for 800 ms. We prepared six objects for each of four semantic categories (Animal, Plant, Food, Tool). Picture images and their line drawings were selected from the Bank Of Standard Stimulus (BOSS) (Brodeur et al., 2014), IMABASE (Bonin et al., 2020), or freepng.ru. Objects were randomly presented 12 times, yielding 576 trials per condition. The recorded data was preprocessed and analyzed using the MNE-Python software package. [RESULT] As shown in the previous study (Janssen et al., 2015), we observed increased signal in the homogeneous condition compared to the heterogeneous condition at the right frontal region during a later time window (400–800 ms), likely reflecting conflict resolution during articulation. The increased activity in the later time window in the homogeneous condition might thus support the viewpoint of a post-lexical interference effect. Unlike previous studies (de Zubicaray et al., 2017) reporting decreased signal in the homogeneous condition in the intraparietal sulcus, we observed an increase in the homogeneous condition at the left parietal region during an early time window (0–600 ms). This might reflect a process of resolving interference effects where the left parietal region is engaged in the selection of the target words during lexicalization. The presence of interference at both early and late time windows partially agrees with a previous study suggesting a mixed account of the classical interference and the response exclusion hypothesis (REH) (Dirani and Pylkkänen, 2020). However, we also observed decreased amplitude at the right frontal regions in the later time window (600–800 ms). This might imply either late-stage facilitation or reduced attention due

to the repetitiveness of the task. Further research is needed to clarify the nature of decrease of activation in the right frontal region.

A50 *Sandbox Series* - Disentangling syntax and prosody in sentence comprehension: The case of cross-serial and nested dependencies

Catalina Torres[1], Sebastian Sauppe, Chantal Oderbolz, Martin Meyer, Balthasar Bickel; [1]University of Zurich, [2]NCCR Evolving Language, [3]ISLE Interdisciplinary Study of Language Evolution

Non-adjacent dependencies in syntax are challenging to process because they separate in time what belongs together in hierarchical structure. The challenge is expected to be stronger for crossed (a1b2a1b2) than for nested (a1b2b2a1) dependencies because more memory stacks are recruited, i.e., the challenge increases with the Chomsky hierarchy. Simultaneously, this challenge is expected to be mitigated by prosodic information that helps parse syntax during listening through the highlighting of syntactic boundaries. We report a planned EEG experiment on the comprehension of adjoined, nested, and crossed dependencies in Swiss German (SG), using a prosodic manipulation. SG provides a unique test case because it exhibits these three dependency types by varying word order in sentence-final verb phrases, keeping compositional semantics and information structure constant. We use sentence-final clusters of two verbs, each with their own object (in pseudo-English translation of 'that Maria saw Manu marinate the lamb', CROSSED: that Maria Manu1 the lamb2 saw1 marinate2; NESTED: that Maria Manu1 the lamb2 marinate2 saw1; ADJOINED: that Maria Manu1 saw1 the lamb2 marinate2). Stimulus sentences were normed for naturalness and variations were created, ensuring the lexical material was constant. A female speaker of SG was recorded, and the speech was acoustically manipulated by resynthesizing duration and fundamental frequency to reduce the acoustic strength of boundaries and prominences. Forty participants will listen to 180 unique critical sentences (50% prosodically manipulated) while EEG is being recorded from 64 electrodes. The combination of word-order variation and natural vs. manipulated speech allows us to disentangle the roles and neural underpinnings of syntax and prosody in language comprehension. The cross-linguistic rarity and complexity of crossed dependencies should lead to increased processing demands. We test this by analysing event-related synchronisation/desynchronisation (ERS/ERD) in individually-defined theta, alpha, and beta bands, time-locked to the presentation of the main and the auxiliary verbs. Theta ERS as domain-general error monitoring system should be sensitive to encountering unexpected word orders. Alpha ERD reflects the release of inhibition in the language network, allowing more intense syntactic processing for crossed over nested/adjoined dependencies. Beta ERD reflects the updating of sentence-level representations when an unexpected or demanding dependency is to be parsed. If the availability of prosodic information facilitates, and possibly foreshadows, syntactic parsing, the ERS/ERD effects should be modulated by our prosodic manipulation. Furthermore, in the unmanipulated prosodic condition, we expect increased neural synchronisation between brain activity and the speech signal, in the delta band. The regression-based analysis takes linguistic surprisal effects into account and further exploratory analysis includes functional connectivity and microstate analyses to shed light on the transient neural network dynamics supporting syntactic and prosodic language comprehension. This study contributes to our understanding of real-time syntactic processing by investigating the variable linearisation of a SG syntactic structure. Additionally, our experimental paradigm allows us to disentangle syntactic from prosodic parsing. Finally, our study allows us to discuss effort during syntactic processing in a meaningful way since all participants are confronted with the three linearised verb clusters, and we don't compare across different speaker groups, as previously done.

A51 *Sandbox Series* - The Adaptation of an Aphasia Tool for Maltese - English Bilingual Adults

Lorraine Vassallo[1], Dr Ritienne Grima[1], Dr Claude Julien Bajada[1], Dr Alexia Rohde[2]; [1]University of Malta, [2]Department of Health, Queensland Health, Australia

Introduction: In bilingual persons with aphasia post stroke (BPwA), recovery of the two languages can vary discordantly, necessitating comprehensive testing in both languages (Paradis, 2014) with a linguistically and culturally equivalent instrument. The lack of standardized, normed and comparable aphasia assessment tools in Maltese and English, limits the assessment of the Maltese - English bilingual adult with post-stroke aphasia. Failure to assess one of the languages hinders accurate evaluation of linguistic competency, and consequently optimal treatment and rehabilitation. The study aims to linguistically and culturally translate and adapt an aphasia assessment tool for Maltese - English bilinguals. A psychometrically robust Maltese - English Aphasia Assessment (MEAA), normed on the Maltese population, will lead to enhanced accuracy in the differential diagnosis of language impairment in Maltese - English bilingual adults. Methods: The study is divided into three phases: (1) translation and adaptation of the Brisbane Evidence-Based Language Test (Rohde et al, 2020) into Maltese (completed); (2) the pilot [Step 1a, N = 15; Step 1b, N = 35] (completed) and normative study [N=100] (currently ongoing); (3) the main study [N =100] during which MEAA will be administered to bilingual persons with stroke (BPwS), with and without aphasia (commencing late 2024). A demographic and language background questionnaire (DLBQ) will determine language history. Performance in both Maltese and English is assessed on MEAA's 49 tasks (5 subtests). Data: Piloting steps 1a and 1b contributed to face and contact validity respectively. Normative data will establish norms for healthy bilinguals on the MEAA while continuing to determine the extent of linguistic equivalence between both language versions. Comparative analysis will progress in phase 3: a group of BPwS and a cohort of BPwA. Results: Preliminary analysis of the MEAA normative data [N=30] provides baseline distribution performance of neurotypical Maltese - English adults. Results to date reflect the Maltese bilingual scenario: perceptual (English M = 14.87, SD = 0.35/ Maltese M = 14.77, SD = 0.57), auditory comprehension (English M = 33.03, SD = 2.09/ Maltese M = 33.87, SD = 1.93), verbal expression (English M = 79.53, SD = 9.54/ Maltese M = 76.37, SD = 8.80), reading (English M = 36.60, SD = 4.11/ Maltese M = 37.03, SD 3.22), and writing (English M = 27.80, SD = 1.16/ Maltese M = 26.73, SD = 2.29).

Conclusion/Summary: An accurate evaluation of the Maltese bilingual's linguistic abilities entails testing both Maltese and English with an equivalent assessment tool. We intend to investigate correlations between the language background (per DLBQ numeric scores) and the MEAA performance. Overall, we anticipate strong internal consistency and validity among the MEAA tasks. Comparative analysis of post-stroke performance across the subtests in both language versions will provide insight into the severity level of impairment, effectively detecting aphasia. The multidisciplinary creation of MEAA will supplement cross cultural and cross linguistic adaptation models of aphasia assessment, contributing to comparable tools across world languages, and potentially broadening further research in the context of other aetiologies of neurodegenerative disease.

A52 *Sandbox Series* - Neural Prediction of Spoken Language Outcomes in Children with Cochlear Implants: A Multi-Center Study

Yanlin Wang[1], Di Yuan[1], Shani Dettman[2], Dawn Choo[2], Denise Thomas[3], Maura E Ryan[4], Shimeng Xu[5], Nancy M Young[3], Patrick C M Wong[1]; [1]Brain and Mind institute, The Chinese University of Hong Kong, [2]Department of Audiology & Speech Pathology, The University of Melbourne, 550 Swanston St, Parkville, Victoria 3010 Australia, [3]Department of Audiology, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois, USA, [4]Department of Medical Imaging, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois, USA, [5]Department of Molecular Genetics, University of Texas Southwestern Medical Center, Dallas, TX 75390

Cochlear implantation has shown to be an effective treatment method to facilitate spoken language development for children with severe to profound hearing loss. Despite early implantation, spoken language development can be quite variable for children with cochlear implants (CIs). Enrolment into early intervention to enhance spoken language development is effective for children with CIs but can be costly. Being able to predict spoken language development before CIs could facilitate allocation of early intervention, that is a higher dose intervention to children who need it most. Our early studies showed that pre-CI MRI neuroanatomical scans obtained as part of the standard assessment protocol could be used to construct predictive models to forecast language outcomes. However, these studies were restricted to children from one medical center who were learning English. It is important to ascertain whether neural predictive models constructed with data from one medical center who are learning one language can be used to predict the outcomes of children who are from other medical centers who are learning other languages. Our multi-center study addressed this question. A total of 278 children from English, Spanish, and Cantonese language-dominant homes who were diagnosed with congenital/early onset sensorineural hearing loss were recruited from Chicago (English: N=143, Spanish: N=37), Melbourne (English: N=81), and Hong Kong (Cantonese: N=17). All children underwent T1-weighted volumetric neuroanatomical magnetic resonance imaging (MRI) as a part of their pre-CI evaluation. Speech and language abilities were examined before and up to three years post-CIs. The slope of speech and language change was calculated for each child as a measure of improvement, with median split used to categorize children into higher and lower improvement groups. Slice-based deep transfer learning models were constructed where neural features were used to predict improvement (higher vs lower), including models with data from one medical data and models with children learning only one language (English or Spanish). We then tested the generalizability of these models across medical centers and languages. Results showed that deep learning models, particularly the MobileNet model, achieved high predictive performance within specific datasets (AUC: 87.1%, ACC: 89.7%, sensitivity: 94.1%, specificity: 92.2%). However, performance dropped to chance levels when models were tested on different datasets (e.g., Melbourne tested with Chicago data) or across languages within the same site (e.g., Spanish tested with English data in Chicago). When all datasets were combined into a large heterogeneous dataset, the predictive performance remained high (AUC: 0.924, ACC: 87.9%, sensitivity: 88.3%, specificity: 87.6%). This suggests that heterogeneous datasets can facilitate generalization across different sites and languages. In conclusion, using pre-CI neuroanatomical data for predicting language outcomes shows promise for precision care, as evidenced by high accuracy in single homogeneous datasets. Nevertheless, our findings indicate no evidence for cross-site and cross-language generalization within the tested sample sizes, underscoring the necessity for multi-center collaborations to gather larger, more diverse datasets. This approach could enhance the development of models capable of generalizing to new patients from varied backgrounds, optimizing resource allocation for early interventions.

A53 *Sandbox Series* - Major white matter tracts underlying language processing-a tractography study

Qingchun WANG[1], Yongkun GUO[2], Fang WANG[2], Yang LIU[2], Xinjun WANG[2,3], Wai-Ting SIOK*[1]; [1]The Hong Kong Polytechnic University, Hong Kong SAR, China, [2]The Fifth Affiliated Hospital of Zhengzhou University, Zhengzhou University, Zhengzhou, China, [3]The Third Affiliated Hospital of Zhengzhou University, Zhengzhou University, Zhengzhou, China*

Aphasia is a neurological disorder that typically results from brain damage, causing significant language deficits due to lesions in cortical regions or subcortical white matter tracts. Recently, the structural connectivity of the brain has drawn intensive attention, as its potential to facilitate language recovery. Although many white matter tracts have been proposed to participate in language processing, these pathways have not been fully examined in Chinese aphasic patients. In this study, we present five Chinese aphasic patients with language disorders resulting from unilateral left-hemisphere lesions. These patients were recruited from a local hospital in Mainland China. Ten healthy participants, matched for age, gender, language and educational background were recruited as the control group. Aphasia was diagnosed using the Chinese Rehabilitation Research Center Standard Aphasia Examination (CRRCAE), a widely used clinical tool in Mainland China. Language abilities, including speech comprehension, speech production, reading comprehension, writing, repetition, and

reading aloud, were assessed by the CRRCAE, generating standardized scores based on correct items. Neuroimaging examinations including anatomical magnetic resonance imaging (MRI) and diffusion MRI were performed on a 3.0T Philips Ingenia scanner with identical scanning sequences for all participants. Behavioral measurements revealed significant language deficits in all tested linguistic domains for aphasic patients. Diffusion metrics, including fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (RD), and axial diffusivity (AD), were extracted for each target white matter tract. An atlas-based diffusion metrics extraction method was employed to analyze indices of hypothesized language-related white matter tracts, including the arcuate fasciculus (AF), superior longitudinal fasciculus (SLF) I-III, inferior longitudinal fasciculus (ILF), inferior frontal-occipital fasciculus (IFOF), uncinate fasciculus (UF), middle longitudinal fasciculus (MdLF), and corticospinal tract (CST) bilaterally. Diffusion metrics were used to examine intergroup differences and the association between white matter integrity and language performance using partial correlation. Consistent with previous neuroimaging studies, aphasic patients exhibited significantly lower mean FA values in most target fiber tracts in the left hemisphere, except for the SLF_I and CST. Similar patterns were observed for MD and RD, with patients showing significantly higher values in left hemisphere tracts except for the first segment of the SLF and CST. Correlation analyses showed that FA measures for the left AF were significantly related to reading comprehension scores ($p < 0.05$). FA values in the left IFOF were also significantly correlated with reading comprehension ($p < 0.05$), and left SLF_III was significantly associated with speech production ($p < 0.05$). To comprehensively examine macro- and microstructural integrity, we reconstructed the left AF, left IFOF, and left SLF_III using probabilistic tractography, revealing evident fiber loss in aphasic patients. Our findings support the involvement of white matter tracts in language processing. The results from diffusion metrics analyses confirmed reduced integrity in language-related fiber tracts in aphasic patients. Correlation analyses highlighted the functional roles of the left AF, SLF III, and IFOF in spoken and written language. Additionally, we provided new evidence for the potential contribution of the left IFOF in Chinese reading. This study also detailed individual deficit patterns of each aphasic patient using tractography.

A54 *Sandbox Series* - Exploring Cross-Categorical Pitch Shift Effects on Mandarin Tone Production

Ya-Ning Wu[1], Will Chih-Chao Chang[1], Gregory Hickok[1]; [1]University of California, Irvine

Introduction: The Dual Speech Coordination model proposed that laryngeal and supralaryngeal control of speech production are coordinated by distinct cortical pathways (Hickok et al., 2023). Based on the model, we hypothesize that speakers recruit a dorsal-lateral system to coordinate pitch vocalization, while a more ventral system is activated to coordinate phonetic/syllabic articulation. However, whether higher-level areas of linguistic planning in the dorsal-lateral system are involved in pitch coordination when the context is linguistically contrastive, such as producing lexical tones, is an open question. Previous research has explored the sensorimotor control of Mandarin tone production using behavioral Altered Auditory Feedback (AAF) tasks, where speech is recorded, manipulated, and present to participants in real time. However, these studies applied constant upward or downward shifts that alter only the pitch height but not the contour of the lexical tones (Tang, 2024). Therefore, the perturbed tone may sound less canonical but not necessarily from a different tone category. To address our research question regarding neural mechanisms underlying pitch control at higher linguistic and lower acoustic levels, we aim to conduct a variation of typical AAF task with fMRI design to investigate how cross-categorical pitch shifts affect Mandarin lexical tone production. Methodology: Participants will be asked to produce the Mandarin monosyllabic word /ma/ associated with three lexical tones: Tone1 (high level tone, 妈/ma1/), Tone2 (rising tone, 麻/ma2/) and Tone4 (falling tone, /ma4/骂) in both the baseline production task (session 1) and the main AAF experiment (session 2). In session 1, participants produce words shown on the screen for 2 seconds, while being recorded with a headset microphone with normal auditory feedback. Out of all recordings, we pick 5 for each target tone that are the closest to the mean pitch height (/ma1/) or slope (/ma2/, /ma4/) to become playback tokens for cross-categorical shift in the main experiment. In session 2, participants perform the same word production task with either normal feedback (Control condition) or cross-categorical pitch shift (Shift condition, e.g, producing /ma2/ but hearing a /ma1/ or /ma4/ token). Results & Discussion: Our behavioral pilot results (N=7) showed that participants exhibited compensation or following responses to cross-categorical shift during contour tone production (Tone2 and 4) but not level tone (Tone1); in addition, the magnitude of responses to shift increased over the time course within a trial. Moving forward to fMRI scanning, we predict that speakers will exhibit distinguishable activation patterns among the dorsal ROIs between conditions. Specifically, we expect to observe quantitative differences of dPCSA activation or qualitative differences of additional area 55b recruitment. Ultimately, our goal is to explore the dorsal-lateral substrates hierarchy underlying pitch control in linguistically contrastive context, which will further elucidate the sensorimotor integration and adaptation mechanisms of speech production in tonal language speakers.

A55 *Sandbox Series* - Role of Gesture in Second Language Comprehension: an fMRI study

Jiaxin Yan[1], Victoria-Anne Flood[1], Motoaki Sugiura[2], Hyeonjeong Jeong[1]; [1]Graduate School of International Cultural Studies, Tohoku University, Sendai, Japan, [2]Department of Human Brain Science, IDAC, Tohoku University, Sendai, Japan

Language and gesture are closely intertwined to facilitate communication and comprehension. Previous research on first language (L1) has shown that gestures enhance comprehension, especially in complex contexts, involving sensorimotor brain areas (Cuevas et al., 2019). Recent behavioral studies on second language (L2) have indicated that gestures also improve L2 comprehension (Lin, 2021; Zhang et al., 2023). Two types of gestures, iconic and metaphoric, have

been extensively examined. Iconic gestures, with their visual characteristics, help L2 learners understand and remember content by concretizing abstract concepts (Macedonia et al., 2011). Metaphoric gestures convey abstract meanings physically, mirroring cognitive processing of abstract language, and helping learners grasp more complex, intangible ideas (Steines et al., 2021). Both types provide visual and contextual cues that support language processing. Despite these insights, specific neural mechanisms underlying the enhancement of L2 comprehension through gestures remain underexplored. Our study aims to investigate these mechanisms by examining the brain activity in L2 learners exposed to speech with these gestures. We focus on sensorimotor and language-related brain regions, examining differences between L1 and L2 as well as iconic and metaphoric gestures. Following a similar design to Steines et al. (2021) and our pilot test, we selected 160 English sentences that have been reviewed and videotaped by two English native speakers. Japanese raters assessed each video for comprehensibility, imageability, and naturalness. These were translated into Japanese and videotaped by two Japanese actors, resulting in 320 video stimuli (160 in L1 and 160 in L2) lasting 5 seconds each. Stimuli consisted of four conditions: L1 with and without gesture, L2 with and without gesture. We manipulated gestures to express various target words, including nouns, verbs, adjectives, and multiword expressions, classifying them as abstract or concrete using concreteness scores from Brysbaert et al. (2014), to explore how gestures represent linguistic elements and impact comprehension. We will recruit 40 right-handed native Japanese speakers learning English as their L2. They will undergo two 20-minute fMRI sessions for L1 and L2, with stimuli counterbalanced across conditions. Using event-related paradigms, videos for each condition will be presented in a randomized order, followed by a comprehension probe question to test participants' attention. After the fMRI sessions, we will conduct memory tests to evaluate how well participants remember words associated with gestures, assessing differences between conditions. We expect the with-gesture condition to show faster reaction times in comprehension probe questions and a higher accuracy rate in memory tests compared to the without-gesture condition, particularly in L2, as gestures compensate for linguistic limitations and enhance comprehension and memory of the content. We predict that fMRI results will show increased brain activity in the with-gesture condition in areas integrating gesture and speech, and in sensorimotor and language comprehension-related areas. We will also analyze differences in activation levels between iconic and metaphoric gestures, and between L1 and L2. Our findings will provide a deeper understanding of how different types of gestures facilitate language processing in L2 communication.

A56 *Sandbox Series* - Psycholinguistic constructs underlying words in naturalistic listening

Xuan Yang[1], Rutvik Desai[1]; [1]University of South Carolina

Understanding how words are represented and organized in the brain is a crucial question in psycholinguistics and cognitive neuroscience. Most studies typically only consider a handful of lexical variables, such as frequency and concreteness. However, words have a large number of partially intercorrelated properties that influence their processing and neural organization. A more comprehensive assessment of the influence of these variables is crucial. Recent studies have begun investigating the neural representation of psycholinguistic variables in naturalistic contexts, such as listening to narratives in an MRI scanner. However, several methodological challenges limit the broader application of these studies, including the limited availability of myriad psycholinguistic variables in individual databases, and the lack of psycholinguistic values for all word forms in naturalistic stimuli. To address these issues, our study leverages the South Carolina Psycholinguistic metabase (SCOPE) (Gao et al., 2023), an extensive collection of psycholinguistic properties aggregated from major databases. By lemmatizing words, we maximize the number of tokens in narratives with available psycholinguistic values for subsequent data analysis. We used 113 psycholinguistic variables from SCOPE, spanning general, phonological, orthographic, semantic, and morphological categories. When original word form values were unavailable, lemma values were used, resulting in 12,375 unique words (5,876 unique lemmas) for analysis. We combined seven datasets from the publicly available Narratives fMRI database (Nastase et al., 2021), consisting of 213 fMRI scans from 102 neurotypical young adults listening to narratives in the scanner. Exploratory factor analysis was performed using the principal axis factoring extraction method and oblimin rotation to extract latent structures of psycholinguistic variables. Factor scores of single words were correlated with the fMRI data in separate models using parametric modulation regression. Six latent factors were extracted (explaining ~50% of the total variance), including those related to word frequency, word length, graphotactic/phonotactic probabilities, feedback consistency, feedforward consistency, and concreteness. These factors represent a total of 113 variables with loadings above 0.4. These factors significantly correlated with performance (response time and accuracy) in behavioral tasks such as lexical decision, word naming, and semantic decision. FMRI results showed that lower frequency factor was correlated with activation in IFG and MTG. Higher length was correlated with bilateral pSTG and SMG. Higher graphotactic/phonotactic probabilities were correlated with activation in bilateral STG. Lower feedback consistency factor was correlated with activation in left ATL. Higher feedback consistency was correlated with activation in bilateral posterior temporal lobe and IFG. Lower concreteness factor was correlated with activation in bilateral ATL and STG. The brain regions identified by these latent factors were largely consistent with previous findings using highly controlled stimuli and tasks. Novel result include spelling-sound consistency effects in a purely auditory task. This study explores the latent structures of psycholinguistic variables for 12,375 words, revealing six interpretable factors at both behavioral and neural levels. This approach provides a novel, comprehensive view of word representation in the brain, bridging the gap between isolated linguistic properties and potential underlying constructs. The findings have significant implications for our understanding of lexical processing in naturalistic contexts.

A57 *Sandbox Series* - Altered Individual Variability in Chinese Children with Reading Difficulties

Yue Yang[1], Jie Chen[2], Chan Tang[2], Guosheng Ding[#]; [1]BeiJing Normal University

Approximately 5-10% of schoolchildren in China suffer reading difficulties characterized by impaired reading performance despite normal IQ. Some researchers posit that the fundamental deficit in reading difficulties lies in the capacity for orthography-phonology mapping. Previous neuroimaging investigations of reading difficulties have primarily focused on identifying group-average differences in brain connectomes between poor readers (PR) and typical readers (TR) when performing reading tasks. However, compared to resting fMRI, task fMRI creates the same processing across all subjects while ignoring some of the characteristics inherent in the subject underlying activation and connection. Here we examined the whole-brain functional connectomes in both PR group and TR during a resting state. Specifically, we collected functional MRI data from 46 children aged from 8.22to 12.47 years old, including 18 PRs and 28 TRs. All participants underwent the Chinese Character Recognition test, commonly utilized to assess word recognition proficiency. Our findings revealed that the functional connectivity during resting state was similar between the two groups and did not exhibit significant differences. Nevertheless, we still assume that individual variability can more sensitively capture differences in the neural mechanisms of poor readers and typical readers. So we further shifted our focus to individual variances, and examined the brain patterns and behavioral performance at the individual level. We examined interindividual variability in functional connectomes (IVFC) within the TR and PR groups. Regions demonstrating the top 5% highest IVFC differences between the two groups were identified as critical areas. The overall IVFC pattern in PRs generally resembled that in TRs, with the PR group exhibiting higher IVFC in a widespread area encompassing the bilateral cuneus, middle temporal gyrus (MTG), insula, as well as the right medial orbitofrontal gyrus (mOFG) and thethe right inferior parietal lobule (IPL). While, as to the TR group, exhibited higher IVFC in unimodal areas. At the participant level, we correlated the IVFC of these regions with Chinese Character Recognition test performance and found that individuals with higher IVFC tended to demonstrate lower behavioral performance, particularly in the default mode network (DMN) and ventral attention network (VAN). Notably, in PRs, this trend was more pronounced ($r<-0.48$, FDR $p<0.05$) than in TRs (FDR uncorrected). In summary, our research provides a novel perspective on the disparities between poor readers and typical readers, suggesting that poor readers may experience disruptions in heteromodal cortices, offering a potential guide to the intervention of these poor readers during education.

A58 *Sandbox Series* - The (Non-)Sentence Repetition Task: A novel assessment of expressive and receptive syntactic competence

Jeremy Yeaton[1], Shiva Upadhye[1], Richard Futrell[1], Gregory Hickok[1]; [1]University of California, Irvine

Introduction. Whether and how receptive and expressive syntactic abilities are related to one another is widely debated, however, high-quality evidence bearing on this question is relatively sparse. Here, we introduce a novel task--the (Non-)Sentence Repetition Task (NSRT)--which makes apples-to-apples comparisons between expressive & receptive syntactic performance on the same items in the same individuals. We present preliminary data from healthy participants ahead of collection from individuals with post-stroke aphasia. Background. Expressive & receptive syntactic competence have typically been assessed using separate tasks with distinct materials. On the receptive side, acceptability judgment tasks are often used, which ask participants to judge whether presented sentences conform to their grammar. On the expressive side, constrained sentence repetition or elicitation tasks, or unconstrained discourse elicitation tasks can be used. Within the context of sentence repetition/elicitation, the Sentence Superiority Effect (SSE)--where a sequence of words is more accurately recalled if it is a well-formed sentence than if it is not--can provide a window into subconscious syntactic processing (Scheerer, 1981). An unanswered question is whether participants can consciously generate a grammatically correct sentence which resolves an error in a presented (ungrammatical) sentence. Methods. Trials in the NSRT occur in 3 phases: 1) judgment of a presented sentence as acceptable or unacceptable; 2) verbatim typed or oral production of the presented sentence even if it was ungrammatical; and 3) production of the corrected sentence if it was judged to be ungrammatical. The stimuli used three types of violations: determiner-noun number agreement ('two boy'), subject-verb number agreement ('two boys walks'), and tense agreement ('two boys were walk'). Each participant saw 60 trials of which 20 were grammatical. We recorded response time and accuracy for the judgments, as well as timestamped typing data for the verbatim and correction phases. We present data from 10 healthy young adult pilot participants here but data collection is ongoing in healthy young adults, older adults, and stroke survivors. Results. Overall, participants performed with both high accuracy (81.8%) and good discriminability (A'=0.90) on the acceptability judgments. Participants were significantly faster and more accurate at judging grammatical than ungrammatical sentences. They showed a significant SSE in the verbatim phase, producing more accurate repetitions in the grammatical than ungrammatical conditions. During the correction phase, participants were highly effective at correcting the presented sentence to generate a grammatical one (95%). During the verbatim phase, restarts constituted a higher proportion of corrective actions when the stimuli were ungrammatical, and fewer restarts were observed when stimuli were judged as grammatical. Additionally, more restarts were observed in the verbatim phase than in the repetition phase for ungrammatical items. Discussion. Our initial results show a significant effect of grammaticality on judgment accuracy and RT, and accuracy of verbatim repetition. They further show subtle differences between the different kinds of grammatical violations, pointing to different processing levels or strategies. Analysis of the backtracking data points to different planning and inhibition strategies in the two production phases. An outstanding question is whether these strategies would be

mirrored in individuals with aphasia.

A59 *Sandbox Series* - The developmental trajectory of word-onset encoding in running speech

Zhen Zeng[1], Patrick Wong[1], Xiangbing Teng[1]; [1]The Chinese University of Hong Kong

Decades of developmental research established that infants' sensitivity to native speech increase rapidly in the first year of life. They can track speech envelope from birth (Barajas et al., 2021) and are able to categorize phonemes on place and manner of articulation by 3 months (Gennari et al., 2021). Yet when and how infants learn to segment words remains an open question. Longitudinal evidence, using Mis-match Responses (MMR) (Werwach et al., 2022) and temporal response functions (TRFs) (Di Liberto et al., 2023), has demonstrated that the EEG amplitudes indexing discrimination and encoding of acoustic and linguistic features undergo non-linear changes in the first year of life. Specifically, Di Liberto et al. (2023), using repeated nursery rhymes, has unveiled that while infants' neural encoding of linguistic features grows linearly from 4 months onwards, their encoding of spectral information demonstrates non-linear growth that peaked at 4 months. This process may be largely driven by decreasing delta power from 4-6 months due to maturation (Chu et al., 2014). Following the latest development in measuring the neural encoding of running speech, the current study investigates infants' word onset tracking in running speech. We hypothesized that word onset encoding improves in earlier months before decrease. The temporal dynamics of word onset encoding may involve both acoustics and higher-level processing (Karunathilake et al., 2023). Here we report data from infants aged newborns (N = 17), 1-3 months (N = 25), 6-8 months (N = 30), as well as adults (N = 30) who underwent ~20-30 mins EEG recording. The stimuli consist of 5 children stories in adult-directed speech, recorded from a female native Cantonese speaker. The stories were then cut into 8 2-3-min-long chunks, with random order of presentation for each participant. EEG data were filtered at 0.5-30Hz for preprocessing. We calculated the word onset TRFs (Crosse et al., 2016) in a -100-800ms sliding time window. Results showed that the word onset TRFs unfolds with a single positive peak around 400-500ms for newborns, 300-400ms for 1-3 month-olds, 250-350ms for 6-8 month-olds, suggesting a single stage acoustics processing and decreasing peak latency for infants. Permutation test showed significant encoding for all four groups. One-way ANOVA comparing the positive peak amplitudes for the three infant groups revealed a significant effect, and pairwise comparison showed that peak amplitudes were the smallest in newborns and largest in 1-3 months. The non-linear amplitude changes may involve maturational changes non-specific to word onset processing (Chu et al., 2014). In contrast, the amplitudes in adults showed dramatic qualitative difference to the infant groups: positive peaks around 100ms and around 250ms as well as a negative peak around 400-600ms, echoing separate processing stages: early acoustics processing and other higher level linguistic processing (Karunathilake et al., 2023). Overall, our findings showed that infants are able to track word onsets in running speech from birth. Participants' EEG peak latency decreased with age. In contrast, amplitudes showed non-linear changes with age, suggesting that the increase of amplitudes may not directly reflect better neural encoding for young infants.

A60 *Sandbox Series* - The Influence of Bilingualism on Neural Connectivity in Children's Reading Development

Kehui Zhang[1], Xin Sun[2], Valeria Caruso[3], Ioulia Kovelman[3]; [1]NYU Shanghai, [2]University of British Columbia, [3]University of Michigan

The journey of reading and literacy development in children is significantly influenced by their bilingual experiences. This study examines how distinct language profiles—specifically English monolingual, Chinese-English bilinguals, and Spanish-English bilinguals—shape the functional neural networks that support reading. Research in cross-linguistic perspectives typically highlights the differences in learning to read between alphabetic languages like Spanish and English, which emphasize phonological associations, and logographic languages like Chinese, which emphasize semantic associations. This differentiation in phonological and semantic processing potentially influences the development of literacy, prompting an investigation into how children's neural connectivity is affected when they learn to read in two languages with differing orthographic demands. To explore these dynamics, we conducted a study with three groups: English monolinguals (N = 50), Chinese-English bilinguals (N = 69), and Spanish-English bilinguals (N = 59), all aged 5-10 years. Participants were born in either Chinese or Spanish speaking households in the U.S. and attended schools where English was the medium of instruction. During the sessions, functional near-infrared spectroscopy (fNIRS) neuroimaging was utilized while children engaged in phonological and morphological awareness tasks in English, structured within an oddball task paradigm. Functional connectivity will be analyzed using the Group Iterative Multiple Model Estimation (GIMME) method, which constructs directed functional connectivity maps by defining regions of interest (ROI) through unified structural equation models. The impact of bilingual experience on neural connectivity will subsequently be assessed using a mixed analysis of variance (ANOVA), with a focus on differences among the language experience groups. Our findings will aim to elucidate both universal and language-specific processing mechanisms underlying children's literacy development, and to demonstrate how bilingualism modifies the neural pathways involved in learning to read. By detailing the distinct neural adaptations in bilingual children, the study will contribute valuable insights into the cognitive neuroscience of language, offering implications for educational strategies tailored to diverse linguistic backgrounds. This research will highlight the complexity and adaptability of the developing brain in multilingual contexts, enriching our understanding of bilingualism's role in educational achievement and cognitive development.

A61 *Sandbox Series* - The neural basis of lexical tone in bilingual language processing

Xindong Zhang[1], Judy D. Zhu[2], Paul F. Sowman[3,4], Xin Wang[1]; [1]Department of Linguistics, Macquarie University, [2]School of Psychological Sciences, Macquarie University, [3]School of

Clinical Sciences, Auckland University of Technology, [4]Faculty of Medicine, Health and Human Sciences, Macquarie University

Mandarin-English bilinguals use pitch to disambiguate lexical meanings in one language but not the other. Previous studies show that these bilinguals are more sensitive to pitch information even when it is not used to differentiate lexical meanings, such as in a non-tonal language like English (Ortega-Llebaria et al., 2017; Wang et al., 2020; Wong et al., 2004). Here, we investigate the neural basis of lexical tone processing in Mandarin-English bilinguals when they perform a task exclusively in English. We ask whether they use pitch information when processing interlingual homophones (IHs), i.e. words that overlap in phonology across language but differ in spelling, meaning or grammatical class. Some of the IHs used in the study are superimposed with four different Mandarin tones. In addition, a control group of monolingual English speakers is tested to show the difference in pitch processing. We hypothesize that Mandarin-English bilinguals will exhibit greater sensitivity to the linguistic features of tones than monolingual English speakers. Magnetoencephalography (MEG) was used to record brain signals to compare the brain activities during lexical tone processing between Mandarin-English bilinguals and monolingual English speakers. Both IHs and non-IHs, which were CV (consonant-vowel) monosyllabic English words, were selected to test the IH effect. We employed the oddball paradigm in which an oddball (or deviant) stimulus was presented within a stream of regularly repeated 'standard' stimuli. In the auditory word sequences, the standards were the natural English pronunciation of IHs and non-IHs. At the same time, four Mandarin tones were imposed on IHs and non-IHs, forming four deviant types. We followed the tone superimposition technique established in Wang et al (2024) to create speech tokens of good quality. In each word sequence, only one lexical tone was presented (e.g., tea3/ti3/ as the deviant in tea/ti/ sequence). Thus, it is a 2 (monolinguals vs. bilinguals) x 4 (Tone 1 vs. T2 vs. T3 vs. T4) x 2 (IH vs. non-IH) design. Data collection is ongoing. Since lexical tone processing is highly relevant to the left hemisphere (LH), we predict that bilinguals will elicit an enhanced LH activity relative to monolingual English speakers when processing deviant IHs but not non-IHs. This is because the IHs have shared phonological representations between Mandarin and English. In contrast, only one language is relevant for the monolingual English speakers. Multivariate pattern analysis will be used for further analysis. Ortega-Llebaria, M., Nemoga, M., & Presson, N. (2017). Long-term experience with a tonal language shapes the perception of intonation in English words: How Chinese–English bilinguals perceive "Rose?" vs. "Rose." Bilingualism: Language and Cognition, 20(2), 367–383. Wang, X., Hui, B., & Chen, S. (2020). Language selective or non-selective in bilingual lexical access? It depends on lexical tones! PLOS ONE, 15(3), e0230412. Wang, X., Jheng, J., & McMurray, B. (2024). Tone Superimposition Technique in Speech Sciences: A Tutorial. https://doi.org/10.31219/osf.io/kwh7n. Wong, P. C. M., Parsons, L. M., Martinez, M., & Diehl, R. L. (2004). The Role of the Insular Cortex in Pitch Pattern Perception: The Effect of Linguistic Contexts. The Journal of Neuroscience, 24(41), 9153–9160.

A62 *Sandbox Series* - Deciphering parallel and hierarchical processes in multisensory gesture-speech integration across diverse semantic states

wanying zhao[1,2], Jiawang Yang[1,2], Yanni Cui[1], Zhouyi Li[1,2], Yi Du[1,2,3,4]; [1]Institute of Psychology, Chinese Academy of Sciences, Beijing, China., [2]Department of Psychology, University of Chinese Academy of Sciences, Beijing, China., [3]CAS Center for Excellence in Brain Science and Intelligence Technology, Shanghai, China 200031, [4]Chinese Institute for Brain Research, Beijing, China 102206

Introduction: In natural communication, messages are frequently conveyed through misaligned multimodal sources, encompassing both verbal speech and non-verbal gestures. Previous studies have demonstrated that preceding gestures facilitate top-down semantic predictions of the upcoming speech. However, a comprehensive understanding of how sensorimotor gestures and verbal speech converge and distill into coherent concepts, and how subsets of these signals transform, remains elusive. Quantifying the information from both sources and their interaction using information-theoretic metrics of entropy, mutual information and information gain, the present study traces the neural responses with High-temporal event-related potentials as gesture precedence speech of various semantic states. Methods: This study manipulated gesture and speech semantic states across nine paradigms, totaling 1368 pairs. Gesture priming on speech was induced by presenting speech after gesture offset. Gesture and speech information were quantified separately using entropy metrics. Bidirectional influence was measured with information gain, convergence with unit information gain, and integration with mutual information. Thirty participants indicated voice gender while fixating on a screen. Representational Similarity Analysis (RSA) correlated neural responses with gesture entropy, speech entropy, and mutual information to explore integration dynamics. Cluster-based permutation tests identified temporal differences in signal transformation during integration by correlating amplitudes with information gains. Results: The study identified distinct neural structures for integrating gesture and speech. Gesture processing occurred earlier (0-250 ms), while speech processing showed a late positive component (650-684 ms). Integration, seen in semantic congruency, happened during N400 (442-542 ms). Temporal patterns correlated with gesture entropy (r=-0.0252, p=.001), speech entropy (r=0.0237, p=.002), and mutual information (r=0.0226, p=.003), indicating modulation by gesture-speech information. For gesture information gain, significance was noted only with balanced gesture-speech information. Speech influenced gesture early (N1, r=-0.51, p=.027), later with increased information (LPC, r=-0.51, p=.027). Significance in speech information gain was observed when auditory stimuli reached semantic states. Early effects (N1-P2) were seen in speech IP conditions, while later effects (N400) emerged during speech after_IP conditions. In both cases, clusters tended to occur earlier with increased gesture semantics. Convergence of gesture-speech information, indexed by unit information gain, was significant except in one condition. Convergence occurred if either source reached semantic states, with clusters （spanning from 200-500ms） revealing delayed responses as the information of either source increased. Conclusion: We present distinct neural engagements during the self-contribution, bi-directional influence, convergence, and integration of gesture-speech

information. (1) The top-down influence of gesture interacts with the bottom-up processing of speech, leading to a unified comprehension where both processes are progressively engaged. (2) Throughout this interaction, there exists a bi-directional influence between gesture and speech, albeit in distinctly different manners. While gesture influences speech after speech has reached its semantic stage, speech influences gesture when there is equilibrium between gesture and speech information. (3) The integration of gesture and speech information, exemplified by the amalgamation of both sources of information, occurs when there is equilibrium between gesture and speech information. Conversely, the convergence of gesture and speech information, demonstrated by unit information gain, takes place when either gesture or speech reaches its semantic stage.

Poster Session B

Friday, October 25, 10:00 - 11:30 am, Great Hall 4

B1 - Fronto-temporal language network highly selective for sign language relative to action semantics, regardless of iconicity

Akshi Akshi[1], Miriam Hauptman[1], Matthew Sampson[1], Qi Cheng[2], Marina Bedny[1]; [1]Johns Hopkins University, [2]University of Washington

Studies of sign languages provide insight into the role of modality (i.e., auditory vs. visuo-manual) in shaping the neurobiology of language. In speakers of auditory languages, left fronto-temporal language networks are highly selective for language over non-linguistic tasks, including action semantics and working memory (Fedorenko et al., 2020). Like spoken languages, sign languages activate fronto-temporal networks (e.g., Neville et al., 1998). Responses to sign languages are partially distinct from responses to pantomime and gesture in group analyses (MacSweeney, et al., 2004, Emmorey, et al., 2011). The present functional magnetic resonance imaging (fMRI) study uses individual subject analyses to test the selectivity of the language network for sign language over action semantics and visual working memory in deaf signers of American Sign Language (ASL), a visuo-manual language. To test whether iconicity affects language selectivity, we compared non-classifier and partially iconic classifier constructions, matched in meaning and word-order. We use handling classifiers where handshapes convey how objects are handled, thus resembling pantomimic actions. Congenitally profoundly deaf participants (N=9) viewed ASL transitive and di-transitive sentences featuring six verbs (Give, Take, Open, Close, Pick-up, Put-down), with various agents and objects (e.g., The man opened the bottle. The woman gave the book to the man.) in these constructions: Subject-Verb-Object with Non-Classifier verb-form (SVO NCL), Object-Subject-Verb with Non-Classifier verb-form (OSV NCL), and Object-Subject-Verb with Classifier verb-form (OSV CL). In control conditions, participants watched action videos (action control) matched semantically to the ASL sentences (e.g., video of a man opening a bottle) and meaningless videos that preserved the presence of motion, human bodies and faces (low-level control). Participants also completed a spatial working memory task, in which they had to remember four (easy) or eight (hard) locations within a 3x4 grid (Fedorenko et al., 2011). We localized bilateral prefrontal and lateral temporal language regions in each subject using leave-one-run-out analysis (top 5% vertices ASL>Control). Inferior frontal and lateral temporal areas exhibited highly selective responses to language relative to both action and low-level control conditions (ps<.005). Responses to classifier and non-classifier constructions and for SVO and OSV word orders were equally language-selective (ps>.05). Next, we localized fronto-parietal working-memory regions in individual participants (working memory hard>easy, top 5% vertices). These regions did not respond preferentially to language compared to action control or low-level control (ps>.2). In whole cortex maps, ASL sentences activated a bilateral fronto-temporal network which was slightly left-biased on average, whereas action videos activated posterior superior temporal and occipito-temporal areas, predominantly in the right hemisphere. The working memory task activated fronto-parietal areas previously observed in hearing people. In deaf signers, the fronto-temporal language network is highly selective for visuo-manual language relative to action observation and working memory. Even when the meanings of the observed actions and sentences are matched, fronto-temporal networks exhibit a robust preference for sentences. Selectivity for visuo-manual language in this network is invariant to iconicity, i.e., classifier vs. non-classifier constructions. Language dissociates from action semantics and working memory networks irrespective of language modality.

B2 - The Cross-Language Activation of First Language (L1) Polysemy in Second Language(L2) Processing: An investigation of whether (L1) Polysemous Words translations are activated in L2 Sentence Context

Mona Alsalmi[1], Nan Jiang; [1]Myrland college park university

A present study aimed to investigate the role of a first language (L1) translation on a second language (L2) word processing in a sentential context by relatively advanced Arabic learners of English using eye tracking. The focus is on cases where a homonymous word in the L1 is realized by independent words in the L2, (e.g. Arabic **قرش** realized by English shark and coin). Using the visual world paradigm, Arabic-English bilinguals and English native participants were auditorily presented with English sentences that are predictive of a specific target word (e.g., “shark” in Scuba divers saw the sharp teeth of a giant shark yesterday) while looking at a visual screen. The screen contained one of the three critical objects: a target object whose English name corresponded to the target word (shark; Arabic: **قرش**) in the target condition, an Arabic competitor object whose Arabic name shared the same Arabic translation with the target word (coin; Arabic: **قرش**) in the Arabic condition, or an object that was unrelated to the target word (drums; Arabic **طبل**) in the control condition. Compared to native speakers of English, relatively advanced Saudi learners of English made more fixations on the critical objects in the Arabic condition compared to the control condition. This study supports the potential automatic activation of L1 translations when processing sentences in L2, even in relatively highly proficient learners, and suggests evidence for the verification model in L2 word

recognition. Keywords: Visual-world Paradigm, Cross-language activation, Homonyms, Target-absent Task.

B3 - "Waves of learning new words": The neural dynamics of cross-situational word learning

Samuel Armstrong[1], Paola Escudero[2], Anthony Angwin[1]; [1]University of Queensland, [2]Western Sydney University

Cross-situational word learning describes the process by which individuals learn new words by tracking and integrating statistical co-occurrences between words and their potential referents across various contexts and time points. In this study, we investigated the neural oscillatory mechanisms underlying the acquisition of written word meanings via cross-situational learning of novel names for familiar objects. Continuous scalp-EEG was recorded from healthy young adult participants (N=19) as they completed a cross-situational word learning task (encoding phase) followed by a semantic relatedness judgment task (recognition phase). During the encoding phase, participants learned meanings of novel written words from repeated encounters with different word-referent correspondences, presented across multiple contexts and timepoints. Repeated encoding encounters led to a build-up in statistical regularities and the gradual disambiguation of correct word-referent co-pairings, subsequently facilitating the formation of new word-object meaning associations. Importantly, participants received no explicit learning instructions nor were they informed of the word learning nature of the experiment; they were simply asked to maintain their gaze on the computer screen. After learning associations between novel written words (e.g., shope) and familiar object pictures (e.g., apple), participants completed a semantic judgment task where learned novel words were paired with familiar written words belonging to either the same (e.g., pear) or a different (e.g., sword) semantic category. For comparison, related and unrelated familiar word pairs were also included in the semantic judgment task. To measure changes in oscillatory responses, we conducted time-frequency analysis to obtain event-related spectral perturbations for novel written words, separately for encoding and recognition tasks. We observed modulations in oscillatory power across multiple frequency bands from 3-50 Hz during both tasks. Notably, there was greater enhancement of theta and low-gamma responses during cross-situational word learning, with gamma showing greater synchronization over left-hemisphere language regions. During the recognition task, theta oscillations exhibited greater power for semantic judgments of related versus unrelated word meanings, with more pronounced enhancements over the left hemisphere. Additionally, greater alpha and beta desynchronization was observed during both encoding and recognition tasks. Our findings are the first to report the oscillatory dynamics underlying cross-situational learning. More interestingly, these oscillatory responses reflect the neural mechanisms involved in the incremental and statistical nature of word learning, providing insight into the temporal and spatial characteristics of neural processes that support the formation and retrieval of novel word meanings.

B4 - White matter diffusivity predicts change in sight word reading following continuous theta burst stimulation to the left temporal parietal junction

C Nikki Arrington[1], Ewelina Bledniak[1], Brianna Kinnie[2], Evelyn Farkas[1], Robin Morris[1], Fumiko Hoeft[2]; [1]Georgia State University, [2]University of Connecticut

Successful coordination of the functional networks underlying reading is highly dependent on the underlying white matter tracts that connect these regions. There are several white matter tracts of interest that support the left-lateralized reading network: the arcuate fasciculus (AF), superior longitudinal fasciculus (SLF), the inferior fronto-occipital fasciculus (IFOF), inferior longitudinal fasciculus (ILF), and the uncinate fasciculus (UF). White matter diffusivity has been shown to predict response to neuromodulation but has not been explored in direct relation to the reading network. Continuous theta burst stimulation (cTBS) is a form of non-invasive brain stimulation that can temporarily inhibit brain activity in targeted brain networks and has been shown to modulate reading ability. It was hypothesized that measures of white matter diffusivity would predict change in reading efficiency following stimulation to the left temporal-parietal junction (TPJ), a targeted node of the dorsal stream of the reading network. Fifty three adults between the ages of 18 and 50 years (M = 22.79, SD = 5.40; 34 female) with a range in reading ability participated in this study. Participants completed the Sight Word Efficiency (SWE) and Phonemic Decoding Efficiency (PDE) subtests of the Test of Word Reading Efficiency-2 prior to and immediately following cTBS to either the left or right LTP or a control site (vertex). Reliable change scores were calculated for SWE and PDE. Participants also completed an MRI session including anatomical and diffusion weighted imaging sequences. FreeSurfer's Tracts Constrained by Underlying Anatomy (TRACULA) was used to extract fractional anisotropy (FA), a measure of white matter diffusivity, for tracts of interest. Individual hierarchical regressions models including baseline sight word reading, full scale IQ, age, and mean FA where used to predict change in SWE and PDE. Mean FA for six individual tracts significantly predicted change in SWE following cTBS to the left TPJ. Mean FA for the following tracts of interest accounted for the variance in SWE Reliable Change Score: (1) left AF: 38% ($F(1, 18) = 10.80$, $p = .004$); (2) right AF: 25% ($F(1, 18) = 5.93$, $p = .025$); (3) left SLF II: 21% ($F(1, 18) = 4.75$, $p = .043$); (4) right SLF II: 27% ($F(1, 18) = 6.68$, $p = .019$); (5) right SLF III: 24% ($F(1, 18) = 5.57$, $p = .030$); and (6) left ILF: 23% ($F(1, 18) = 5.48$, $p = .031$).). There were no significant relations between PDE Reliable Change and any white matter tract of interest following cTBS to the left TPJ. Additionally, there were no significant relations between SWE or PDE Reliable Change and any white matter tract of interest following cTBS to either vertex or right TPJ. These findings suggest that increased diffusivity of white matter tracts associated with the left hemisphere reading network and their right hemisphere homologues may support the positive impact of cTBS following stimulation to a targeted node of the reading network. Individual differences in white matter diffusivity may underlie differences in behavioral outcomes following neuromodulation.

B5 - Multiple Lesion Sites Associated with Alexia and Agraphia in Speakers of English and Arabic: A Cross-Cultural Study

Venu, Balasuramanian[1], Maha, Aldera[2], Morgan, Okula[1], Jordan, D'Angelo[1]; [1]Seton Hall University, Nutley, [2]Princess Nourah University, Riyad, Saudi Arabia

Introduction. The study of alexia with agraphia (AWA,), in its pure form or in association with aphasia, might offer insights into the neural underpinnings of the interface between reading and writing, as originally suggested by Joseph-Jules DeJerine in 1890. A recent systematic scoping review disclosed several lesion sites (Levy et al, 2023., Kim et al, 2015., Kirschner & Webb, 1982., Purcell et al, 2014) and the symptom complex associated with AWA in speakers of English language (Balasubramanian et al, 2023). An important question to be asked, in this context, is this: Does AWA syndrome look the same across languages/scripts? This issue has implications for both cognitive and neural models of the interface between reading and writing. Hence, a cross-cultural perspective is taken in the current study. The relevance of cross-cultural studies is exemplified in several studies of the past (Bates, et al, 2001; Boerner et al, 2023; Bolger, Perfetti, Schneider, 2005; Chen et al, 2009; Menn, Niemi,] & Ahlsen, 1996; Valaki, et al, 2003). The Problem: What are the lesion sites associated with AWA syndromes in speakers of English and Arabic? What are the distinctive characteristics of AWA syndromes in speakers of English and Arabic? Method: Case-series analyses (Schwartz & Dell, 2010) of AWA syndrome in six Arabic (M:4, F:2) and six English aphasic subjects (M: 2, F: 4) were undertaken. Demographic details of all subjects were gathered. Materials: Experimental tests were chosen from PALPA (Kay, Lesser, & Coltheart, 1992) and Arabic adaptation of these tests were used to identify the central alexia and agraphia. Only lexical level oral reading and writing (to dictation) was targeted. Aphasia diagnosis was completed for all subjects. Results: Multiple lesion sites associated with AWA were seen in both Arabic and English cases, as attested by MRI/CT scan images. AWA syndromes in both linguistic groups were either concordant or discordant types. Conclusions. The results of the current cross-cultural study have yielded similar results in both linguistic groups, despite a few differences in the respective scripts. Both scripts/writing systems are alphabetic in nature. In a cross-cultural study, it seems that writing systems that differ markedly might yield different answers to the research questions. There is a need for more cross-linguistic studies. With regards to the lesion sites associated with AWA syndrome, we need to recognize that recent lesion studies and voxel-based lesion analyses (Baldo, 2018; Kim et al, 2015; Purcell et al, 2015) as well as functional imaging studies of neurologically typical cases (Wilson et al, 2019) point to several different neural structures where reading and writing might converge. These findings reinforce the results of a scoping review of AWA reported earlier (Balasubramanian et al, 2023) Thus, the issue of the neural bases of the convergence of oral reading and writing warrants further investigation. Application of newer approaches to network localization, such as the one proposed by Boes and colleagues (2015), must be considered for further research on the neural underpinnings of AWA.

B6 - Neuro-behavioral correlates of visual statistical learning in Chinese second language reading

Bo Bao[1], Haoru Wang[1], Yanzi Zhang[1], You Li[1], Guiping Xu[1]; [1]JINAN UNIVERSITY

Initially identified in infant word segmentation (Saffran et al., 1996), statistical learning (SL) refers to the process of extracting statistical regularities from the environment. SL is recognized as an important cognitive factor in language learning, and the orthographic depth of a written system is one of the significant factors moderating the strength of the correlation between SL and reading performance. And the correlation is also evident in neural activity, particularly in the delta band during the online learning stage of SL, notably the inter-trial phase coherence (ITPC) at 1.1 Hz (chunk-rate) and 3.3 Hz (item-rate) . However, research on the impact of SL on second language acquisition, particularly in non-alphabetic languages like Chinese, remains sparse. Notably, reading performance in Chinese second language learners lags other language skills. And the relationship between this lag and visual statistical learning is not well understood, especially regarding the underlying cognitive neural mechanisms. This study explored the unique impact of visual SL based on the cognitive profile of Chinese second language reading and investigated the specific pattern of the neural synchronization during the visual SL among the Chinese second language learners. In study 1, we recruited 29 Chinese second language learners, conducted a sentence reading fluency test (Bai et al., 2020), and administered a battery of other cognitive measurements, including working memory, rapid naming, visual perception skills (TVPS-4), visual SL (the classic triplet learning paradigm with black and white abstract pictures). The reading profile showed that visual statistical learning could significantly negatively predict sentence reading fluency even after the controlling the other related factors, contrary to previous findings that indicated a positive relationship between SL and reading skills. This discrepancy suggests differences between first and second language learning. So, we further recruited 20 native Chinese speakers and 20 Chinese second language learners in Study 2, collecting their EEG signals during a visual SL task and measuring the cognitive skills found to be correlated with SL ability in Study 1. The ITPC at both the chunk (1.1 Hz) and item (3.3 Hz) rates were compared between groups. The results revealed significant group differences in the later stages of visual SL, with Chinese second language learners exhibiting significantly lower neural synchronization at the item rate (3.3 Hz) compared to native speakers. Additionally, within the Chinese second language learners' group, ITPC at 3.3 Hz was positively correlated with the general cognitive and visual perceptual abilities, particularly forward working memory and two sub-skills of visual perception: sequential memory and visual figure-ground. Our study highlights the unique role of visual SL in Chinese second language reading and provides new insights for neural mechanisms of SL among Chinese second language learners. The specific neural pattern observed among Chinese second language learners may shed light on the lag of Chinese reading development. The distinct roles of visual SL in second language reading development across different written systems call for a finer-grained account of different hierarchies of reading (word decoding or reading

comprehension) and different learning stages of second language learners.

B7 - Comparing LLM layerwise activation with EEG dynamics during language comprehension with RSA

Jonathan Brennan[1], Maria Figueiredo[1], Gabriel Mora[1]; [1]University of Michigan

INTRODUCTION: Large Language Models (LLMs) have emerged as a compelling in silico model for aspects of human language processing. Statistical alignment between human brain signals and model internal states provide evidence supporting some shared representational properties between these systems. Representational Similarity Analysis (RSA) is one tool to probe those internal states by: (i) comparing model internal activations for each word in some linguistic input, yielding a matrix M of pairwise similarities, (ii) repeating that step for human neural activations yielding pairwise similarity matrix N, and (iii) comparing the similarity of M to N as a measure of model-to-human alignment. Here we use RSA to test the strong hypothesis that that layerwise activation in a LLM align monotonically with the temporal dynamics of human neural responses recorded with EEG. METHODS: Data come from an open EEG dataset of N=33 English users who listened to a 12 minute audiobook while signals were recorded from 61 electrodes at 500 Hz (0.1-200 Hz pass band; linked mastoid reference). Data are epoched at word onset and eye blink artifacts removed with ICA; epochs/channels with excessive noise are marked with the autoreject algorithm. We compute word-to-word pairwise spatial correlation between epochs at 12 timepoints (-0.1-1 s). The model is GPT2, a pre-trained 12-layer transformer which was presented with the same story text as the human participants. We compute word-by-word pairwise correlation between activations at each layer, after accounting for epochs excluded in the human data. Finally, we compare the cosine similarity of the human and model correlation matrices, yielding a time-series of RSA values per layer per dataset; these are submitted to a hierarchical bayesian regression for statistical analysis; <timepoint,layer> pairs are statistically reliable if the 95% credibility interval excludes zero. RESULTS: Reliable increases in similarity relative to baseline are observed beginning around 200 milliseconds in model layer 6; similarity values then increase across layers 7 through 10 and then decline, matching previous reports with MEG. Interestingly, similarity increases across a wide time-window, with even later layers showing high similarity at early time-points. A hint of layer-to-time alignment emerges when examining correlation peaks, which shift from ~200 ms in layers 6 and 7 to ~500 ms by layer 10, although peak analysis is notoriously noisy. CONCLUSIONS: RSA analysis shows similarity in layer-wise activation in GPT2 and human EEG signals, confirming prior reports with fMRI, MEG, and ECoG. This similarity emerges in middle layers of the networks and spans a broad timewindow from 200 to >800 ms with little evidence that earlier layers better correspond, on the whole, to human responses at earlier timepoints. Different dynamics between model and human EEG signals point to different organizational principles for the representational spaces in these systems which plausibly reflect architectural differences that pose limits on how well LLMs can aid in understanding human neural systems. Human neural language circuits, for example, combine top-down and bottom-up mechanisms, whereas transformer LLMs like GPT2 are solely feed-forward.

B8 - Functional connectivity patterns in post stroke aphasia: task level differences

Nicole Carvalho[1], Maria Varkanitsa[1], Isaac Falconer[1], Anne Billot[2,3], Swathi Kiran[1]; [1]Center for Brain Recovery - Boston University, [2]Department of Neurology, Massachusetts General Hospital & Harvard University, [3]Department of Psychology, Center for Brain Science, Harvard University

Introduction Traditionally, the study of the neural correlates of language processing in people with aphasia (PWA) has relied on language-constrained tasks to engage language-related brain regions and understand the functional organization of the language network. In addition, resting-state fMRI has also been used to measure altered connectivity patterns in PWA. Tasks, such as resting-state and language localizers, are constrained in timing and/or do not fully capture the nuances of naturalistic language processing. The aim of this study is to determine whether functional connectivity (FC) patterns differ in tasks that have varying language demands. Methods 29 chronic PWA (4F, age: mean=58.7 years, range=19.7–75.7 years, time post stroke: mean=90.6 months, range=5.2–530.1 months, WAB-AQ: mean=80.8, range=31.5-99.6) due to left hemisphere stroke lesion and 27 neurotypicals (21F, age: mean=64.3 years, range=44–80 years) participated in the experiment. All subjects completed a structural and functional MRI protocol including resting-state, movie watching (e.g., a silent animated short PIXAR film), story listening (e.g., a simple short story), and language localizer (e.g., sentences and lists of nonwords presented one word or nonword at a time, in a blocked design) tasks, lasting about 5 minutes each. Lesions were masked out using ITK-SNAP. Data was preprocessed using the CONN EL pipeline (https://web.conn-toolbox.org/resources/conn-extensions/evlab), including segmentation, normalization, motion correction, co-registration, resampling, removal of outliers beyond default CONN thresholds, and smoothing. Then, a region of interest (ROI) to ROI connectivity analysis was conducted using the default CONN atlas. Mean composite whole-brain and within-network connectivity estimates were calculated, resulting in nine estimates for each participant (i.e., whole-brain and cerebellar, dorsal attention (DAN), default mode (DMN), frontoparietal, language, salience, sensorimotor, and visual networks) per task. These estimates were entered as dependent variables in regression models looking at the group, task, and interaction effects between group and task. Results Overall, the main group effect showed that PWA exhibited significant lower whole-brain and within-network FC than neurotypicals. At the whole-brain level across groups, the language localizer task elicited higher connectivity compared to rest (p=0.001), movie watching (p=0.0001) and story listening (p<.0001). Within-network analyses showed (a) no differences in connectivity patterns across tasks in the language, frontoparietal, salience, sensorimotor, and cerebellar networks, (b) overall, story listening elicited significantly lower connectivity than the language localizer task in the DMN (p=0.001), significant interaction effects between group and task in the (c) DAN and (d) visual network between all tasks except the language localizer. During story listening (p=0.0008), movie

watching (p<.0001), and resting-state (p<.0001), PWA exhibited significantly lower connectivity than neurotypicals in the DAN. During story listening (p<.0001), movie watching (p=.0368) and resting-state (p=.0001), PWA exhibited significantly lower connectivity than neurotypicals in the visual network. Conclusions In line with previous research, results indicate that overall PWA exhibited lower connectivity than neurotypicals. Language tasks elicited similar FC patterns in the language network, yet they elicited varying levels of connectivity in non-language networks. This variation of FC patterns may be a function of language processing that may be indicative of a PWA's deficit or may serve to support language processing in a lesioned brain.

B9 - Role of a candidate-dyslexia gene on rapid auditory processing; insights from comparing a preclinical model to children

Tracy M Centanni[1,2], Logun Gunderson[2], Vishal Thakkar[2], Monica Parra[2], Brad Wilkes[1]; [1]University of Florida, [2]Texas Christian University

Despite the knowledge that dyslexia is the most common neurodevelopmental disorder, affecting up to 15% of the population, the interventions that exist do not help all readers achieve fluency. Dyslexia is a polygenic disorder, influenced by several genes that are often non-overlapping across individuals. It is therefore exceedingly difficult to evaluate the role of individual candidate-dyslexia genes on neural plasticity in humans. One of the most well-studied genes implicated in dyslexia is DCDC2, a gene involved in early brain development, amongst other functions throughout the lifespan. In children with dyslexia, this gene is associated with reading speed, working memory, and differences in brain volume. Prior work utilizing rodent models with Dcdc2 manipulation also reported poor working memory and anatomical differences. Our own prior work suggested that this gene may impair rapid perceptual processing, specifically of speech sounds, and may interfere with neural plasticity during training. The first goal of the current study was to expand this work and probe the effects of this gene on 1) anatomy, 2) rapid auditory perception, and 3) plasticity using a novel knockout rat model. Rats with homozygous or heterozygous knockout and their wild-type littermate controls were trained on a rapid speech sound discrimination task previously developed and validated by our group. Auditory evoked potentials were recorded in response to tones and broad band noise burst trains in rats following training (N = 25 across the genotype groups) and in a group of age-matched naïve controls (N = 22 across the genotype groups). Brain tissue was then fixed and extracted prior to undergoing anatomical and diffusion-weighted 17.6T MRI. While we did not observe a specific rapid perception deficit following Dcdc2 knockout, there is an effect of this gene on neural development and response to training. To evaluate the potential translational value of this work, we compared these data to a sample of children with dyslexia, in which rapid stimulus perception was measured and DCDC2 was genotyped. A sample of children between 7-12 years old with (N = 33) and without (N = 33) dyslexia were recruited. Following assessment, they completed several tasks of rapid stimulus processing, including rapid auditory perception (of tones, speech, and consonant-vowel-consonant sounds), rapid visual perception (of letters and shapes), and a visuo-spatial working memory task. All tasks were based on previously validated and published protocols. Saliva samples were mailed to the lab and several variants of interest on DCDC2 were genotyped. In children with dyslexia, we observed a specific deficit in reaction times without a corresponding accuracy hit, in line with the preclinical data. We will highlight the effects of genotype on neural plasticity for tones and noise burst trains and effects of training on the brain in the preclinical model and suggest future directions for translational research into the role of this gene in dyslexia. These findings will be discussed in the context of what we know about this gene in humans with dyslexia and how these preclinical findings may inform our future studies of non-responders to intervention.

B10 - Age-related differences in semantic-based generalization

Sao-Wei Chang[1], Jinyi Hung[1]; [1]MacKay Medical College, New Taipei City, Taiwan

Human semantic knowledge is generally considered preserved during aging. While differences between older and younger adults were often in other cognitive processes, degradation in semantic knowledge is typically pathological. It is thus assumed that healthy older adults receive good top-down knowledge support, which allows them to keep the boundary of the concepts clear and be able to overcome bottom-up surface interference. Here we assessed to what extent did the healthy older adults did in making semantic judgment that relied heavily on top-down processing. We also compared their performance to a group of younger adults to examine the effect of aging on semantic processing. Eighteen older adults (mean age = 64.2, mean edu = 12.6) and 10 younger adults (mean age = 21.1, mean edu =14.1) completed a word-to-picture matching task in which participants were asked to select which items, from an array of 8 pictures, were examples of the probe word. Following Lambon Ralph et al. (2010), we included typical, atypical, pseudotypical, partially related, same category, and unrelated exemplars to test the effect of typicality and surface similarity. We also tracked participants' eye movements during the task and set each exemplar as an area of interest (AOI) to examine participants' online performance. Group comparisons were performed to examine the accuracy and eyetracking metrics among exemplars. The results showed that relative to the younger adults, older adults were more likely to select atypical and pseudotypical exemplars (atypical $t(46) = 1.97$, $df = 46$, $p = 0.05$; pseudotypical $t(46) = 3.25$, $p = 0.002$). Eyetracking results also showed that overall older adults had slower time to first fixation (mean diff = 891, $F(1) = 97.04$, $p < 0.01$) and greater number of fixations (mean diff = 0.56, $F(1) = 18.88$, $p < 0.01$) among exemplars; especially in the atypical, partial, and the pseudotypical ones. Older adults spent more time viewing the exemplars, but their performance was comparable with the younger adults. It shows that the difference between older and younger adults may mainly be the speed of processing and not necessarily the degradation of the knowledge itself. On the one hand, older adults were more likely to correctly identify atypical exemplars; together with their performance in correctly excluding partial and same category exemplars, it seems that older adults benefit from well knowledge support and are more lenient to concepts. On the other hand, older adults tend to

were more likely to be confused by the surface similarity than the younger adults. These findings suggest that older adults have different semantic processes from younger adults, although older adults still maintain good boundary of concepts, they are more likely to be influenced by bottom-up surface similarity.

B11 - Reduced White Matter Integrity in Cantonese-Speaking Children with Developmental Language Disorder: Preliminary Evidence Supporting the Procedural Circuit Deficit Hypothesis

Xiaocong Chen[1], Jueyao Lin[1], Angel Chan[1], Michael Ullman[2], Min Ney Wong[1], Caicai Zhang[1]; [1]The Hong Kong Polytechnic University, [2]Georgetown University

Introduction: Developmental Language Disorder (DLD) affects various childhood language difficulties, though it notably impacts morphosyntax. The Procedural circuit Deficit Hypothesis (PDH; Ullman et al., 2020) posits that DLD may be largely explained by abnormalities of the basal-ganglia-based circuitry underlying procedural memory. Previous studies of the PDH have predominantly focused on English-speaking children and examined gray matter in the basal ganglia and associated circuitry (Ullman et al., 2024). Given the distinct linguistic characteristics of Chinese (e.g., sparse inflectional morphology and less informative structural sequence cues), this study focused on Cantonese-speaking school-age children with DLD and their age-matched typically developing (TD) peers. We examined microstructural differences in white matter tract integrity between the DLD and TD groups. Additionally, we investigated whether microstructural metrics predicted receptive grammar skills in these children, focusing on grammar comprehension, which has relatively few cognitive and motor confounds. Methods: Twenty-two native Cantonese-speaking children participated (11 DLD, 4 girls, 8.98±1.65 years old; 11 TD, 5 girls, 9.34±1.72 years old). Diffusion tensor imaging (DTI) was performed using a 3T SIEMENS system. Tract-Based Spatial Statistics (TBSS) and Region of Interests (ROI) analyses were conducted to identify group differences in fractional anisotropy (FA) values of major white matter tracts. Receptive grammar skills were assessed using a standardized grammar comprehension test. Results: TBSS analysis revealed some clusters of smaller FA values in DLD children than in TD children (ps <.05), particularly in parts of the corpus callosum and internal capsule. ROI analyses also suggested that DLD children had reduced mean FA values in the splenium and genu of the corpus callosum, and in the bilateral anterior and posterior limbs of internal capsule (ps <.1). After controlling for age, gender, and non-verbal IQ, regression analyses revealed that the mean FA values of the splenium and genu of corpus callosum and the bilateral posterior limbs of internal capsule, were significant positive predictors of the receptive grammar scores (with two groups collapsed; ps<.05), while the mean FA values of the bilateral anterior limbs of internal capsule were marginally significant positive predictors of the receptive grammar scores (ps <.1). Conclusion: Consistent with Lee et al. (2020), these preliminary results support the PDH by showing reduced structural integrity (i.e., smaller FA values) in the DLD group compared to the TD group in the bilateral anterior and posterior limbs of internal capsule. The internal capsule, a prominent white matter structure in the corticostriatal system, connects the cortex and basal ganglia, with its anterior limb linking to the prefrontal cortex and the posterior limb to motor and sensory cortices. Additionally, the significantly smaller FA values of the splenium and genu of the corpus callosum align with previous DTI studies on DLD, suggesting poorer inter-hemispheric information integration in this population (Kim et al., 2006; Paul, 2011). These findings enhance our understanding of the neural substrate of DLD and may have therapeutic implications for the disorder.

B12 - The language mosaic: MRI evidence from task-independent measures in monolinguals and bilinguals

Xuanyi (Jessica) Chen[1], Esti Blanco-Elorrieta; [1]New York University

In recent years, there has been active consideration that bilingualism may produce cognitive and neural benefits (Bialystok, 2017) as indexed by neural adaptations in several anatomical regions (e.g., supramarginal gyrus, prefrontal regions, white matter tracts; Pliatsikas, 2020). However, these results have been marked by inconsistency across experiments, suggesting that there may be qualitative differences between monolingual and bilingual individuals that are grounded in biological underpinnings, but offering little clarity to what those may be. The reasons for these inconsistencies may be two-fold. First, researchers have often relied on a simplified binary framework and made categorical distinctions between monolingual and bilinguals instead of establishing a bilingualism spectrum and assessing adaptations that result from the degree of bilingualism. Second, researchers have mostly focused on a handful of regions and reported the one region where groups vary in each project, preventing us from obtaining a complete, whole-brain account of how neural machinery adapts as a function of acquiring two languages. Here, we evaluate the impact of bilingualism on whole-brain anatomy by combining neuroscience and machine learning to create a comprehensive mosaic that reflects where and when neuroplasticity associated with multilingualism develops. We acquired structural, resting-state and diffusion-weighted images for 25 English monolinguals, and 25 Mandarin-English bilinguals. To overcome the simplified binary framework, we defined bilingualism qualitatively (categorical: mono vs bilingual) and quantitatively (continuous: by calculating a compound score for the degree of multilingualism). Specifically, we constructed a theoretical-driven multilingual scale that captured the 'multilingual-ness' of each subject accounting for their AoA, ability rating, and the total number of languages they know. From the MRI data, we obtained 1) gray matter, white matter, and subcortical ROI volume in 116 regions with voxel-based morphometry and 2) 168 ROIs with surface-based morphometry, 3) cortical thickness in 68 gray matter regions; 4) fractional anisotropy in 90 ROIs, and 5) resting-state connectivity between 164 ROIs. For each measure and ROI, we tested whether it showed a categorical or continuous effect of bilingualism using linear regression, corrected and uncorrected for total brain volume. To capture potential structural differences distributed across brain areas incorrectly include pseudotypical exemplars, showing that they

(i.e., to obtain a multi-dimensional 'mosaic' of anatomical profiles), we used supervised and unsupervised machine learning (i.e., K-means clustering, hierarchical clustering, and classification analyses with SVM) for each of the five metrics mentioned above. The results showed no consistent differences in any of the measures and ROIs after FDR correction. We found a significant difference in cortical volume of right precuneus only when the total brain volume was entered as a covariate. Additionally, our machine learning algorithms did not identify distinct anatomical patterns for monolinguals and bilinguals except for our SVM for cortical volume and thickness in surface-based analyses. However, follow-up analyses with simulated data showed that the SVM relied on a single varying dimension instead of reflecting an overall distinct anatomical profile. In all, the exhaustive analyses of structural differences show an overarching similarity between monolingual and bilingual brains, whether bilingualism is defined qualitatively and quantitatively, offering no evidence for multilingualism-induced neuroplasticity.

B13 - The Influence of Distractor Modality on Propositional Language in Healthy Ageing

Jessica Chow[1], Gail Robinson[2]; [1]University of Queensland

Introduction Propositional language is a fundamental cognitive ability required in everyday interactions. Propositional is the voluntary generation of ideas and involves core language skills (e.g., naming) and non-linguistic cognitive abilities, such as attention and executive functions. One way to investigate the influence of attention on propositional language is by using distractor interference. Interference control is an executive process, in which difficulties in propositional language production can occur in healthy ageing and individuals with executive dysfunctions (e.g., neurodegenerative diseases). This project sought to better understand the influence of attention and executive functions on propositional language production in healthy ageing. We investigated this by using non-verbal interference, which varied in modality type (i.e., auditory vs visual). Method Forty-two young adults and 28 older adults completed a novel picture-description task with interference. In this task, participants were asked to produce two sentences about the pictorial scene under two different interference conditions: auditory and visual distractors. A third control condition (i.e., distractor absent) was included to establish baseline responses between younger and older adults. We measured the number of filled pauses, response latency, quality of ideas produced (i.e., propositional density), quantity of ideas (i.e., speech rate), and errors produced (i.e., cohesion, coherence, idea repetitions, premature commitment errors, and total errors). Results Older adults produced more filled pauses compared to younger adults. Moreover, older adults produced more filled pauses in the distractor absent condition compared to other distractor modalities. Across both age groups, participants also had faster response latencies in the auditory distractor condition compared to the visual distractor condition. Compared to older adults, younger adults had a faster speech rate, but this was irrespective of distractor modality. Propositional density was also higher in the visual distractor condition compared to the auditory distractor condition across both age groups. In relation to the types of errors produced, in the distractor absent condition, cohesion errors were the most common errors produced compared to other error types. In the auditory distractor condition, both cohesion and premature commitment errors were the most common errors produced compared to other error types. In the visual distractor condition, cohesion errors were the most common errors, particularly by older adults compared to younger adults. Across the distractor conditions, participants produced a higher number of total errors in the auditory distractor condition compared to the other distractor conditions. Moreover, older adults in general produced a higher number of total errors compared to younger adults, but this was not specific to a distractor modality. Conclusion Consistent with prior literature, we found that ageing influenced propositional language, which was modulated by interference. Compared to visual interference, auditory interference influenced response latency and the number of errors produced. However, for propositional density to be influenced, the interference may need to contain meaning.

B14 - Pitch memory, but not pitch aptitude, predicts implicit statistical learning of non-native tone contrasts by older adults

Yin-To Chui[1], Susu Lai[1], Zhen Qin[1]; [1]The Hong Kong University of Science and Technology

Tone languages integrate segmental and tonal information to make meaning. Despite this complexity, as well as age-related decline in psychoacoustic abilities and dynamic pitch perception, older adults have been reported to demonstrate successful perceptual learning of L2 tones if explicit feedback is given. On the other hand, implicit statistical learning may pose additional challenges as it poses higher requirements on psychoacoustic and statistical learning abilities. Older learners have also been shown to recruit additional cognitive abilities to compensate for decline in sensory processing, such as phonological memory. The recruitment of compensatory mechanisms may be exacerbated in an implicit statistical tone learning task given the added difficulty. This study examined the implicit statistical learning of L2 tonal contrasts by older adults through distributional training (i.e., exposure to probability distributions of auditory tokens) and investigated the role of different cognitive factors in learning. 64 L1-Cantonese older adults (mean age: 62.9 years) learned to discriminate a perceptually difficult Mandarin level-falling tone contrast following a pre-test, training, post-test procedure. ABX discrimination was administered for pre-/post-tests, with tokens consisting of two pseudo-syllables (nua, fao) produced by two genders to test generalization. Training stimuli (female nua only) were synthesized by interpolating naturally produced Mandarin level and high-falling tones into six equidistant steps. Participants either heard a bimodal distribution (two-peak resembling level-falling categories) or unimodal distribution (one-peak resembling single ambiguous category). The bimodal group is expected to outperform the unimodal group in post-training discrimination (bimodal improvement and unimodal suppression in support of distributional learning). A cognitive battery was also administered that measured the learners' pitch aptitude (just-noticeable-difference of pitch contour), pitch memory (average tone span), and working memory (average backwards digit span). Mixed-effects logistic regression models were performed on participants' accuracy in the ABX discrimination tasks, with fixed effects of Distribution (Unimodal

vs Bimodal) and Session (Pre-test vs Post-test). Results showed a main effect of Session (z=3.74, p<.001), suggesting that both groups improved through training. However, the interaction between Distribution and Session was not significant (z=-0.49, p=.622), suggesting no divergence between bimodal/unimodal improvement. Results for cognitive predictors showed that the three-way interaction between Distribution, Session, and Predictor was significant only for pitch memory (z=-2.08, p=.037). Post-hoc simple slopes analysis revealed that pitch memory predicted improvement in the unimodal group only. Specifically, higher pitch memory resulted in worse post-training improvement (i.e. better suppression from unimodal exposure). Both analyses suggest the results are driven by the performance of the unimodal group. Contrary to expectation, the unimodal group did not suppress improvement through exposure to a distribution that facilitated the formation of a single category. This was explained through large individual variability in pitch memory – only individuals high in pitch memory showed suppression. The lack of group results highlights a difficulty in implicit statistical learning of tones for older adults, where only “good learners” (high in pitch-related memory capacity) may be able to store the distributional information for subsequent tonal discrimination. This ability is perhaps more important during unimodal exposure because of the lesser acoustic salience of the tokens.

B15 - Disentangling Semantic Retrieval and Composition in Understanding "Novel-But-Familiar" Combinations

Ziyi Ding[1], Ming Song[1], Qing Cai[1,2]; [1]Key Laboratory of Brain Functional Genomics (MOE & STCSM), Affiliated Mental Health Center (ECNU), Institute of Brain and Education Innovation, School of Psychology and Cognitive Science, East China Normal University, No. 3663, North Zhongshan Road, Shanghai, China, 200062, [2]NYU-ECNU Institute of Brain and Cognitive Science, New York University Shanghai, No. 3663, North Zhongshan Road, Shanghai, China, 200062

Deriving combinatorial semantics from component words encompasses multiple processes, including the retrieval of known meanings and their integration into a unified entity. Previous research showed that the anterior temporal lobe (ATL) typically plays an important role in semantic composition. However, its activation is seldom observed in processing weak associations or unfamiliar combinations. Conversely, the middle temporal gyrus (MTG) predominantly responds to more challenging semantic combinations. The distinct functions of the ATL and MTG in semantic composition remain to be clearly defined. This study hypothesizes that the ATL primarily retrieves meanings for both individual words and their combinations as a whole, particularly for familiar combinations. In contrast, the MTG is crucial for the semantic composition of expressions, especially when the overall meaning is challenging to discern. We propose that both the ATL and MTG are integrally involved in combinatorial semantics. To further delineate the roles of composition and retrieval, this study includes a newly introduced condition termed "novel-but-familiar" combinations, which pairs familiar concepts with new expressions (e.g., ‘voice box’ for ‘stereo’). Participants were asked to make sense of these combinations during fMRI scans. Four types of combinations were included: familiar, novel, novel-but-familiar, and non-sensical. Each condition included 30 unique combinations. Each combination was presented twice, allowing comparisons between initial exposures and subsequent repetitions. We also minimized the syntactic effect by including an equal number of noun-noun and verb-object combinations. Combination types were reassigned based on responses from post-scanning questionnaires. To disentangle the roles of composition and retrieval, the current study introduced a new condition, "novel-but-familiar" combinations, which describe familiar concepts in novel expressions (e.g. "voice box (声音盒子)" corresponds to "stereo (音响)"). Participants were asked to try to comprehend the meanings of the combinations and decide their meaningfulness during fMRI scanning. Four types of combinations were randomly presented: familiar combinations, novel combinations, novel-but-familiar combinations, and nonsense combinations. Each type included 30 unique combinations, with each combination presented twice. An equal number of noun-noun and verb-object combinations was included to balance the impact of syntax. The types of combinations were reassigned based on the post-scanning questionnaires. Results showed that in line with previous findings, the ATL predominantly responded to familiar combinations, whereas the MTG was more active with novel combinations. Notably, the "novel-but-familiar" condition significantly engaged both the ATL (compared to "novel") and MTG (compared to "familiar"), suggesting their distinct roles in deriving combinatorial semantics. Finally, both the ATL and MTG exhibited significant activation in response to the first presentations compared to their repetition for all meaningful combinations. The results emphasize the collaborative efforts of the ATL and MTG in comprehending a wide array of conceptual combinations, suggesting that while the ATL underlies the retrieval of established meanings, while the MTG is actively involved in the composition of component meanings, especially for novel combinations that lack an integrated semantic representation.

B16 - Grey matter volume is associated with language performance in children with diverse language development profiles

Elizaveta Dmitrova[1], Tatyana Bolgina[2], Militina Gomozova[2], Tatyana Zhilyaeva[3,4], Ulyana Nasonova[3], Olesya Klekochko[3], Evgenij Klyuev[3], Olga Dragoy[2,5]; [1]Higher School of Economics, Nizhny Novgorod, Russia, [2]Higher School of Economics, Moscow, Russia, [3]Privolzhsky Research Medical University, Nizhny Novgorod, Russia, [4]V.M. Bekhterev National Medical Research Center for Psychiatry and Neurology, St. Petersburg, Russia, [5]Institute of Linguistics, Russian Academy of Sciences, Moscow, Russia

Introduction: Previous studies on neural correlates of language disorders, such as developmental language disorder (DLD) and speech sound disorder (SSD), assessed the brain structural differences between participants in groups according to the diagnosis (Badcock et al., 2012; Girbau-Massana et al., 2014; Pigdon et al., 2019). However, taking into consideration the variability of language and behavioural performance in these disorders and debates on the diagnostic criteria (Gomozova et

al., 2024; Lancaster & Camarata, 2019; Stringer et al., 2023), we attempted to study language outcomes and their associations with grey matter alterations in a group of Russian-speaking children with diverse language development profiles. Methods: Fifty children participated in the study (18 females, M(age)=6.4, SD(age)=0.4): 25 typically developing children, nine children with DLD, and 16 children with SSD. Firstly, to measure language and speech abilities of each child a face-to-face assessment was performed with the Russian Child Language Assessment Battery (RuCLAB) (Arutiunian et al., 2022). This standardised battery consisted of 11 subtests on language comprehension and speech production, which allows for a complex analysis of language skills. Each subtest's data were transcribed (for production subtests) and scored, resulting in 11 language scores (in percentage of correct answers) for a child. These data were further included into the voxel-based morphometry (VBM) analysis. Secondly, each participant underwent structural MRI scanning to obtain T1-weighted MRI image (1.5T Siemens Essenza scanner, with TR/TE, 1900/3.37 ms; 1 x 1 x 1 mm3 voxels, 256 x 256 mm field of view; 176 axial slices). The VBM analysis (Ashburner & Friston, 2000, 2003) was performed in the SPM12 toolbox (https://fil.ion.ucl.ac.uk/spm/software/spm12/) in MATLAB, R2023a (The MathWorks Inc., 2023). Age, gender and language scores of each subtest of the RuCLAB were added as covariates in multiple regression models. Results: The results of the VBM analysis revealed increased grey matter volume (GMV) (significant at the FWE-corrected level, p<.05, cluster-size threshold k=20 voxels) associated with higher language scores in the RuCLAB subtests assessing verb comprehension (cluster in the left putamen, peak-level p=.01, size=39 voxels), sentence comprehension (cluster in the left medial superior frontal gyrus, peak-level p=.02, size=33 voxels) and object naming (cluster in the right caudate, peak-level p=.02, size=21 voxels). Conclusion: Our analysis revealed increases in GMV in the putamen and caudate nucleus associated with better performance in the verb comprehension and object naming tasks in a group of children with diverse language development profiles. Structural and functional abnormalities in these regions were reported previously in children with DLD (Badcock et al., 2012) and were proposed to be associated with language learning difficulties due to their involvement in procedural learning processes (Krishnan, Watkins & Bishop, 2016; Ullman & Pierpont, 2005). Our results go in line with previous studies and highlight the involvement of the striatum in language development, however, more research is needed to better understand the findings.

B17 - Stages of lexical impairments inform efficacy of transcranial magnetic stimulation on sustained aphasia treatment outcomes

Haley C Dresang[1], Denise Y Harvey[2], Leslie Vnenchak[2], Peter Twigg[2], Sam Cason[2], Adelyn Brecher[3], Lynn M Maher[4], Roy H Hamilton[2], H Branch Coslett[2]; [1]University of Wisconsin-Madison, [2]University of Pennsylvania, [3]Moss Research Rehabilitation Institute, [4]University of Houston

Introduction- A growing body of evidence has shown that transcranial magnetic stimulation (TMS) can enhance naming abilities in post-stroke aphasia. However, there is substantial variability in the efficacy of TMS, and it remains unclear which individuals are good candidates for TMS treatment approaches (Martin et al., 2009). One factor that may contribute to TMS treatment efficacy is the locus of aphasia impairment (Harvey et al., 2019). Computational models of word retrieval account for deficits occurring at two stages: the translation of meaning to word form (i.e., semantics), and the translation of the word to its sound form (i.e., phonology; Dell et al., 1997). This study investigated how semantic and phonological characteristics of baseline naming impairments may inform the efficacy of TMS on long-term naming improvements following language treatment in individuals with chronic aphasia. Methods- Thirty participants with aphasia underwent ten sessions of inhibitory TMS to right pars triangularis (rPTr) preceding modified constraint-induced language treatment. Nineteen participants were randomly assigned to active TMS and eleven were assigned to sham TMS. Participants completed the Philadelphia Naming Test (PNT; Roach et al., 1996) at baseline and at three- and six-months post-treatment. We coded PNT errors following established guidelines (Schwartz et al., 2006) and used the SP computational model (Foygel & Dell, 2000) to derive semantic and phonological parameters (i.e., s- and p-weights). We conducted two linear regression models, one for each parameter weight. The outcome measure was the proportional improvement in naming, calculated as pre-to-post treatment changes divided by the potential improvement from baseline. Fixed effects included two interactions: TMS x timepoint; TMS x parameter weight. Results- We found greater proportional naming improvements overall following both active (M=0.09, SD=0.28) and sham TMS (M=0.04, SD=0.30). Both models had significant main effects of TMS, such that active TMS was associated with greater naming improvements than sham. The s-weight model revealed significant interactions between TMS and time ($\chi2(1)= 5.78$, $p < 0.001$), as well as between TMS and baseline s-weight ($\chi2(1)= 32.26$, $p < 0.001$). The p-weight model also revealed significant interactions between TMS and time ($\chi2(1)= 6.13$, $p < 0.001$), as well as between TMS and baseline p-weight ($\chi2(1)= 0.75$, $p= 0.003$). Post-hoc analyses showed that individuals with greater s-weight showed greater naming improvement following active TMS than sham ($\beta= 12.43$, $SE= 0.62$, $t= 20.06$, $p < 0.001$), and improvements were greater at 6-months compared to 3-months for active TMS, while sham showed no difference across time ($\beta= 0.10$, $SE= 0.01$, $t= 8.49$, $p < 0.001$). In contrast, individuals with greater p-weight who received active TMS compared to sham showed greater naming improvement ($\beta= 3.97$, $SE= 1.33$, $t= 2.99$, $p= 0.003$) but only at 6-months post-treatment ($\beta= 0.11$, $SE= 0.01$, $t= 8.54$, $p < 0.001$). Conclusions- This study is among the first in a larger sample to demonstrate that baseline linguistic characteristics of individual aphasia patients contribute to variability in sustained TMS and aphasia treatment outcomes. These findings may have implications for clinical decision making as well as mechanistic accounts of brain stimulation for neurorehabilitation.

B18 - Lesions to the left hemisphere language network alter word reading activity in the undamaged visual word form system

Sara M. Dyslin[1], Andrew T. DeMarco[1,2], Ryan Staples[1,3], Peter E. Turkeltaub[1,2,4]; [1]Center for Brain Plasticity and Recovery, Georgetown University, [2]Center for Aphasia Research and Rehabilitation, Georgetown University, [3]Georgetown-Howard Universities Center for Clinical and Translational Science, Georgetown University, [4]MedStar National Rehabilitation Hospital

Reading relies on an area of the brain's object recognition system in the ventral occipito-temporal cortex (vOTC) that becomes specialized for word recognition as we learn to read, called the visual word form area (VWFA). Prior fMRI studies in neurotypical controls have proposed a posterior-to-anterior gradient of increasing sensitivity to larger fragments of words in the VWFA, and also that the VWFA receives top-down information from language regions. Lesions to perisylvian language regions often cause alexia, which could be partly explained by abnormal visual word form processing due to the loss of top-down connections. This hypothesis has never been tested. Further, previous studies have shown that right hemisphere (RH) homotopes may partially support language after left hemisphere (LH) stroke, but these findings have not been extended to the RH homotope of the VWFA (rVWFA) in alexia. Here, we examine how lesions to the left hemisphere language network affect activation of the VWFA within the left and right vOTC during reading. Participants included 12 chronic left hemisphere stroke survivors (LHSS) (Age=58.3(16.1); Gender (7F/5M); Months-since-stroke=42.9(32.4); Oral reading accuracy: Words=84.0% (12.0%), Pseudowords=57.4% (38.2%)) and 17 demographically-matched controls. All participants completed three runs of a novel fMRI task consisting of 24 15-second blocks of rapidly presented words, pseudowords, false font strings, or fixation. Stimuli were presented for 150ms with a 150ms inter-stimulus interval and a total run time of 6 minutes. First-level contrasts of words>false fonts were combined in a mixed-effects model across three runs to provide a wholebrain t-statistic activation map for each participant. Group analyses determined the averaged magnitudes of activity within a Neurosynth-derived LH VWFA (lVWFA) mask and a corresponding rVWFA ROI. These ROIs were also divided into anterior and posterior subregions to assess spatial organization within the VWFA. Three 2x2 ANOVAs and post-hoc analyses assessed the main effects and interaction of group by hemisphere on magnitude of activation within 1) the entire lVWFA vs rVWFA, 2) the anterior subregions of the ROIs, and 3) the posterior subregions of the ROIs. There was a significant interaction of group and hemisphere in the whole VWFA ($F(1,1)=4.46$, $p=0.039$) and the anterior VWFA ($F(1,1)=4.23$, $p=0.044$), and a trending interaction in the posterior VWFA ($F(1,1)=3.66$, $p=0.06$). The nature of the interactions differed by subregion. The interaction in the anterior VWFA was driven mainly by greater right hemisphere activity for LHSS than controls, with five individuals who had especially high activation exceeding every control participant. In the posterior VWFA, the interaction was mainly driven by reduced activity for the LHSS in the left hemisphere. Eleven LHSS participants activated posterior lVWFA less than the control average. These results provide key lesion evidence that VWFA processing partly relies on top-down connections from the language network. Further characterizing the lesion effects on VWFA processing, including the factors that drive RH recruitment, will help reveal the nature of interactions between the vOTC and the language network. Additional work will also determine if the aberrant lVWFA activation underlies reading deficits in alexia, and if post-stroke reorganization in the rVWFA supports recovery.

B19 - Introducing A Real-Time Measure of Comprehension During Natural Speech Listening

Irmak Ergin[1], Jill Kries[1], Shiven Gupta, Laura Gwilliams[1]; [1]Stanford University

Speech comprehension has been described as an effortless, robust process; yet, in real- world contexts, it is common for a listener to misunderstand, or to fail to derive meaning entirely. To experimentally measure speech comprehension, researchers have used post-hoc measures such as comprehension questions, self-ratings, and summarization. These measures fail to capture the time resolution of comprehension, which emerges dynamically as speech unfolds. Challenges in behaviorally measuring real-time comprehension have led to an impoverished description of the neural processes supporting online comprehension. We designed and tested a novel way of measuring real-time speech comprehension during naturalistic listening. We built a slider device that synchronizes with behavioral and neural recording software, and provides millisecond read-out. Fourteen native English participants listened to audiobook segments while providing continuous comprehension ratings using the slider. To inject variability in comprehension success, speech segments were presented 1-5 times the original speed. We tested the time-resolved slider against three established methods of assessing speech comprehension: (i) 10-point scale rating; (ii) a multiple choice question accuracy; (iii) a written summary. We evaluated the cosine similarity between the segment and written summary using vector embeddings from GloVe and BERT. Additionally, we obtained working memory and auditory acuity measures using the Digit Span and Digit-In-Noise tasks respectively, to account for by-subject variability in comprehension scores not due to comprehension per se. To validate our time-resolved measure against traditional post-hoc measures, we used Mixed Effects Linear Regression with real-time comprehension as the independent variable, three post hoc measures as fixed effects, and working memory and auditory acuity as random slopes over subject. We found significant effect of self-rating and written summary similarity, and non-significant trend for multiple-choice accuracy. By-subject measures were not significant predictors. We found that multiple-choice accuracy was consistently above chance, even when the participant reported understanding nothing, which we attribute to difficulty in designing question sets that are independent from story context and real-world knowledge. Furthermore, we found that written summaries were significantly more similar to later portions of the spoken segment than earlier portions, which highlights a bias limitation of this approach. Overall, our findings demonstrate the validity of our novel time-resolved comprehension measure. They suggest that it is possible to derive an online behavioral measure of speech comprehension in real-time - the lack of which has been

a major limitation of naturalistic language studies. This overcomes numerous limitations of static post-hoc assessments, including recency bias for summarization, and challenges of multi-choice question design. We propose that this continuous speech comprehension measure can be effectively integrated with neuroimaging techniques, offering a valuable tool for future research on dynamic processes during naturalistic listening.

B20 - Short timescale flexibility of functional networks facilitates long-term connectivity changes underlying treatment-induced post-stroke aphasia recovery

Isaac Falconer[1], Maria Varkanitsa[2], Anne Billot[3,4], Swathi Kiran[2,5]; [1]Chobanian & Avedisian School of Medicine, Boston University, Boston, MA, USA, [2]Center for Brain Recovery, Boston University, Boston, MA, USA, [3]Department of Neurology, Massachusetts General Hospital & Harvard Medical School, Charlestown, MA, USA, [4]Department of Psychology, Center for Brain Science, Harvard University, Cambridge, MA, USA, [5]Department of Speech, Language, and Hearing Sciences, Sargent College of Health and Rehabilitation Sciences, Boston University, Boston, MA, USA

Post-stroke aphasia (PSA) is a very frequent sequela of stroke with major implications for quality of life. Recovery trajectories of language ability after stroke varies greatly, with factors like initial aphasia severity and lesion characteristics being among the most reliable predictors. However, a significant portion of this variation remains unexplained. With the goal of elucidating factors and mechanisms underlying interindividual differences in recovery trajectories, our previous work used resting-state functional MRI to investigate dynamic functional connectivity (dFC), which refers to time-varying interregional correlations in the blood-oxygen-level dependent (BOLD) signal, in PSA. Greater temporal variability (TV) of dFC at baseline predicted greater treatment-induced improvement in picture naming. We proposed the following mechanism for this finding: (1) Transient inter-regional synchronization facilitates synaptic plasticity between regions and (2) greater TV represents a greater diversity of connectivity configurations sampled over time, producing more opportunities for plasticity. This study sought to test this mechanism by investigating the relationships between TV, treatment-induced network changes, and behavioral treatment response. This study consisted of retrospective analyses of behavioral and functional imaging data from a cohort of 30 individuals with chronic PSA due to left hemisphere strokes. Each participant received up to 24 2-hr sessions of semantic aphasia therapy. Picture naming accuracy was assessed at baseline, at each session, and post-treatment. Resting-state functional MRI scans were obtained at baseline and post-treatment and were used both for estimation of dFC using a sliding window analysis and for calculation of region-of-interest (ROI or “node”) based static functional connectivity (sFC) matrices. Treatment-induced network connectivity changes were quantified using graph metrics of static functional connectivity (sFC, i.e., time-invariant interregional BOLD signal correlations). Relationships between (1) baseline TV of dFC, (2) treatment-induced network connectivity changes (i.e., sFC graph measure changes), and (3) behavioral treatment response were evaluated using multiple linear regression models accounting for potential confounders such as lesion size and initial severity. Additionally, simulations of healthy (i.e., non-lesioned) neural dynamics were performed using a parametric mean field model to further investigate the influence of short-term dynamics on long-term connectivity changes. Each simulation included one of several alternative Hebbian plasticity rules whereby transient coactivation leads to changes in connection strength. Higher baseline TV was found to be predictive of treatment-induced decreases in node-level strength (i.e., sum of sFC of a node’s connections) (β=-0.282, p=3.04e-05), which were in turn associated with greater behavioral treatment gains (β=-3.38, p=0.00318). These decreases in node-level strength were also significantly associated with global increases in small-worldness (β=-0.0529, p=9e-07), a measure of balance between local clustering of nodes and global network efficiency, which was in turn significantly associated with better behavioral treatment response (β=1.15, p=0.0034). Simulation results were consistent with these findings showing that only plasticity rules that drove down connection strengths between non-hub nodes produced increases in global graph measures similar to those seen in patients with greater treatment gains. Overall, both the experimental findings and simulations provided support for higher TV facilitating node-level changes that result in global network changes that support recovery.

B21 - From neural signals to behavior: taking into account inter-trial variability in EEG

Raphaël Fargier[1], Emeline Manka[2], Giulio Massari[1], Fanny Meunier[1], Patricia Reynaud-Bouret[2]; [1]Université Côte d'Azur, CNRS, BCL, France, [2]Université Côte d’Azur, CNRS, LJAD, France

The speed and accuracy with which speakers produce words are the results of successive mental operations that are achieved by functionally connected assemblies of neurons. Yet, our ability to identify these operations in brain recordings and characterize their spatial and temporal dynamics remains a challenge. Modeling and statistical tools, like segmentation/clustering approaches, can translate brain signals into a sequence of neural patterns or micro-states that, in turn, may be linked to specific cognitive/linguistic processes. This approach has been used, for example, to locate attentional and semantic interference effects on word production or reveal neurocognitive changes across the lifespan. However, the available algorithms cannot be used to reliably characterize the dynamics of processes when speed of word retrieval varies from trial to trial. They are traditionally applied on averaged signals or event-related potentials (ERPs), meaning that we use epochs of same lengths to study processes that are achieved with different timings. Averaging trials can therefore lead to spurious mixing of different neurocognitive dynamics, which affect our ability to test hypotheses about activation flow in models of lexical access (e.g. seriality/cascading of processes). There is thus a need to scale the dynamics of neural processes at the level of individual trials of different lengths in order to improve our ability to map neural activity to cognitive processes and to behavior. In Study 1, we tested a new segmentation/clustering algorithm (based on Pascual-Marqui’s model (1995)), built to deal with epochs of

different lengths. Our "multi-trials" (with varying durations) model takes multiple trials as input and runs one unique segmentation, giving one unique set of microstates to describe all trials. We used simulations to validate our algorithm and compared it to both models applied to independent single trials and applied to averaged signals. Compared to the two other models, our "multi-trials" model made significantly less errors on 1) the microstate sequence, 2) topographies of microstates, and 3) their time-distribution. In Study 2, we apply our algorithm to a new EEG dataset of a picture naming experiment specifically designed to generate variations of reaction times (RTs). We manipulated the visibility of the pictures to be named by adding visual noise, with the goal of testing whether longer RTs would relate to longer processes distributed across all cognitive stages or strictly restricted to early processes such as visual/conceptual recognition. For that, two different levels of "salt-and-pepper" visual noises were applied to our pictures (N=200) to create two experimental conditions. The two stimuli lists were matched on a set of psycholinguistic variables known to affect accuracy and speed, and were counterbalanced across participants. Data are currently being collected and we plan to apply our "multi-trials" model on all EEG trials. We discuss the interest of this new approach to tackle current debates in the field of language production (e.g. seriality/cascading), and more generally to improve our understanding of brain-behavior relationships.

B22 - A Systematic Review of Neurobiological Models of Language Processing: Implications for Enhancing Neurosurgical Precision and Planning

Akshita Garg[1], Venu Balasubramanian[1]; [1]Seton Hall University-CNARL

This review systematically examines the evolution of biological language models from classical localizationist frameworks to contemporary network-based approaches, elucidating their significance in enhancing surgical precision and preserving language functions in patients undergoing brain surgery. The objectives include categorizing language models based on underlying theoretical frameworks and methodological paradigms, analyzing their strengths, limitations, and clinical relevance for neurosurgical planning and execution, and synthesizing existing knowledge to offer novel insights into the neural architectures subserving language processing. Method. An extensive PubMed literature search utilizing queries such as the use of neural models of language processing in neurosurgery, and the implications of language models for neurosurgery yielded numerous qualified articles (total: 126). The seminal Wernicke-Broca model laid the foundation derived from lesion studies and electrical stimulation mapping, though subsequent models challenged this modular view by highlighting the involvement of distributed networks and subcortical structures. Dual-stream models, such as the one originally proposed by Hickok and Popel (2004), which distinguished streams for phonological and semantic aspects, emphasizing dissociation within structural connectivity (Simos et al., 2000; Roux et al., 2015; Sierpowska et al., 2019). Network-based approaches enabled precise mapping of language regions through functional connectivity atlases, while lesion-symptom analyses provided insights into the semantic network's structural connectivity (Langs et al., 2014; Collard et al., 2016; Kuiper et al., 2020; Milton et al., 2021). Intraoperative remapping unveiled cortical plasticity, emphasizing the need for dynamic surgical planning (Ng et al., 2023; Freyschlag & Duffau, 2014; Duffau, 2014; Jin et al., 2021; Rofes et al., 2019; Duffau, 2016; Szalisznyó et al., 2017). Multimodal integration research highlighted the integration of perception and production-based representations for effective speech processing (Cogan et al., 2014; Roux et al., 2015; Almairac et al., 2015; Collard et al., 2016; Nourski et al., 2016; Sierpowska et al., 2017; Ding et al., 2020). Neural tuning models revealed the involvement of a broad perisylvian network in language comprehension (Berezutskaya et al., 2017; Long et al., 2016). Investigations into the subthalamic nucleus challenged the cortical exclusivity view, highlighting subcortical roles in linguistic processes (Whelan et al., 2004; Erlich et al., 2011; Courtemanche et al., 2003; Brown et al., 1997; Haber & Knutson, 2010; Zheng et al., 2019; Zikopoulos & Barbas, 2007; Yin & Knowlton, 2006). By synthesizing diverse models, this review offers a novel perspective emphasizing a multimodal network-based approach accounting for dynamic reorganization of language functions, enabling precise neurosurgical interventions, and optimizing outcomes. Integrating biological language models allows neurosurgeons to achieve precise interventions while preserving critical language functions, improving patient recovery. Future research should focus on developing comprehensive language mapping tools, real-time intraoperative monitoring, personalized rehabilitation strategies, and integration with neuroprosthetics. Potential limitations include data integration complexity, inter-individual variability, limited neuroimaging resolution, and translational challenges. Robust data integration frameworks accounting for individual differences, advanced neuroimaging modalities, and interdisciplinary collaborations are crucial for successful clinical translation.

B23 - Linguistic markers of Alzheimer's disease and related dementias (AD/ADRD): an analysis of funded research at the National Institute on Aging and opportunities to advance the field

Maryam Ghaleh[1]; [1]National Institute on Aging (NIA), National Institutes of Health (NIH)

Background: Alzheimer's disease and related dementias (AD/ADRD) are a substantial global health issue. No effective treatment currently exists to cure AD/ADRD after onset, therefore, early detection is crucial in optimizing the benefits of early interventions to delay or prevent the onset of AD/ADRD. AD pathology starts silently decades before the clinical symptoms appear, and thus AD biomarkers play an essential role in early detection and risk assessment. However, most AD/ADRD biomarkers are invasive and expensive. Moreover, access to biomarker testing is limited by the availability of specialized facilities and trained clinicians. Due to these limitations, disparities exist in the access to biomarker testing for racial/ethnic minorities, those with lower socioeconomic status (SES), and those living in under-resourced settings including low- and middle-income countries (LMICs), where two-thirds of people with AD/ADRD currently live. To reduce health disparities in AD/ADRD, assessment and diagnostic tools are

needed that are valid, affordable, and accessible for all populations globally. Changes in language performance have been shown to occur long before clinical diagnosis of AD/ADRD. Therefore, change in language function can potentially be used as an early biomarker of AD/ADRD, that is easily accessible, low-cost, and non-invasive. Yet, research on linguistic markers of AD/ADRD is limited, and has mainly been conducted in non-Hispanic white cohorts from High-income countries. Furthermore, out of over 7000 languages that exist in the world, research so far has mainly focused on English-speaking populations totaling approximately 18% of the global population. Given the differences in languages and their neural representation, as well as population-specific neuropathological differences in AD/ADRD, differences might exist in AD/ADRD linguistic markers across different languages and populations. Findings from studies on white English-speaking populations might not be generalizable to other populations, which warrants a more focused global approach to the study of language markers of AD/ADRD in diverse populations. National Institute on Aging (NIA) supports the development of novel biomarkers for AD/ADRD and works to increase its support of research in minority and health disparate populations, to achieve health equity. The current analysis aims to characterize the existing portfolio of research grants focusing on language markers of AD/ADRD supported by the NIA to understand gaps and opportunities for scientific advancement. Methods and Results: Using the NIH Query, View, and Report (QVR) system, combined with Research, Condition, and Disease Categorization (RCDC) codes, we will identify research grants focused on language markers of AD/ADRD that are funded by the NIA from 2015 to 2024. Further analyses will be performed to understand which populations (e.g., race/ethnicity, regions) and languages were included in these studies and identify key resources that were used to support research in this area. Additional analysis will be performed to identify other resources and opportunities that could be leveraged to support research in this field. Conclusion: This analysis provides an overview of the landscape and resources used for AD/ADRD language biomarker research, as well as identifies gaps, and opportunities that can be used to accelerate the pace of research and discoveries in this area.

B24 - A framework to account for demand-based functional reorganisation in post-stroke aphasia

Ajay Halai[1], Niklas Wiemers[1,2], Matt Lambon Ralph[1]; [1]MRC Cognition and Brain Sciences Unit, University of Cambridge, UK, [2]Department of Neurology, University of Leipzig Medical Center, Germany

Background: Understanding how language recovers in post stroke aphasia (PSA) is challenging, particularly in terms of neural mechanisms driving recovery (Stefaniak et al., 2020). Our current theories of recovery suggest different systems that are recruited such as residual language systems (Saur et al., 2006), right hemisphere homologue (Stockert et al., 2020) or multiple-demand network (MDN) (Brownsett et al., 2014) - but crucially not why or how. PSA patients have heterogenous lesions, in terms of site and size, which place differential demands on the underlying residual system and its' capabilities for reorganisation - resulting in multiple patterns of recovery that are based on the demand and resources available. Theoretical framework: Our proposed framework considers four factors in combination. Computational models have shown that residual left language regions can compensate a mild 'lesion'; whereas moderate/severe lesions increase contralateral regions. Next, language has modular features in the brain (Hickok & Poeppel, 2007) and studies have shown lesion site specific deficits (Stockert et al., 2020 frontal vs temporo-parietal). A third consideration is how multiple networks interact to support language, where demand and spare capacity will determine how these are weighted. For example, domain-specific network changes have been demonstrated by Ueno et al., (2011) who showed damage to the dorsal pathway led to some recovery driven by ventral stream reorganisation. Conversely, domain-general networks such as MDN is recruited during stroke aphasia recovery (Geranmayeh et al., 2017). Finally, language is multi-dimensional meaning that core underlying features of language can be disrupted independently depending on lesion site/size (Ueno et al., 2011) and have unequal recovery trajectories that relate to (de-)activation in the brain (Stefaniak et al., 2022). Investigation: We addressed how the combination of these factors impact recovery by focusing on the role of the MDN and right language homologue hypothesis in recovery, where we hypothesise that involvement of either system will be demand dependent. Chronic post-stroke aphasia patients (n=57) were assessed with an extensive behavioural battery, structural and resting-state fMRI. First, we found that peri-lesional functional connectivity (FC) decreased, while FC between peri-lesional and domain-specific networks in both hemispheres and peri-lesional and MDN increased with greater damage to core language clusters. Next, we used mediation analysis to determine if lesion load to a critical functional cluster mediated the relationship between FC-behaviour. The relationship between FC and phonology performance remained unchanged after including lesion load to a phonology ROI, whereas FC and fluency were significantly mediated by lesion load to a fluency ROI. Lastly, we built prediction models using lesion size, lesion load, functional connectivity, and combinations of these (plus interactions) to predict behavioural outcome. We were able to predict phonology and fluency but failed to predict semantics and executive cognition and adding functional connectivity improved performance for phonology only. Together, we demonstrated demand-dependent reorganisation within/between multiple language-relevant networks that individually relate to language dimensions.

B25 - Cellular representations of natural social interactions in humans

Mohsen Jamali[1], Irene Caprara[1], Analise Bottinger[1], Elizabeth Mayer[2], Jing Cai[1], Douglas Kellar[1], Ziv Williams[1]; [1]MGH, Harvard Medical School, [2]Northeastern University

Social interaction is an integral part of human life, enabling us to effectively communicate and form meaningful connections with others. Understanding the fundamental cellular processes that underlie natural social communication, however, has remained a major challenge. In this study, we leveraged a unique opportunity to perform semi-chronic recordings from

frontotemporal neurons (n= 251) in participants (n = 5) engaged in natural dialogue to reveal intricate cellular representations of social interactions. To quantify and track these interactions, we mapped the participants dialogue to specific social constructs using natural language processing and word embedding techniques. We then identified neurons with selective responses to these constructs and modeled their ensemble activities. By further analyzing neuronal activities across numerous interaction events, we identified neuronal populations that selectively represented specific constructs such as social agency, emotionality, clout, allure, and tone, along with their real-time dynamics. We also found that distinct classes of neurons encoded the agency of interaction, dynamically transitioning across agents. Finally, we observed that the activity patterns of these neurons reliably predicted not only the types of interactions but also the upcoming responses of the social agents they were interacting with. Together, this research begins to illuminate the basic cellular mechanisms of human social communication and provides a tentative cellular framework for understanding social behavioral and communication in humans.

B26 - Neural Correlates of Deep Comprehension of Second Language Reading: Focus on Retrieval Practice

Hyeonjeong Jeong[1], Carlos Makoto Miyauchi[1], Wataru Suzuki[2], Ryuta Kawashima[1], Motoaki Sugiura[1]; [1]Tohoku University, Sendai, Japan, [2]Miyagi University of Education, Sendai, Japan

According to McNamara (2007), comprehension can be categorized into "shallow comprehension" and "deep comprehension." Shallow comprehension involves understanding the superficial content of the language, while deep comprehension involves constructing new knowledge by integrating it with one's existing knowledge. Various factors influence language comprehension, including how the language content is accessed. Recent studies have reported that retrieval practice, which involves actively recalling information, promotes deeper understanding than mere reading activities (Karpicke and Blunt, 2011). However, the neural mechanisms responsible for such phenomena and the effects of using a second language (L2), which is less proficient than the native language (L1), remain unclear. In this study, using fMRI, we investigate the brain mechanisms underlying deep comprehension through ‘retrieval practice’ during the comprehension of L2 text content. We also examine the effects of language proficiency on these mechanisms by comparing L1 and L2 performance, as well as mere reading activities. The participants were 43 right-handed university students (20 females) with Japanese as their L1 and English as their L2. An English proficiency test (Oxford Placement Test) was conducted on the day of the experiment. Six texts on unfamiliar topics (politics, economics, music, psychology, science, etc.) were prepared in English and Japanese, selected from the TOEFL Reading section based on pilot tests. The stimuli texts were counterbalanced across conditions and languages to avoid reading the same content in both English and Japanese within participants. The text lengths were approximately 1,900 characters in Japanese and 450 words in English. Before entering the fMRI, participants read two texts in each language (L2 and L1) and understood the content under either the Retrieval Practice intervention, where they explained the text in their own words, or the Mere Reading condition, where they read the text twice. Inside the fMRI, parts of the texts from the Retrieval Practice, Mere Reading, and Novel Text conditions were presented randomly. Participants judge whether they had read the content before or if it was new while comprehending the content. After the fMRI measurement, a multiple-choice test was conducted on the texts read under the retrieval practice and reading conditions to measure individual comprehension levels. The results showed that behavioral comprehension levels were significantly higher in the Retrieval Practice condition than in the Mere Reading condition for both languages. For the brain analysis, using SPM12, we focused on the brain activity while reading the texts. The brain results showed significantly greater activity in the precuneus and left angular gyrus for the Retrieval Practice condition in L2 text comprehension compared to the Mere Reading condition. Furthermore, higher angular gyrus activity in the Retrieval Practice condition was associated with higher L2 proficiency, but no such effect was found in Mere Reading condition. These results indicate that retrieval practice promotes deep comprehension, particularly in L2 text reading, with the angular gyrus being deeply involved in this intervention.

B27 - The Effects of Endogenous Semantic Variables during Productive Lexical Retrieval: A Behavioral-Neural Dual Swinging Model (DSM)

Keyi Kang[1], Sifan Zhang[1], Haoyun Zhang[1]; [1]University of Macau

Conceptual preparation is the first step in language production. Endogenous semantic variables, reflecting inherent semantic properties of concepts, could influence productive lexical retrieval (Lampe et al., 2022, 2023). Among many variables, semantic richness, which refers to the number of semantic features associated with concepts, may enhance the accumulated activation spreading to the concept leading to conceptual facilitation. Semantic density, indicating the degree of intercorrelation among concepts, may activate more semantically related alternatives causing lexical interference (McRae et al., 2005; Abdel Rahman & Melinger, 2019; Rabovsky et al., 2021). The effects of conceptual facilitation and lexical interference, especially their interaction, are critical for understanding the effects of semantic variables on lexical retrieval. Yet, empirical understandings and underlying mechanisms of such process remain limited. Here, we propose a Behavioral-Neural Dual Swinging Model (DSM) revealing the swinging between conceptual facilitation and lexical interference, as well as extending the swinging to neural resource allocation. Specifically, processing concepts with more semantic features (i.e., higher semantic richness) requires more intensive semantic engagement and greater utilization of semantic-related neural resources. The cumulative activation of semantic features may elicit greater behavioral conceptual facilitation when retrieving target concepts. When the conceptual facilitation outweighs the lexical interference, there will be a facilitation-dominant effect associated with better behavioral performance and less engagement of domain-general regions. On the other hand, processing concepts with higher semantic density may induce interference from more co-activated competitors, demanding greater inhibitory control and the involvement of domain-general neural resources during

lexical selection. When lexical interference outweighs the conceptual facilitation, there will be an inhibition-dominant effect associated with worse behavioral performance and greater engagement of domain-general regions. To further test the model, we examined the interactive effect of semantic richness and semantic density on productive word retrieval both behaviorally and neutrally, using a picture naming paradigm. Parametric modulation analyses were conducted to reveal the BOLD changes sensitive to the natural non-dichotomous distribution of semantic variables. Results showed that retrieving concepts with higher semantic richness was significantly associated with lower error rate and faster retrieval speed (ps < 0.001), along with greater involvement of semantic-related regions and less involvement of domain-general regions. Though there was no significant effect of semantic density behaviorally, processing concepts with higher semantic density engaged more cognitive control neural resources, indicating an overall interference effect. There was also a significant interaction between semantic richness and density on reaction time ($p < 0.01$). Further Johnson-Neyman analyses showed that the semantic density effect varied from significant inhibition to no effect to significant facilitation as semantic richness increased. Correspondingly, the facilitation from semantic richness could offset the interference of semantic density, leading to decreased involvement of domain-general regions. These results nicely support the DSM by showing that productive retrieval is driven by the swinging between semantic richness-induced conceptual facilitation primarily managed in semantic-related regions and semantic density-induced lexical interference managed in domain-general regions. Moreover, the conceptual facilitation accumulated from semantic richness plays a decisive role, mitigating interference from competitors and the neural demands in domain-general regions.

B28 - Longitudinal functional neuroimaging of recovery from aphasia in the first year after stroke

Anna V. Kasdan[1], Lily Walljasper[1], Marianne Casilio[1], Sarah M. Schneck[1,2], Deborah F. Levy[1,3], Jillian L. Entrup[1], Sydney Franklin[1], Michael de Riesthal[1], Stephen M. Wilson[1,4]; [1]Vanderbilt University Medical Center, [2]Shirley Ryan Ability Lab, [3]University of California San Francisco, [4]University of Queensland

Most individuals with aphasia due to stroke recover over time to varying extents, with lesion location being the most important predictor of recovery[1]. This recovery process shows a decelerating timecourse, with the greatest gains made in the first month, but with continued improvements throughout the first year and into the chronic phase. Recovery is thought to reflect neuroplasticity, or functional reorganization of surviving brain regions, but the nature of this putative process is largely unknown. To investigate the neural correlates of language recovery after stroke, we are carrying out a longitudinal project in which individuals who have experienced an acute, left-hemisphere supratentorial stroke are studied at 4 timepoints: 2-5 days (T1), 1 month (T2), 3 months (T3), and 1 year (T4) post-stroke. Speech and language abilities are evaluated at each timepoint using the Quick Aphasia Battery (QAB)[2], and fMRI is completed at T2-T4 wherever possible. Participants perform an adaptive language matching fMRI paradigm: the comparison between the language (semantic matching) and perceptual (symbol matching) conditions is a reliable and valid contrast for use in people with aphasia[3]. Here, we report data from a total of 61 patients with longitudinal fMRI data (either 2 or 3 timepoints from T2, T3, T4). Data were processed with standard procedures using AFNI, FSL, and FMRISTAST. Group analyses were thresholded at $p<.01$ and then corrected for multiple comparisons with permutation testing (n=1000) within bilateral perisylvian regions of interest[4]. Behaviorally, patients improved on the QAB overall measure from 1 to 3 months (T2: 7.2+2.6; T3: 7.8+2.5; ΔQAB = 0.6 + 0.8, $p<.001$) and from 3 to 12 months (T4: 8.1+2.2; ΔQAB = 0.3 + 0.5, $p=.008$). First, we explored group-level maps at each timepoint. Language maps appeared quite similar at 1 month (n=51), 3 months (n=56), and 1 year (n=39), all revealing a core left-hemisphere fronto-temporal language network, not dissimilar from language maps in neurotypical controls. Next, we looked at changes in activation across time. From 1 month to 3 months (n=46), there was increased functional activation in the left inferior frontal gyrus pars orbitalis (extent=7,472 mm3, $p=.003$) and some subthreshold activation along the posterior superior temporal sulcus (extent=1,944 mm3, $p=.08$). There were no significant changes in functional activation between 3 months and 1 year (n=34), despite continued behavioral gains. Overall, activation changes were modest and did not fully account for the substantial behavioral recovery that was observed. Future work will explore whether there are changes in the capacity of spared language regions to process language, which may not be reflected in changes in activation magnitude or extent across recovery. [1] Wilson et al., Brain. 2023; 146(3): 1021-39. [2] Wilson et al., Plos One. 2018; 13(2): e0192773. [3] Wilson et al., Hum Brain Mapp. 2018; 39(8): 3285-307. [4] Casilio et al., Brain. 2024; in press.

B29 - Functional specificity is a core principle of human brain organization, as revealed by highly anatomically atypical brains

Hope Kean[1], Agata* Wolna[1], Niharika Jhingan[1], Sara Swords[1], Alan Shewmon[2], Mark Richardson[3,4], Evelina Fedorenko[1]; [1]MIT, [2]UCLA Medical School, [3]Department of Neurological Surgery, University of Pittsburgh, [4]Massachusetts General Hospital*

The human brain contains many areas and networks of areas that show a high degree of selectivity for particular inputs (Kanwisher 2010). However, it is unclear to what extent functional specialization is a core principle of human brain organization, or whether other brain architectures could also support typical-like cognition. We investigate this question by studying individuals who were born or grew up with atypical brains but have intact, typical-like cognition. Unlike cases of adult-onset brain damage, usually associated with cognitive difficulties, many cases of early tissue damage (due to presumed prenatal or perinatal stroke) or tissue displacement (due to cysts and hydrocephalus) are characterized by intact cognition (e.g., Tuckute et al., 2022; Newport et al. 2017). Given that functional specialization is a spatial luxury, we ask whether different perceptual and cognitive functions remain segregated in the presence of severe spatial constraints. We tested a group of individuals (n=21) with brain cysts ranging in size from 5g (a

teaspoon) to 258g (a large grapefruit), with an average size of 63g (a lemon) resulting in significant brain tissue reduction (up to 7%; with cysts taking up to 21% of the whole brain volume (mean = 6,17%)), along with a set of age-matched neurotypical controls (n=30). Each participant completed a wide range of 'localizer' tasks while undergoing fMRI, along with a comprehensive set of cognitive behavioral assessments. We focused on parts of the brain where different specialized areas are located in close proximity, which should make it most likely that some spatial overlap would be observed in cases of insufficient space. In particular, we examined functional specificity in the i) ventral visual pathway, focusing on face-, body-, and scene-selective areas (Pitcher et et al., 2011); ii) superior temporal sulcus and adjacent cortex, focusing on areas selective for dynamic faces, interacting bodies, and theory of mind (Pitcher et al., 2011; Deen et al., 2015; Isik, Koldewyn et al., 2017; Saxe & Kanwisher, 2003); iii) lateral frontal cortex, focusing on areas selective for language vs. domain-general areas of the Multiple Demand network (Fedorenko et al., 2010; Fedorenko et al., 2013; Braga et al., 2020); iv) medial frontal cortex, focusing on areas selective for theory-of-mind and domain-general areas of the Multiple Demand network (Saxe & Kanwisher, 2003; Saxe et al., 2006; Fedorenko et al., 2013); and v) lateral temporo-parietal cortex, focusing on areas selective for language and theory-of-mind (Fedorenko et al., 2010; Saxe & Kanwisher, 2003; Shain et al., 2022). Our results show that despite substantial reduction in brain tissue, these participants show the same degree of functional specificity as controls, as evidenced in both i) the magnitudes of response to the preferred vs. non-preferred stimuli, and ii) the degree of spatial overlap between the relevant areas. In other words, even when space is scarce, different perceptual and functional systems remain robustly segregated. Thus, functional specialization appears to be a hard constraint on brain organization, presumably for reasons of computational and metabolic efficiency as has been much discussed over the years (e.g., Chlovski & Koulakov, 2004).

B30 - Quick, Don't Move!: Wh-Movement and Wh-In-Situ Structures in Rapid Parallel Reading – EEG studies in English, Urdu, and Mandarin Chinese

Hareem Khokhar[1,2], Jill McLendon[1], Donald Dunagan[1], Zahin Hoque[1], Dustin Chacón[1,2]; [1]University of Georgia, [2]University of California Santa Cruz

[INTRODUCTION] A major question in the neurobiology of language is how the brain represents syntactic structure. This is challenging, because surface properties of languages may obscure underlying similarities. Linguistic theory posits that wh-in-situ constructions (Mandarin Chinese, ~'she read which book?') and wh-movement constructions (English, 'which book did she read?') share abstract properties, despite superficial differences (Huang 1982), and engage similar memory retrieval mechanisms (Santi & Grodzinsky 2007; Xiang et al. 2015). Here, we present EEG data collected in two wh-in-situ languages, Urdu and Mandarin Chinese (MC) and one filler-gap language, English. Contrasting with previous studies, short sentences were presented in parallel, centered in the fovea and read in one fixation, partially mitigating memory demands of word-by-word reading. Some grammatical features are distinguished by EEG/MEG responses in parallel presentation (Snell & Grainger 2019; Flower & Pylkkänen 2024; Krogh & Pylkkänen 2024). Our results show that brain activity distinguishes wh- vs. NP-object constructions in all languages within 800ms, but we failed to find a clear cross-language uniform response to wh- vs. NP-structures. [METHODS] Participants (N = 35 English; 33 Mandarin; 27 Urdu) were given a sentence-matching task (Flower & Pylkkänen 2024); they saw a target sentence followed by a memory probe test sentence, with brain activity continuously recorded using a 64-channel EEG. Target sentences were presented for 200ms followed by 600ms of blank screen. Participants decided whether they matched via key press. Stimuli were 64 sets of questions, manipulating Subject Type (Wh, NP) and Object Type (Wh, NP). [RESULTS] [Behavioral] In all languages, memory probe task performance was lower for wh- compared to NP-object constructions (ps < 0.05), but observed no effect of wh- vs. NP-subjects. Memory probe task performance was lower for wh-subject, wh-object (ps < 0.05), suggesting an additional cost for 'multiple wh-' structures. [EEG Sensor Data] Analyses were conducted independently per language. Spatio-temporal cluster-based permutation tests (Maris & Oostenveld 2007) were conducted with ANOVAs Subject Type × Object Type, from 200–800ms post-sentence onset, with p<0.05 for English and MC p<0.2 for Urdu, 20ms and 3-sensor minimum clustering parameters. For English, wh-objects elicited a positivity 380–486ms and 500–557ms over right posterior sensors (ps < 0.05); for Urdu, wh-objects elicited a negativity 558–800ms over right fronto-parietal sensors and frontal midline sensors; for MC, we observe a bipolar response, with positivity 200–266ms in bilateral fronto-parietal and anterior midline sensors with a negativity 200–227ms in right posterior sensors, followed by a 311–389ms positivity over anterior midline sensors. Wh-subjects only elicited a reliable response in English: a negativity in left lateral sensors 294–320ms. [CONCLUSION] We sought to identify the neural bases of wh-constructions, abstracting away from superficial features of individual languages (wh-in-situ vs. wh-movement) and the processes deployed in word-by-word reading. In English, Urdu, and MC, neural activity was sensitive to wh- vs. NP-objects, although the topographic distribution, polarity, and timing of the effects were not uniform. Nonetheless, some patterns emerge – right posterior sensors respond to wh-objects in English and MC, and midline anterior sensors to wh-objects in Urdu, MC.

B31 - Intervention effects in WHY questions as a presupposition violation: Evidence from an ERP study

Keonwoo Koo[1], Wonil Chung[1], Myung-Kwan Park[1]; [1]Dongguk University

Ko (2005) accounts for the Intervention Effect in Korean, particularly in sentences *[amuto [CP John-iway ...] / *[John-un [CP amuto way ...] vs. in terms of merging WHY in the CP-SPEC [John-un [CP amuto way ku chayk-ul ilk-ci-anh-ass-nunci] mwul-ess-ta]. Ko's explanation is based on the positioning of "why" within the CP-SPEC of an interrogative clause. When "why" is merged in an interrogative CP, it doesn't need to move to be licensed since the interrogative Q is nearby, avoiding the

Intervention Effect. Conversely, in a declarative clause, "why" must move to the nearest Q in a higher interrogative clause, which an intervening subject or focus blocks. Tomioika (2009), building on his earlier work (2007), offers a different perspective. He attributes the differences in Intervention Effects between "why" and other wh-phrases to their presuppositional nature. For "why" questions, the non-wh part of the question is presupposed, unlike other wh-questions which reflect an epistemic bias rather than true presupposition. This distinction, Tomioika argues, accounts for the absence of Intervention Effects for "why" in some contexts and their presence in others. Our research aims to investigate how Non-Presuppositional Intervention (NPI) effects interact with "why" by examining Ko's and Tomioika's claims through two experiments: an offline acceptability test and an ERP (Event-Related Potential) experiment. Twenty-one Korean speakers participated in the study. The offline acceptability task's ANOVA results indicated a significant main effect of intervention. ERPs were measured at critical regions, including (1) matrix interrogative negative verbal complexes (malhaci anhassni), (2) embedded declarative negative verbal complexes (kumantwuci anhasstako), and (3) embedded interrogative negative verbal complexes (kumantwuci anhassnunci). In pair-wise comparisons, the critical region in (1) produced early and late positivity in the 300-700ms interval at anterior regions, with significant effects in the 300-450ms window and a P600 effect in the 450-750ms window. The critical region in (2) elicited a significant N400 and N600 effect (sustained negativity) at anterior regions, while (3) yielded a significant P400 effect at posterior regions. The ERP results across the conditions suggest that a positivity is recorded when the critical regions involve verbal complexes with both negation and the Q particle, as seen in (1) and (3). In condition (1), the embedded verbal complex with the Q particle enters a syntactically global dependency relation with "why" in the embedded clause. In contrast, condition (3) involves a syntactically local dependency. The presupposition violations associated with "why" questions in Korean (and Japanese, as noted by Tomioika, 2009) trigger a positivity, indicating rapid, on-line integration of presupposed content and contextual information. Unlike these two conditions, (2) has the critical region that only contains the negation without the Q particle. The stark failure of licensing WHY that co-occurs in the embedded clause with the intervening NPI leads to perceiving this condition as involving semantic anomaly, thus recording a sustained negativity.

B32 - Predicting Treatment Response in Chronic Post-Stroke Aphasia: Pre-Treatment Variability in Naming Indicates Neuroplastic Potential of the Middle Temporal Gyrus

Sigfus Kristinsson[1], Janina Wilmskoetter[2], Roger Newman-Norlund[1], Chris Rorden[1], Leonardo Bonilha[1], Julius Fridriksson[1]; [1]University of South Carolina, SC, USA, [2]Medical University of South Carolina, SC, USA

Introduction Recent findings indicate that variability in lexical-semantic processing may be associated with language recovery in aphasia1; however, the mechanism driving this effect remains unclear. Several established models of speech production offer that otherwise unexplained variability in performance (e.g., object naming) may indicate flexibility within the semantic network.2 This notion is neurobiologically grounded in the middle temporal gyrus (MTG); the MTG is a critical hub for lexical-semantic processing3, and MTG lesion is associated with particularly poor language recovery in post-stroke aphasia.4 In this study, we tested the hypothesis that treatment-induced language recovery in aphasia relies on upregulation of functional activity in the MTG and, critically, that pre-treatment variability in lexical-semantic processing is a reliable indicator MTG-mediated language recovery. Method A total of 107 participants with chronic post-stroke aphasia following a left hemisphere lesion underwent extensive neuropsychological assessment and neuroimaging prior to receiving six weeks of restorative anomia treatment. Recovery was assessed as raw change in performance on the Philadelphia Naming Test (PNT) from pre- to post-treatment. The PNT was administered twice at baseline and lexical-semantic processing was measured as the difference in performance across the two administrations (henceforth, 'lexical-semantic variability'). Multiple regression was used to determine the effect of lexical-semantic variability, pre- to post-treatment upregulation of activity within the MTG, and their interaction on treatment-induced recovery, while adjusting for lesion volume, proportional lesion within the MTG, and baseline PNT score. Results Participants improved their performance by 7.7 items on average and average lexical-semantic variability was 6.8 items. The primary statistical model ($F(6, 26)=2.94$, $p=.025$, $R2=.42$) revealed a significant interaction between MTG activation change and lexical-semantic variability ($B=-2.06$, $p=.024$), in addition to a significant main effect of lexical-semantic variability ($B=1.18$, $p<.01$), whereas MTG activation change was not independently associated with recovery ($B=4.59$, $p=.30$). Additionally, we tested the potential complementary role of the contralateral MTG in a post hoc analysis; briefly, a significant interaction was observed between functional recruitment and lesion size ($p<.002$), suggesting a complementary role in case of smaller lesions, but a maladaptive role in larger lesions. With the addition of this term, the effect of left hemisphere MTG activation change was also significant ($B=9.28$, $p<.05$) in the final model ($F(8, 24)=4.40$, $p<.01$, $R2=.60$). Conclusion Consistent with our hypotheses, these findings suggest that lexical-semantic variability, measured as the inconsistency in accurate confrontation naming prior to treatment, predicts treatment-induced language recovery in chronic aphasia and, specifically, that the effect of lexical-semantic variability is mediated through upregulation of activity in the MTG bilaterally. These findings hold promise to inform prognostication efforts in the clinical management of aphasia, and support the development of neurobiologically-informed aphasia treatments.

B33 - Leveraging large language models to capture and quantify neural signatures of uncertainty in narrative comprehension

Yang Lei[1], Yongqiang Cai[1], Guosheng Ding[1]; [1]Beijing Normal University

Studying uncertainty in human language comprehension has traditionally been challenging due to the inherent difficulty in

quantifying this abstract cognitive construct, especially in the context of naturalistic language tasks. In this study, we combined large language models and neuroimaging technologies to investigate the neural correlates of uncertainty during naturalistic language comprehension. By leveraging a large language model, Open Pre-trained Transformers, to quantify the uncertainty associated with predicting upcoming content, we obtained an uncertainty time course aligned with story comprehension. Using a Least Absolute Shrinkage and Selection Operator (LASSO) regression model, we established a relationship between neural signatures and the uncertainty time course, identifying specific neuronal signatures that correlated with the estimated uncertainty. Notably, these neural signatures of uncertainty generalized across different story datasets, suggesting their robustness and independence from specific stimulus characteristics. Furthermore, we found that the uncertainties quantified by the model are distinct from pure hidden layer representations, as they exhibit a stronger association with those specific neuronal signatures than with token embeddings. Additionally, we observed modality-specific effects, with the involvement of the auditory cortex in representing uncertainty, which presents a novel finding not observed in previous studies. Our findings provide empirical evidence that large language models can capture the neural signatures of uncertainty in semantic processing during narrative comprehension. Crucially, these findings reveal the existence of distinct neuronal signatures of uncertainty that are robust across different story datasets. Overall, our work contributes to a deeper understanding of language comprehension and highlights the potential of large language models as powerful tools for investigating uncertainty in naturalistic language tasks.

B34 - When "Mary divorce John" becomes acceptable: An ERP investigation on the trend of transitivization in Mandarin

Chia-Hsuan Liao[1], Jia-Ying Tsai[1]; [1]National Tsing Hua University

Introduction. Mandarin exhibits some flexibility in the number and the type of arguments that can occur with verbs. In social media, an increasing number of intransitive verbs are being used transitively (e.g., "Mary divorce John"), which linguists define as light verbs (Tsai, 2017; Lin, 2002). From a processing perspective, how these light verbs are parsed in sentence contexts remains unclear. To address the gap, we conducted an ERP experiment comparing the processing profiles of light verbs with those of unaccusative verbs (Perlmutter, 1978), a type of intransitive verbs that can never be used transitively (e.g., *"Fear disappeared participants"). If light verbs have indeed become transitive, no ERP differences would be observed between transitive and intransitive conditions. By contrast, if comprehenders still consider them intransitive, their ERP responses should be identical to the patterns observed with Unaccusative verbs: We predicted a P600 effect at the object noun phrase (NP) in the transitive conditions, as the presence of the object NP violated the subcategorization restrictions of the verb (Kielar, Meltzer-Asscher & Thompson, 2012). Design. The experiment used a 2X2 design, crossing Verb Type (Light, Unaccusative) with Transitivity (Transitive, Intransitive). Verbs were selected from social media and previous research (Tsai, 2017; Perlmutter, 1978). The lexical frequency of the verbs was matched between conditions. Each stimulus consisted of two clauses, always beginning with a NP1-Adverb-Verb-NP2 sequence. Transitive conditions were indicated by the presence of a comma after NP2, whereas Intransitive conditions had a comma after the verb, implying that NP2 should be interpreted as the subject of the subsequent clause. Participants (N=32) read 120 critical sentences (30 items per condition) and 120 fillers word-by-word, and performed a binary acceptability judgment task at the end of each sentence. ERP responses were time-locked to the onset of a verb and continued until the end of NP2. Results and Discussion. Both Light and Unaccusative in the transitive conditions elicited a larger LAN response at the verb, and a larger P600 response at NP2. The LAN effect indicates that the transitive use of these intransitives violated their subcategorization restrictions, whereas the P600 effect indicates that comprehenders preferred to interpret the post-verbal NP as the subject of the subsequent sentence. Since there were no qualitative differences between the two types of verbs, we suggest that comprehenders still consider light verbs intransitive. The goal of the study was to capture language change in progress, and we did observe significant variations at both the item and individual levels. Future work will focus on these variations by increasing the sample size and accounting for individual differences. By doing so, we can provide biological evidence for language change from a synchronic perspective. Additionally, further work may explore the impact of different linguistic contexts on the processing of these verbs, providing a deeper understanding of the mechanisms underlying language change.

B35 - Exploring neural mechanisms of bilingual language control: an fMRI study using functional localizer approach

Keng-Yu Lin[1], Agata Wolna[2], Jakub Szewczyk[1], Kalinka Timmer[3], Michele Diaz[4], Zofia Wodniecka[1]; [1]Jagiellonian University, [2]Massachusetts Institute of Technology, [3]University of Warsaw, [4]Pennsylvania State University

Bilinguals usually need to navigate between their first language (L1) and second language (L2). When they need to use one of the languages, speaking in L2 is usually harder than speaking in L1, as reflected by longer reaction times and increased neural activity in L2 (vs. L1). This difficulty is argued to reflect the greater engagement of the bilingual language control (BLC) mechanisms. The demands become even more challenging when bilinguals have to switch between L1 and L2. One of the most commonly used paradigms to test BLC is the language-switching task. On the behavioral level, it typically demonstrates that switching to L1 is related to bigger costs than switching to L2 (a.k.a. language switch costs asymmetry) and that the requirement to switch between languages results in L1 becoming overall slower than L2 (a.k.a. reverse language dominance). However, it remains unclear (i) whether the asymmetric switch costs and the reverse language dominance reflect the same language control mechanism, and (ii) whether the behavioral effects in language switching reflect the increased difficulty for language-specific processing, or the engagement of domain-general control mechanisms. We

conducted an fMRI study to identify brain networks involved in BLC during language switching. To explore whether the control draws on domain-general or language-specific mechanisms, we examined brain responses within two well-established functional networks identified at the individual-subject level: the domain-general Multiple Demand (MD) Network (Duncan et al., 2010) and the Language Network (Fedorenko et al., 2010). Forty-five Polish-English bilinguals completed a cued language-switching task where they named pictures in L1Polish and L2English, as well as two functional localizer tasks: a language localizer task, which contrasts listening to intact vs. degraded speech (Malik-Moraleda et al., 2022), and a domain-general (MD) localizer, which contrasts hard vs. easy working memory tasks (Fedorenko et al., 2013). Using the localizers, at the level of individual subjects, we identified functional regions of interest (corresponding to 10% of the most active voxels for a localizer contrast), from which we drew the estimates of brain responses to the language switching task. Our results revealed a language switch cost asymmetry in both the language and the MD network, whereas the reverse language dominance effect was reflected only in the MD network. The dissociation between the reverse language dominance effect and the asymmetry of switch costs within these two networks suggests that these phenomena are supported by at least partially separate mechanisms. On the one hand, both effects are reflected in the MD network. This suggests a domain-general nature of the mechanisms supporting the bilingual language control which is in line with previous research postulating that BLC relies largely on the domain-general mechanisms. On the other hand, however, the asymmetry of switch costs was also reflected in the language network, suggesting that the effect is also underlain by language-specific processes. We speculate that while the reverse dominance reflects a general and large-scale, proactive control adjustment, the asymmetry of switch costs partially reflects short-term, local and reactive changes in the activation of the two languages.

B36 - The impact of conversational eyebrow movements on intention recognition: An fMRI Study

Yuyong Liu[1], Heyonjeong Jeong[2,3], Ayumi Takemoto[3,4], Motoaki Sugiura[3,5]; [1]Graduate School of Medicine, Tohoku Univ., [2]Graduate School of International Cultural Studies, Tohoku Univ., [3]Institute of Development, Aging and Cancer, Tohoku Univ., [4]Riga Stradins University, [5]International Research Institute for Disaster Science, Tohoku Univ.

Rapidly recognizing the speaker's intentions, such as asking a question, is important for successful communication. This recognition is often facilitated by conversational facial signals (e.g., eyebrow frowns and raises). Based on the observation that the facial cues appear earlier than the accompanying speech, it is hypothesized that the precedence of facial cues aids the following predictive language processing. To the best of our knowledge, however, this hypothesis has not been empirically validated. Additionally, we examined whether certain eyebrow movements specifically signal questioning. While eyebrow frowns and raises have long been associated with questioning in face-to-face communication, several studies challenge this with the evidence that asking questions did not have more eyebrow raises than providing responses. This ongoing debate forms the second research question of the current study. Regarding the two research questions, our hypotheses are: 1) the precedence of conversational facial signals enhance the recognition of questions, and 2) the eyebrow frowns and raises specifically signal questions. To examine these hypotheses, we conducted an fMRI experiment to investigate the brain activity related to perceiving the early and late appearance of eyebrow movements accompanying questions and statements. We predicted that the brain regions involved in understanding intentions, such as the temporal-parietal junction (TPJ) and middle prefrontal cortex (mPFC) would be more efficient in processing the early appearance than the late appearance of eyebrow movements when identifying questions. We created video clips of Japanese uttering one sentence while making facial expressions that involve eyebrow frowns or raises as experiment stimuli. Crucially, we manipulated the timing of the facial signals, which appear either 750ms earlier(early-condition) or later (late-condition) than the onset of the speech, and we used two social actions: asking questions and stating facts. Forty-nine native Japanese participated in the experiment, watching each video stimulus, and judging whether the speaker was asking a question or stating a fact. The two-way repeated measures ANOVA on response time (RT) revealed a main effect of timing, with faster RT in the early-conditions compared to the late-conditions. Furthermore, the whole brain analysis revealed a main effect of the timing in the middle temporal gyrus (MTG), with decreased activation in early-conditions in comparison with late-conditions. The region-of-interest (ROI) analyses on mPFC and TPJ showed no significant difference among conditions. The MTG's involvement in inferring intentions from perceiving actions (Schurz et al., 2014) supports our hypothesis that the precedence of facial signals helps to efficiently predict speakers' intentions based on facial motion perception. However, the lack of interaction effects indicates that eyebrow frowns and raises do not specifically signal questions. In addition, the negative findings of ROI analyses imply that understanding intentions may not necessarily rely on the precedence of facial signals.

B37 - Task demands influence phonological representation during syllable perception in tonal languages

ling liu[1], hua fan[1], yuting meng[1]; [1]Beijing Language and Culture University

The ability to perceive speech is essential for effective human communication as it allows individuals to differentiate meanings conveyed by different speech sounds. In tonal languages, semantic information can be communicated through three phonological features: consonants, vowels, and lexical tone. Despite numerous studies on the topic, the precise phonological representation during the perception of syllables remains a subject of ongoing investigation. In the present study, we used magnetoencephalography (MEG) to record the responses of participants engaged in a speech perception task in which participants were asked to judge whether the two preceding (audio1) and following (audio2) syllables were the same in terms of their overall (syllables task, subject n = 27), tone (tone task, subject n = 30), or consonants (consonant task, subject n = 19) (three parallel experiments). To explore how task modulates

phonological representation, we focus our anlysis on brain responses when subject listened to audio2.Through multivariate pattern analysis (MVPA), we aim to decode phonemic features from MEG sensor signals for either audio1 or audio2. After the onset of audio2, we successfully decoded not only its phonological features but also certain phonological aspects of audio1, indicating that the perception of audio2 triggers the automatic reactivation of phonological information from audio1. Specifically, after the onset of audio2 for 200-400ms, the syllable task reactivated consonant, vowel, and tone. Conversely, the tone task only reactivated tone and vowel, while the consonant task reactivated only consonant and vowel. Collectively, these findings imply that phonological attributes of consonants, vowels, and lexical tone may remain active during the perception of syllables in tonal languages. The encoding of consonants and tone seems to be separate, while the representation of consonant and vowel, or vowel and tone, may be interconnected. We propose a novel hypothesis: the syllabic representation structure of consonant-vowel-tone may stored distinctly as consonant-vowel (C-V) and vowel-tone (V-T) forms.

B38 - Magnetoencephalography reveals attentional modulation of neural tracking of speech linguistic structure in children

LINGXI LU[1], DANNI WU[2]; [1]Beijing Language and Culture University

The human brain can efficiently track different levels of linguistic structures, such as syllables, phrases and sentences, to comprehend speech. However, there exists conflicting evidence regarding the role of attentional resources in processing linguistic structures: Some studies posit that constructing higher-level linguistic structures requires attentional engagement, while others suggest that adults can automatically process higher-level linguistic structures. Children, in comparison to adults, exhibit incomplete attentional control and cognitive executive functions. Thus far, how the child's brain tracks hierarchical linguistic structures and whether it relates to top-down attention remains elusive. To address this issue, we recruited 25 healthy children (aged 3-10 years) and 23 young adults (aged 19-25 years), all native Mandarin Chinese speakers. Using magnetoencephalography and the frequency-tagging paradigm, we examined the multi-level neural tracking responses of speech linguistic structures in two groups (children and adults) under active and passive listening conditions. Our findings revealed robust neural tracking responses to syllabic, phrasal, sentential structures under both active and passive listening conditions in both groups. Notably, neural tracking responses to sentences were significantly stronger under the active condition than the passive condition. In addition, children exhibited significant weaknesses in the neural representation of phrases compared to adults, although their tracking responses of syllables was stronger than adults. Analysis of attentional gain in both groups sheds light on the modulatory role of attentional resources in processing linguistic structures: adults showed greater attentional gain than children, and the gain particularly occurs at the sentential and phrasal levels compared to the syllabic level, implying that attention primarily influences the processing of higher-order linguistic structures. These findings demonstrate that, like adults, the child's brain can generate neural representations of hierarchical linguistic structures in speech. Furthermore, higher-level linguistic structures are also processed under passive condition, supporting the hypothesis of automatic processing of hierarchical linguistic structures.

B39 - Neurocognitive patterns of verb production deficit therapy: a single case with logopenic variant Primary Progressive Aphasia

Sladjana Lukic[1]; [1]School of Communication Sciences and Disorders, Florida State University

Introduction Primary Progressive Aphasia (PPA) is a neurodegenerative syndrome characterized by progressive deterioration of language. In a recent meta-analysis (Cotelli et al., 2020), 50 studies examined behavioral treatments for PPA; however, no prior studies have determined neural changes from pre- to post-treatment and tested for generalization effects across different contexts. This study determined word retrieval difficulties in an individual with logopenic variant PPA (lvPPA) and identified behavioral and neural changes after Verb Network Strengthening Treatment (VNeST; Edmonds et al., 2009). Methods Using a single-subject multiple baseline experimental design, we examined treatment effects in lvPPA and investigated which brain areas are used during task-based and resting-state functional magnetic resonance imaging (fMRI/rs-fMRI). A 58-year-old male lvPPA underwent a VNeST of three-argument verbs over 13 weeks totaling 52 hours and completed the adaptive language mapping fMRI paradigm (Wilson et al., 2018) and rs-fMRI, capturing neural changes of verb-thematic networks before and after therapy. We examined the generalization from verb naming to other contexts (one- and two-argument verbs and noun production, sentence generation, and connected speech) and self-reported emotional experiences. Results The Quick Aphasia Battery (QAB) assessments revealed difficulties in word finding, repetition, and sentence processing, and a structural MRI of the brain shows left lateralized temporoparietal atrophy, consistent with lvPPA diagnoses. The participant generally improved verb naming and increased performance by approximately 47% on the treated items (ES.h =0.9) but not on untreated items (ES.h = -0.2). Moreover, the participant showed at least a 20% performance increase on the Picture Naming and Repetition sections of the QAB from pre- to post-therapy. The connected speech aphasic features were reduced, indicating that the lvPPA's overall communication abilities improved due to VNeST by eliciting nouns and verbs as co-units. Functional imaging results showed that at the macro level, language organization was similar to healthy controls (Wilson et al., 2018) as well as pre- to post-therapy. Lastly, pre- and post-self-reported emotional experiences and improvements in perceived communicative ability were observed. Conclusions Taken together, these findings allow us to better understand the neural correlates of verbs and their thematic role processing ability and compensate for their impairment in individuals with PPA. Finally, naming skills across nouns and verbs are critical to detect and treat, and the study indicates that the verb-thematic network is strengthened in lvPPA through forming substantive connections between the neural substrate for each agent-patient pair and the

verb itself, and related verbs and their thematic pairs.

B40 - Braille Reading in Blind and Sighted Individuals

Artur Marchewka[1], Maciej Gaca, Alicja Olszewska, Aleksandra Herman, Katarzyna Jednoróg; [1]Nencki Institute of Experimental Biology Polish Academy of Science

The human brain possesses an extraordinary capacity to reorganize itself in response to altered experience or training. In blind individuals, the occipital cortex undergoes substantial sensory tuning to process tactile inputs such as Braille reading. At the same time, recent neuroimaging studies show that Braille reading can engage the visual cortex of sighted subjects, providing an opportunity to investigate the limits of experience-dependent neuroplasticity. Here, we investigate differences and similarities in brain activation during Braille reading between 21 blind and 17 sighted individuals (all women) who underwent seven months of tactile Braille reading training. In the fMRI scanner, the participants performed an experimental lexical decision task and a control tactile task (six-dot sign detection). The fMRI analysis comparing experimental to control tasks revealed common activation in both groups in the left ventral occipito-temporal cortex as well as in the left inferior frontal and precentral cortex, underscoring their modality-independent role in word recognition. Blind participants showed higher activation than the sighted mainly in occipital areas, in line with previous reports of cross-modal reorganization and repurposing of visual processing areas following visual deprivation. Conversely, sighted individuals showed higher activity than blind individuals in left somatomotor regions and the right cerebellum, suggesting increased involvement of motor and spatial control in line with their lower Braille reading proficiency. This research contributes to our understanding of neuroplasticity, revealing converging adaptations in both the blind and the sighted to tactile Braille reading. It highlights the flexibility of the human brain, advancing our knowledge of how sensory experiences shape cognitive processes.

B41 - The effect of language task type and participant factors on functional Near-Infrared Spectroscopy data quality from left and right hemisphere stroke survivors

Erin Meier[1], Lisa Bunker[2], Hana Kim[3], Alexandra Zezinka Durfee[4], Victoria Tilton-Bolowsky[5], Argye Hillis[6]; [1]Northeastern University, [2]Midwestern University, [3]University of South Florida, [4]Towson University, [5]Johns Hopkins University School of Medicine

Introduction: Few functional neuroimaging studies of early aphasia recovery exist, likely in part due to the logistical challenges of conducting fMRI in this population (e.g., lack of portability, contraindications). Functional Near-Infrared Spectroscopy (fNIRS) is less costly than fMRI and can be performed in different testing sites (e.g., at bedside) but comes with its own limitations, such as signal attenuation due to hair thickness/color and skin pigmentation, especially in people of color. Relatively little research to date (and thus gold standards) in stroke survivors with and without aphasia also limits the application of this tool to address research gaps. Thus, in this study, we determined if fNIRS data quality varied by (1) stroke laterality and chronicity, (2) fNIRS task type, and (3) demographic variables. Methods: Ninety-five individuals (mean age: 63.4 years, 65 men, 55 white/35 Black/3 Asian/2 other race), including 57 left and 38 right hemisphere stroke survivors, completed at least one fNIRS session, enrolling at either the acute (n=52), subacute (n=21), or chronic (n=22) stroke stage. Participants completed three fNIRS tasks that varied in language and speech motor demands, from low to high: (1) resting state, (2) discourse comprehension (passive listening to 60s stories), and (3) picture naming (overt naming of pictured objects and actions). Data were acquired with a 16x16 NIRx NIRSport2 and 46 long and 8 short channels positioned over bilateral language areas. To assess data quality, we extracted peak spectral power (PSP), scalp coupling indices (SCI), and number of bad channels (channels with below-threshold PSP and SCI for more than 30% of data acquisition windows) from the QT-NIRS Toolbox (Hernandez & Pollonini, 2020). Results: Left and right hemisphere stroke survivors did not differ in PSP ($p>0.59$), SCI ($p>0.29$), or number of bad channels ($p> 0.40$) for any task. Worse PSP (FDR-$p<0.001$) and more bad channels (FDR-$p<0.001$) were found for picture naming compared to resting state and discourse comprehension. Before correction for multiple comparisons, higher PSP was associated with greater stroke chronicity for resting state ($r=0.21$, $p=0.048$, FDR-$p>0.05$) and picture naming ($r=0.29$, $p=0.022$, FDR-$p>0.05$). Across tasks, SCI tended to be higher for older participants (range: $r=0.188$-0.290, FDR-$p=0.222$-0.027) and women compared to men (range: $W=188$-540, FDR-$p=0.001$-0.138). Black participants had lower SCI across all three tasks (FDR-$p<0.022$) and lower PSP for resting state (FDR-$p=0.047$) than white participants. Conclusions: This study is motivated by the need to better understand stroke, task, and demographic variables that influence fNIRS data quality in order to inform task design and fNIRS analysis for future studies. While language task data quality did not differ by stroke laterality, participants earlier in their recovery tended to have worse PSP, which has implications for longitudinal stroke recovery studies. As expected, data quality was worse for picture naming due to its higher speech motor demands than the other two tasks. While data quality varied by demographic factors in expected ways, these findings illustrate the need to control for such measures in analyses rather than exclude participants from fNIRS studies (Girolamo et al., 2022; Kwasa et al., 2023).

B42 - Learning in logopenic variant Primary Progressive Aphasia: an EEG investigation

Kyriaki Neophytou[1], Panteleimon Chriskos[2], Jessica Gallegos[1], Nathan Crone[1], Panagiotis D. Bamidis[2], Kyrana Tsapkini[1,3]; [1]Johns Hopkins School of Medicine, [2]Aristotle University of Thessaloniki, [3]Johns Hopkins University

Introduction: The logopenic variant of Primary Progressive Aphasia (lvPPA) is primarily characterized by repetition and naming deficits. In addition, previous research has shown that learning disabilities occur more frequently in lvPPA compared to the other PPA variants (Miller et al., 2013). However, learning abilities in this group remain understudied. The primary area of atrophy in lvPPA is the left parietal lobe, while, usually, the underlining pathology is Alzheimer's Disease (AD) (Gorno-

Tempini et al., 2008). In AD there is evidence of increased delta rhythm in EEG signal during resting-state (Babiloni et al., 2013; Huang et al., 2000; Kwak, 2006). Although delta rhythm is the main characteristic of slow wave sleep, relationships between delta rhythm have also been reported during cognitive tasks across populations (Başar et al., 2001; Knyazev, 2007). Regarding the relationship of delta rhythm and learning abilities, increased delta rhythm has been reported in children with learning disabilities (Jäncke & Alahmadi, 2016; Martínez-Briones et al., 2020). EEG studies in PPA are scarce (Chriskos et al., Submitted; Moral-Rubio et al., 2021; Utianski et al., 2019). To the best of our knowledge, this is the first investigation of the relationship between resting-state EEG signal and cognitive processing in PPA, specifically of the delta rhythm and its relationship to learning abilities in lvPPA. Methods: Participants were 9 patients with lvPPA (mean age=68.3 years, SD=9.5). Learning ability was assessed using the total score (i.e., the sum of trials 1-5) of the Rey Auditory Verbal Learning Test (RAVLT), which has been found to be a significant predictor in the early diagnosis of AD (Moradi et al., 2017). Delta rhythms (0.5-4 Hz) were extracted from eyes-closed resting-state 8-channel EEG recordings, and analyzed both per channel and as an average across all channels. The statistical analysis included a set of multiple linear regressions with RAVLT total score as the dependent variable and delta rhythm as predictor. Disease severity and age were also included as covariates. In total, 9 regression models were used: one for the average delta rhythm across all channels, and one for every channel separately. Results: The analysis showed a statistically significant relationship between the RAVLT total score and the average delta rhythm across all channels (p=0.006; R2=0.65), such that the higher the delta rhythm, the lower the learning performance. Significant relationships in the same direction were also found with the delta rhythm of every channel separately, but after Bonferroni correction, only channel P5 (i.e., left parietal lobe) showed a statistically significant effect (p=0.026; R2=0.68). Conclusion: These results show, for the first time, a relationship between delta rhythm and learning ability in PPA, specifically in lvPPA. The significant association of learning abilities with the delta rhythm in the left parietal lobe in lvPPA suggests that this area could be an appropriate neuromodulation target for improving learning abilities. Finally, our findings highlight the importance of evaluating the power of delta rhythm in lvPPA, which might relate to AD being the underlying pathology in this population, and can potentially serve as an electrophysiological biomarker.

B43 - A cross-linguistic comparison of neural encoding of speech in autistic school-age children

Nikolay Novitskiy[1], Hoyee Hirai[1], Janna Guilfoyle[2], Joseph C.Y. Lau[2], Kritika Nayar[2], Trent Nicol[2], Jennifer Krizman[2], Nina Kraus[2], Molly Losh[2], Patrick C. M. Wong[1]; [1]The Chinese University of Hong Kong, [2]Northwestern University

Pitch serves as a fundamental aspect of language and communication, signaling both lexical meaning and intonational patterns in speech. Atypical intonation is widely observed in autism, reflecting a component of a core symptom domain (i.e., social-communicative differences). Difficulties in effectively perceiving and utilizing pitch may lead to breakdowns in communication, as emotional nuances, emphasis, and the intended meaning of the message are conveyed within the dynamic patterns of intonation. Although differences in pitch perception have been found in some studies of autistic children, the extent to which language background (e.g., tone vs. non-tone languages) may further modulate the autism-related effects is not clear. In tone languages, pitch can alter word meaning, making perception and processing of pitch even more crucial for semantics. While differences in neural pitch encoding have been consistently found in autistic children speaking a tone language (e.g., Cantonese), mixed results have been observed in their non-tone language-speaking (e.g., English) counterparts. The current cross-linguistic study examined the extent to which neural encoding of speech, particularly pitch features, may be modulated not only by autism-related characteristics but also by language background (tone vs non-tone). Specifically, we hypothesized that larger differences would be observed between Cantonese-speaking autistic and typically developing (TD) children, relative to their non-tone autistic and TD peers. 129 children between 8 to 15 years old were enrolled, encompassing 49 autistic and 50 TD native Cantonese-speaking children in Hong Kong and 15 autistic and 15 TD native English-speaking children in Chicago. Autistic children met ADOS-2 autism classification criterion in addition to having a formal autism diagnosis. All children listened to a /da/ syllable via insert earphones while electroencephalography (EEG) was recorded. Specific to the Hong Kong site, children also listened to lexical pitch patterns embedded in the syllable /ji/. 19 early-latency response metrics (seven of which were pitch-related) were extracted, consistent with prior studies of neural encoding in autistic children with different language backgrounds. A series of ANCOVA with Language (Cantonese vs English), Diagnosis (autistic vs TD), Sex, and Age was conducted to test the potential of an interactive effect of Language x Diagnosis on neural speech encoding. Main effects of Diagnosis were found in two EEG features: Pre-stimulus Noise (p=0.0062) and Response Consistency (p=0.0177), supporting the notion of neural hyperexcitability in autism. Significant Language x Diagnosis interaction was found only in Response Consistency (p=0.0471) and Middle-Frequency (260-750 Hz) Spectral Amplitude (p=0.0476). In general, these results did not support the hypothesis that differences in neural encoding of speech in autistic children were driven by language background. In addition, machine learning (ML) was used to conduct binary classification of diagnostic status within each Language group. Taking neural responses to /da/ as input, ML revealed more accurate classification of diagnostic status in the English groups (AUC=0.83) than the Cantonese groups (AUC=0.64), indicating cross-language differences. Curiously, classification results were much higher for the /ji/ responses (AUC=0.83), which were available only for the Cantonese group. A larger and more linguistically balanced sample size is needed to for conclusive results.

B44 - Machine Learning-based Prediction of Real-world Communication Accuracy in Post-Stroke Aphasia using Structural MRI, Clinical Aphasia Testing, and Linguistic Data as Key Predictors

Shreya Parchure[1], Leslie Vnenchak[1], Apoorva Kelkar[2], Olufunsho Faseyitan[1], John Medaglia[2], Denise Harvey[1], Roy Hamilton[1], H. Branch Coslett[1]; [1]University of Pennsylvania, [2]Drexel University

Predictors of language performance in Persons with Aphasia (PWA) beyond general measures such as lesion size and location are currently lacking. Recent studies have sought to combine multiple neuroimaging modalities and behavioral testing to develop predictions. A limiting factor in these models is their reliance on data (e.g., fMRI) not typically available in clinical settings. To address this issue, we used machine learning approaches to predict performance of PWA during interpersonal communication in Constraint Induced Language Therapy (CILT). The algorithms were created to be explainable and to use predictors likely to be available in routine clinical settings. We also test the importance of various structural MRI neuroimaging features in the AI models, to depict how stroke damage and remaining connectivity of intact brain tissue translate into language function in aphasia. Participants included 40 individuals with chronic poststroke aphasia with WAB-AQ scores between 25-80. Data came from CILT session interactions involving a participant and therapist. Response accuracies of agent nouns were scored by blinded raters. Random forest classifiers were constructed to predict noun accuracy in CILT exchanges, using PWA stroke demographics, structural MRI white matter strengths, and linguistic priors about task difficulty. Data included 5472 trials from 40 PWA (33% of trials were correct and 66% incorrect), of which 90% was used for training classifiers. Models were optimized for the following parameters: number of independent decision trees making parallel classifications, and maximum depth of decision splits per tree. Multi-collinear features were hierarchically clustered using Ward's linkage, to avoid erroneous importance of correlated neuroimaging regions. Feature importance was measured for each predictor in the model using 20 permutations and compared to a random number feature as null model benchmark. The best prediction of language performance was achieved by random forest trained on PWA stroke type, aphasia severity, linguistic metrics of task difficulty, and white matter connectivity strength from structural MRI (F1=0.89). This model resulted in a significantly superior performance compared with models trained on all features (F1=0.78, $p<0.01$) or single feature sub-sets of only stroke demographics, linguistic priors, or structural neuroimaging (F1 range=0.64–0.80, $p<0.01$). Of note, the best model showed high specificity for incorrect responses (93% recall score) with lower sensitivity for correct responses (77% precision). Important predictors in the model include linguistic priors (noun frequency and naming agreement of the trial), stroke severity (WAB-AQ score and aphasia type-especially whether Broca's aphasia) and white matter strength of brain regions from structural MRI. Key predictor regions were: left insula, bilateral inferior temporal gyri, superior frontal regions, and deep gray matter structures such as thalamus and hippocampus. Using commonly available information from PWA after stroke, our model can accurately predict language performance for naming during interpersonal communication in a therapy setting. Important predictors are linguistic priors, structural neuroimaging connectivity, and aphasia characteristics; these factors carry complementary information in predicting language performance in PWA.

B45 - Disentangling auditory and audiovisual speech perception during movie viewing using optical brain imaging

Jonathan Peelle[1], Aahana Bajracharya[2], Arefeh Sherafati[3], Michael Jones[2], Emily Milarachi[4], Noel Dwyer[2], Adam Eggebrecht[2], Tamara Hershey[2], Jill Firszt[2], Joseph Culver[2]; [1]Northeastern University, [2]Washington University in Saint Louis, [3]UCSF, [4]Penn State

Human interaction involves communicating in busy environments, conversations that provide context, and the ability to see a talker's mouth while they speak. However, many of these features are missing from laboratory studies of speech processing. The goal of the current study was to better understand everyday communication using a movie, which mimics many of the same cues found in natural environments. In two experiments, participants viewed ~10 minutes from the movie The Good, the Bad, and the Ugly (1966). Their only task was to watch attentively. To measure regional brain activity we used high-density diffuse optical tomography (HD-DOT). HD-DOT is free of acoustic noise, and permissible for people with implanted medical devices, making it well suited for studies of naturalistic listening in a variety of participants. Our HD-DOT system has 96 sources and 92 detectors, providing good coverage over large portions of the occipital, temporal, and frontal lobes. In Experiment 1 we examined responses to auditory-only and audiovisual speech in a publicly available data set containing data from 58 adults. We manually identified speech events in the movie clip, additionally classifying each as auditory-only speech (the speaker's mouth was not visible) or auditory-visual speech (the speaker's mouth was visible). We created regressors for the two speech types using a canonical hemodynamic response function, which we entered in a whole-brain GLM. We found activity for auditory-only speech strongest in the superior temporal lobes, with activity related to audiovisual speech showing increases in visual cortex and along the right lateral temporal lobe. In Experiment 2 we followed a similar analysis plan to compare responses between a group of 18 adults with a cochlear implant and a group of 18 controls with good hearing. We found that listeners with cochlear implants showed significantly more activity in left dorsolateral prefrontal cortex than did listeners with normal hearing, consistent with prior work using more standard laboratory paradigms. In conclusion, we use optical brain imaging to isolate responses to auditory-only and auditory-visual speech during movie viewing. In participants with good hearing, we found expected modality-preferential responses in auditory and visual cortex. In listeners with cochlear implants, we found additional activity in left prefrontal cortex, consistent with increased cognitive demand during listening. These findings lend further support for the hypothesis that the brain regions supporting successful comprehension depend on moment-by-moment fluctuations in the modality of information being processed, as well as the acoustic clarity of the speech signal.

B46 - "So much to say": Investigating the receptive language abilities of autistic non- and minimal-speakers using electroencephalography

Hannah Rapaport[1], Selene Petit[1], Alexandra Woolgar[1]; [1]MRC Cognition and Brain Sciences Unit, University of Cambridge

Introduction Despite the exponential growth in global funding for autism research since 2001, approximately 30% of the autistic population who have no or minimal spoken language (henceforth, 'non-speakers') remain chronically under-researched. This empirical neglect is in part because standardised tools and experimental paradigms rarely accommodate autistic non-speakers' communication, motor and sensory challenges, making it difficult to conduct reliable and valid assessments of their cognition. In the near-absence of empirical data, it has been widely assumed that autistic non-speakers have a limited understanding of language. However, this assumption is incompatible with the growing community of autistic non-speakers who have learnt to communicate by pointing to letters on a stencil or typing on a computer keyboard – suggesting that at least some non-speakers have excellent receptive and expressive language. Anecdotal reports of non-speakers' language being underestimated by educators, family members and the public lead to concerns for non-speakers' education, career prospects and wellbeing. It is therefore vital that we develop novel methods to empirically assess the language abilities of autistic non-speakers. To meet this need, the aim of the current study was to determine whether non-invasive brain recording could be used to detect neural signatures of language comprehension in individual autistic non-speakers and age-matched neurotypical counterparts. Methods Following our pre-registered plan (https://osf.io/3wfbx), we used a wireless, gel-free ElectroEncephaloGraphy system to record the brain responses of 28 autistic non-speakers (Mage = 16.7 years; range: 5-28; 6 females) and 37 neurotypical participants (Mage = 14.6 years; range: 5-37; 15 females) as they listened to a series of spoken sentences. Half of the sentences ended with a word that was congruent with the sentence (e.g., "In spring, flowers BLOOM."), and half, incongruent (e.g., "In spring, flowers CRY."). A difference in the brain response between the more-predictable congruent sentences and the more-surprising incongruent sentences (known as the 'N400' effect) would offer neural evidence of language comprehension. Notably, our neural measure of language comprehension bypasses the need for a behavioural response. Preliminary Results Using univariate analyses, we found significant, cluster-corrected N400 effects for the neurotypical group in central (352 to 680 ms) and right-temporal (617 to 781 ms) regions-of-interest, but no significant effects for the autistic group. At the individual-level, we found significant cluster-corrected N400 effects in a subset of neurotypical and autistic individuals. We are currently running multivariate pattern analyses to determine whether we can discriminate between patterns of neural activation associated with the congruent and incongruent sentences. Full analyses will be completed in mid-2024. Conclusion Our preliminary results provide an early proof of concept, demonstrating that it is possible to detect neural signatures of language comprehension in individual autistic non-speakers. This work has the potential to advance and potentially challenge scientific understandings of non-speakers' language abilities, and could have important implications for how non-speaking autistic people are perceived and treated by family, practitioners, employers and the public.

B47 - Improving the Validity, Feasibility, and Reliability of Presurgical Language Mapping in Refractory Epilepsy

Aoife Reardon[1-3], Sonia Brownsett[1-3], Lisa Gillinder[1,4], David Copland[1-3], Katie McMahon[5]; [1]University of Queensland, [2]Surgical Treatment and Rehabilitation Service (STARS), [3]La Trobe University, [4]Princess Alexandra Hospital, [5]Queensland University of Technology

Background: Neurosurgical interventions are often indicated to achieve seizure freedom in chronic refractory epilepsy. However, with resection comes the risk of aphasia, an acquired language deficit, which can significantly impact upon post-surgical quality of life. Whilst clinicians endeavour to minimise risk through pre-surgical language mapping protocols, evidence suggests the prevalence of post-surgical aphasia may be underestimated. Limitations of currently implemented fMRI language mapping paradigms include omission of known language regions (most notably, the anterior temporal lobe), limited consideration of task monitoring, inadequate tailoring of task difficulty to patient ability, poorly matched baselines, and limited consideration of longitudinal reliability. Aim: To investigate the validity, feasibility, and intrasubject reliability of a combination of current recommended, evidence based, and novel paradigms in a control group, using a test-retest design. Method: Seven language mapping tasks (autobiographical writing, noun semantic decision, verb semantic decision, adaptive semantic, adaptive rhyme, sentence completion, and silent word generation) were completed by healthy controls (n=20) at two timepoints. Tasks were evaluated in terms of 1) feasibility to complete within the MRI scanning environment; 2) validity with reference to a priori regions of interest; and 3) test-retest reliability, by calculating a similarity metric between activation maps obtained at each timepoint. Results: Through monitoring motion artefact, self-report, and number of correct trials (where applicable), all tasks were deemed feasible to complete within the MRI scanning environment. Activation maps for group level univariate contrasts revealed verb semantic decision, adaptive semantic, and autobiographical writing tasks most reliably activated known language regions of interest, with current recommended clinical paradigms (sentence completion and silent word generation) failing to activate all areas of surgical interest, most notably the anterior temporal lobe. Mean intrasubject test-retest reliability for all tasks fell within the fair range (0.4–0.6), with the exception of the adaptive semantic task, which was in the good range (0.6-0.75). Conclusion: Current recommended language mapping paradigms are grounded in historic neuroanatomical models of language, and fail to reliably map all areas of surgical interest, including the most frequently resected region in patients with refractory focal epilepsy, the anterior temporal lobe. Clinical paradigms should incorporate a combination of tasks (written autobiographical, adaptive semantic, adaptive rhyme, verb semantic decision) to ensure that the functional language network is comprehensively mapped. This will ensure patients and clinicians are able to make informed treatment choices when evaluating the risk-benefit trade-off of ongoing seizures against the possibility of post-surgical aphasia.

B48 - Prosodic Pitch Perception in Right Premotor Cortex: A Transcranial Magnetic Stimulation Study

Daniela Sammler[1,2], Tilo Zotschew[2,3], Gesa Hartwigsen[2,4]; [1]Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany, [2]Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [3]University of Bremen, Bremen, Germany, [4]Leipzig University, Leipzig, Germany

Speech perception is believed to recruit (pre)motor cortex (PMC) in the left dorsal auditory stream. Articulator-specific involvement of left PMC has been found for the perception of phonemes and lexical tones. However, PMC's role for prosody—the melody of speech—still lacks investigation. Motor control of prosodic pitch contours is anchored in the right (and left) PMC. This kindles questions of hemispheric lateralization, reminiscent of auditory asymmetries. Moreover, the role of PMC in supporting either perceptual or response-related processes is still a matter of debate. The present study used repetitive transcranial magnetic stimulation (rTMS) and behavioral drift diffusion modelling to (i) assess the causal role of right PMC in prosodic pitch categorization, compared to left PMC and a non-prosodic pitch control task (speaker gender categorization), and to (ii) disentangle the weighting of perceptual vs. response-related biases in PMC contributions. In two separate sessions, 24 listeners (M ± SD = 27 ± 3.4 years) categorized prosodic pitch contours (question vs. statement) and speaker gender (male vs. female) of monosyllabic words while receiving inhibitory or sham rTMS of left or right PMC (MNI: ±45, 5, 40 mm). A 5-pulse train of 10 Hz rTMS was delivered in each trial, time-locked to word onset. The order of sessions (left/right PMC) and blocks (prosody/gender task, sham/effective rTMS) was counterbalanced across subjects. Single trial response times and accuracies were analyzed with the drift diffusion model (DDM; fast-dm) to decompose latent processes that lead to a decision. Parameters v (drift rate; rate of evidence accumulation), a (threshold separation; indicating response biases), and t0 (non-decision time; decision-independent time for stimulus encoding and button press) were compared between tasks (prosody/gender), stimulation (effective/sham), and hemispheres (left/right) using rmANOVAs. Multiple regressions were used to predict ∆v (effective–sham) in both tasks from individual ratings of (i) perceptual focus on prosodic contour, (ii) on mean pitch, (iii) amount of subvocal rehearsal, and (iv) stimulated hemisphere, controlled for (v) years of musical training and (vi) perceived task difficulty. Drift rate v in the prosody task dropped after effective compared to sham stimulation of right (but not left) PMC, and more strongly in participants who were biased to focus on the prosodic contours. No such effects were found for parameters a and t0 or the categorization of speaker gender. Neither amount of subvocal rehearsal, nor years of musical training or perceived task difficulty influenced ∆v. The combined findings extend the modulatory role of PMC in speech perception from phonemes and tones to speech prosody. In particular, the results highlight the causal role of right PMC in pitch contour categorization, in line with auditory cortical asymmetries. The absence of rTMS effects on parameter a denoting response biases, and the stronger modulation of performance in case of a stronger perceptual bias towards pitch contour suggests a role of PMC in perceptual rather than solely response-related processes. Future studies should investigate the time-course of PMC involvement during prosody processing using chronometric protocols to substantiate this conclusion.

B49 - When no doesn't mean no: negation as a challenge for predictive-coding approaches to language processing

Matthias Schlesewsky[1], Sophie Jano, Ina Bornkessel-Schlesewsky, Barbara Kaup; [1]University of South Australia, [2]University of Tuebingen

Incremental processing is a basic tenet of psycholinguistic research, positing that linguistic input is interpreted in real time. Neurobiologically, incrementality has been explained via predictive coding: if only the unpredicted portions of the linguistic input are encoded, this could explain the rapidity of language processing (Pickering & Garrod, 2007). Negation has long been a thorn in the side of incrementality. Fischler et al. (1983) first reported that N400 effects in simple sentences ("A robin is (not) a bird/vehicle") were unaffected by negation. This pattern has proven to be highly consistent across a range of manipulations involving negation (e.g. Wiswede et al., 2013; Dudschig et al., 2018), thus leading to the suggestion that negation may not be processed in real time (e.g. Herbert & Kissler, 2014). These findings are surprising since negation can have a profound effect on our interaction with the environment (e.g. "This mushroom is (not) poisonous."). Moreover, they appear to challenge a view of the brain as a "predictive machine" which constantly seeks to verify or falsify the predictions about the environment generated by its current internal model. Here, we examined the effect of negation on incremental predictive processing by focusing on prediction matches in addition to prediction mismatches. To this end, we used antonym relations (e.g. "The opposite of black is white/yellow/nice"). Expected antonyms, as the sole appropriate continuation, elicit a target-related P3, while the two unexpected continuations engender a graded N400 depending on their relation to the antonym (unrelated, "nice" > related, "yellow") (Roehm et al., 2007). Forty speakers of Australian English (33 female; mean age: 24.1, range: 18-36) were presented with negated and non-negated sentences as in the above example using rapid serial visual presentation while their EEG was recorded. Antonym sentences were interspersed with an equal number of non-antonym sentences (50% of which were negated). From a predictive-coding perspective, one would hypothesise no observable antonym-P3 effect for the negated antonym conditions: even if a negation cannot be fully integrated into the current sentence meaning incrementally, it should, from a predictive coding perspective, at the very least eliminate the status of the antonym as a predicted target word. In other words, while the negation makes it difficult to formulate predictions for the continuation of "The opposite of black is not ...", it should rule out "white" as the predicted next word. Contrary to the hypotheses, we observed indistinguishable EEG responses to negated and affirmative antonym sentences: both showed the previously observed graded N400 effect (unrelated > related) accompanied by a P3 for the antonym condition. Neurobiologically, the P3 has been linked to the release of noradrenaline from the brainstem locus coeruleus in response to motivationally significant stimuli

(Nieuwenhuis et al., 2005; for language, see Sassenhagen et al., 2014). It thus occurs in response to stimuli that are highly relevant for our interaction with the environment. Strikingly, this response is not modulated by negation in real time. This finding poses a challenge for predictive coding as a fundamental mechanism of human information processing.

B50 - Effects of bilingual experience on the slope of aperiodic activity in EEG signals during anticipation of imminent words in sentence contexts

Katherine Sendek[1], Tamara Swaab[2]; [1]University of California - Davis

The presence and utility of lexical semantic prediction in bilingual L2 has been debated, with many studies showing decreased, delayed, or non-existent effects of prediction in L2. Competing theories suggest that the differences are either due to L2-specific differences in experience or to a general effect of bilingualism, wherein differences are due to the presence of two languages. However, these studies have typically compared L2 in bilinguals to monolinguals. Thus, the conflicting findings on prediction during sentence processing may be due to a conflation of bilingual and L2 effects. Studies that investigated prediction in both L1 and L2 have shown slightly delayed prediction effects in both languages, suggesting that there is an effect of bilingualism on prediction, rather than an L2-specific effect. In the present study we examined effects of language experience in Mandarin-English bilinguals using EEG. The goals of the study were to 1) isolate the potential impact of bilingual experience on prediction, and 2) examine if neural and cognitive individual characteristics contribute to modulation of predictive processing in bilinguals with different language experience. We measured the amplitude of the N400 to critical words that were either highly predictable or not in the context, and the slope of the aperiodic activity prior to the onset of the critical words. This is broadband EEG measure has been shown to be sensitive to neural signal efficiency or connectivity, with steeper slopes indicating greater efficiency. The steepness of the aperiodic slope is furthermore predictive of the size of the N400 effect – greater N400 effects of cloze probability are predicted by a steeper slope. In the present study, we recorded EEG during English sentence reading for English monolingual, English-Mandarin bilinguals, and Mandarin-English bilinguals. We hypothesized that if differences in language prediction were due to L2-specific factors, then we would see more similarity between the English monolinguals and English-Mandarin bilinguals compared to the Mandarin-English bilinguals. In contrast, if the differences are due to general bilingual effects, then the two bilingual groups would be more similar compared to the monolingual group. In this ongoing study, participants (N= 10 monolinguals, 14 bilinguals) read 80 sentences (40 high cloze). Our preliminary analysis showed a significant N400 effect of cloze probability for the monolingual group ($t(9) = -2.72$, $p<.05$) and the combined bilingual groups ($t(13) = -7.36$, $p<.05$); a significantly steeper aperiodic slope for the bilingual groups relative to the monolingual group, and an interaction between aperiodic slope and group, wherein aperiodic slope was only a significant predictor of the size of the N400 effect for the monolingual group. Overall, our N400 results suggest that Mandarin-English bilinguals predict imminent words in sentences contexts. Furthermore, the increased neural connectivity suggested by the steeper aperiodic slope in bilinguals suggest neural adaptations associated with managing two languages. However, the lack of a predictive relationship between aperiodic slope and the N400 effect in bilinguals suggests that bilingual neural processing mechanisms during language comprehension may differ from those of monolinguals.

B51 - The role of language comprehension ability on anxiety in autistic and typically-developing children

Matthew Ganquan Shi[1,2], Hanlin Wu[1], Gary Yu-Hin Lam[1], Xin Kang[3], Patrick CM Wong[1], Xiujuan Geng[1]; [1]The Chinese University of Hong Kong, [2]The University of Maryland, College Park, [3]Chongqing University, China

#Introduction# Autistic children have a higher prevalence of anxiety than typically developing (TD) children (van Steensel & Heeman, 2017). Limited social communication (SC) skills among autistic children may lead to social rejection and subsequent anxiety (Wood & Gadow, 2010), while language deficits can also contribute to heightened anxiety (Asher & Gazelle, 1999). Given the prevalence of language delay or deficits in autistic children (Tager-Flusberg, 2016), we investigate the role of language comprehension (LC) skills in autism severity (AS) and anxiety levels (AL), potentially shedding light on the underlying neuronal mechanism. We hypothesize that (i) poorer LC skills predict higher AS, particularly SC skill differences, and AL, and (ii) higher AS predicts higher AL. Path analysis is employed to test these hypotheses. #Methods# Fifty-three Cantonese-speaking children aged 8-12 years, diagnosed as autistic (N=32, M:F=29:3) or not (N=21, M:F=14:7), were recruited from local mainstream schools. All participants had normal hearing and nonverbal IQs > 85 and were administered the Autism Diagnostic Observation Schedule, Second Edition, Module 3 (ADOS-2; Lord et al., 2012) and Textual Comprehension subscale of the Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS-TC; T'sou et al., 2006). Their parents filled out the Anxiety Scale for Children with [Autism Spectrum Disorder] (ASC-ASD; Rodgers et al., 2016) and the Spence Children's Anxiety Scale (SCAS; Spence, 1997, 1998; not used in the current study). ADOS-2 total scores reflect AS, while the Social Affects (SA) subtotals suggest SC skills difficulties. HKCOLAS-TC assesses LC skills. ASC-ASD measures AL. Correlation analysis was conducted among (i) LC, AS, and AL, and (ii) LC, SC, and AL. Using R's "lavaan" package, path analysis tested our hypotheses with the following settings (abbreviations represent variables): (1)-a $AL=\alpha1+\beta1*LC+\beta2*AS+e1$ (1)-b $AS=\alpha2+\beta3*LC+e2$ (2)-a $AL=\alpha1+\beta1*LC+\beta2*SC+e1$ (2)-b $AS=\alpha2+\beta3*LC+e2$ #Results# Pearson's Correlation results were as follows (the tilde ~ means "correlate ... and ..."; *p<0.05, **p<0.01, ***p<0.001): LC~AS/SC: -0.48***/-0.43***; LC~AL: -0.40*; AS/SC~AL: 0.36**/0.30*. Path analysis (N=53) revealed that LC significantly predicted AS ($\beta=-0.482$, $p=0.001$, $R^2=0.173$), which in turn predicted AL ($\beta=0.622$, $p=0.003$). LC did not directly affect anxiety ($\beta=-0.339$, $p=0.169$). Together, LC and AS explained 24.6% of the variance in AL ($R2=0.246$). These findings suggest

that LC influences AS, which subsequently predicts AL. Parallel results were obtained when using SA subtotals to represent SC skill difficulties: LC predicted SC skill difficulties (β=-0.351, p=0.006, R^2=0.131), which in turn predicted AL (β=0.584, p=0.022). No direct prediction was found between LC and AL (p=0.080). #Discussion and conclusion# The path modeling established a mediation model among language comprehension skills, autistic features, and anxiety in school-age autistic and typically-developing children. The indirect effect of language on anxiety differs from Rodas et al. (2017), possibly due to different assessment criteria (grammar vs. integrative comprehension) and age range. Impaired comprehension may lead to avoidance in social interaction and ineffective communication, resulting in increased anxiety. The results call for specific treatment targeting language comprehension. Moreover, as the neuronal mechanism behind autistic traits remains elusive, our behavioral research provides a possible model connecting them with language and anxiety.

B52 - Does the language system reinvent itself in healthy and pathological ageing? MEG evidence of large-scale functional connectivity changes in older individuals and Parkinson's disease patients.

Yury Shtyrov[1], Rasha Hyder[2,1], Mads Jensen[1], Andreas Højlund[1]; [1]Aarhus University, [2]Cardiff University

Whereas many neurocognitive abilities decline with age, and even more so with age-related neurological disorders, changes in speech comprehension mechanisms in healthy and pathological ageing remain obscure, as the language function appears remarkably resilient to age-related degradation. We investigated the neural processing of spoken language in healthy older individuals and in patients with Parkinson's disease (PD) — a neurodegenerative disorder which, apart from the motor system, adversely affects various cognitive functions. We devised a patient-friendly paradigm to probe language comprehension at different levels (lexical, semantic, morphosyntactic) without confounds related to active attention and overt motor responses that can be compromised in these populations. Participants were presented with spoken stimuli (action/abstract verbs, grammatically correct/incorrect inflectional forms, pseudowords) without any task, while their cortical activity was recorded using MEG. By applying machine learning-based classification algorithms on beamformer source estimates, we found that, for all linguistic contrasts, oscillatory activity patterns in bilateral distributed fronto-temporal networks diverged between older participants and younger controls across several frequency bands, suggesting multiple age-related changes in neurolinguistic circuits, possibly due to ageing as such and to compensatory processes taking place. These included a 200-ms delay (~100 vs. ~300 ms) in medium-gamma activation for the lexical (word/pseudoword) contrasts, a similarly delayed (~150 vs. ~400 ms) semantic activation accompanied by a beta-to-alpha shift in peak frequency, multiple changes for morphosyntactic contrasts, and overall, a more bilateral activation in older participants than in younger ones. Furthermore, a logistic regression classifier was able to classify newly diagnosed early-stage PD patients vs. healthy age-matched participants based on functional connectivity within large-scale temporo-fronto-parietal networks. The best classification results were achieved for responses to verbs and to incorrect inflections, indicating augmented involvement of both the core language cortices and the motor system in speech processing. These findings demonstrate quantifiable changes in cortical language-system connectivity in PD, which arise early, in the absence of overt clinically detectable cognitive or language deficits. Finally, we investigated effects of bilateral and unilateral deep-brain stimulation of the subthalamic nucleus (STN-DBS) on neural responses to spoken language in advanced PD. Compared to DBS-off state, both bilateral and right unilateral STN-DBS stimulation yielded significant dissociations in verb processing, with greater neuromagnetic responses for action verbs than abstract ones, potentially indicating restored engagement of the motor system in processing action-related semantics. For morphosyntax, only left unilateral stimulation yielded significant changes, with greater neuromagnetic responses to incorrect inflections than correct ones. This suggests that DBS can recover the normal incorrect>correct ELAN pattern, well-known from E/MEG studies in healthy adults. In sum, we show multiple changes in large-scale distributed neural networks underpinning spoken language processing, which take place in both healthy and neuropathological ageing. Furthermore, our results indicate that brain stimulation techniques are not only useful for ameliorating motor deficits in Parkinson's disease but may also help restore normal neurolinguistic activity patterns. Finally, the present patient-friendly design combining task-free exposure to different linguistic stimuli with time-resolved neurophysiological recordings may in the future help develop non-invasive biomarkers of functional neurocognitive deficits in healthy and pathological ageing.

B53 - Shared cortical language networks with convergent hierarchical network dynamics for lexicosemantic processing in comprehension and naming

Kathryn Snyder[1], Kiefer Forseth[1], Oscar Woolnough[1], Elliot Murphy[1], Greg Hickok[2], Nitin Tandon[1]; [1]UTHSC, [2]UC Irvine

Lexicosemantic processing is a fundamental component of language that describes the mapping between concepts and sensorimotor forms such as phonology or orthography. Furthermore, prominent psycholinguistic models suggest that spoken and written language engage a shared lexicosemantic processing network in both speech perception and production, yet the convergent neural mechanisms are unclear. Here, we used electrocorticography (ECoG) to identify the spatiotemporal network dynamics of lexicosemantic processing in comprehension and naming. Data were obtained from 68 patients who underwent invasive electrocorticography and completed auditory (AN) and orthographic (ON) naming (8,664 electrodes). We analyzed gamma activity (65-115Hz) using a surface-based mixed-effects multilevel analyses to identify lexicosemantic processing networks during speech comprehension and naming. Next, we isolated discrete cognitive states and associated network dynamics using autoregressive hidden Markov models (ARHMM). Lastly, we used direct cortical stimulation (DCS) to attribute causality to critical nodes. At speech onset, activation of superior temporal

gyrus (pSTG) was followed by superior temporal sulcus/middle temporal gyrus (pSTS/pMTG), and posterior middle frontal gyrus (pMFG). For each written word, visual cortex activity was followed by activation of lexical and phonological reading routes (middle fusiform gyrus, mFus; pSTG; pSTS/pMTG, intraparietal sulcus, IPS; pMFG; pars triangularis, pTr; pars opercularis, pOp). Both modalities engaged pSTS/pMTG and pMFG for comprehension, and activity was correlated with the number of sentential constituents available to be merged into a meaningful phrase ($p<0.01$) implicating both regions in linguistic composition. The last word activated a shared network (pSTS/pMTG; mFus; IPS; pTr) for naming. ARHMM isolated 5 states for AN and 6 for ON with 3 convergent states. The first convergent state occurring at stimulus offset was characterized by outflow from pSTS/pMTG, mFus, IPS, and pTr, and state duration was correlated with reaction time ($p<0.001$) implicating it in lexical access. Lastly, DCS of lateral temporal cortex (LTC) showed an anterior-to-posterior gradient of modality-based functional disruption with more anterior regions preferentially disrupting AN and more posterior regions preferentially disrupting ON. Regions that disrupted both AN and ON were located primarily within the planum temporal and pSTS/pMTG. At stimulus offset, DCS of pSTS/pMTG, mFus, IPS, and pTr disrupted both AN and ON. Our results show that naming to spoken and written descriptions recruit shared cortical language networks for both speech comprehension and lexical access. Additionally, we showed that neural states and associated network dynamics are convergent for lexical access. Lastly, we found that speech processing in LTC follows an anterior-to-posterior gradient of modality-based functional specialization with PT and pSTS supporting multimodal speech comprehension. Juxtaposing network dynamics of multimodal lexicosemantic processing in speech perception and production informs our understanding of specialized and shared language networks providing new insights to facilitate designs of neural prosthetics for language disorders.

B54 - Dependence on Linguistic and Sensory Experience Predicts Individual Differences of Word Representation in Different Brain Areas

Ming Song[1,2,3], Jing Wang[1,2,3], Qing Cai[1,2,3]; [1]Shanghai Key Laboratory of Brain Functional Genomics (Ministry of Education), East China Normal University, [2]Shanghai Changning Mental Health Center, Shanghai, China, [3]Shanghai Center for Brain Science and Brain-Inspired Technology, Shanghai, China

Humans learn and represent the meanings of words through both linguistic and sensory experiences. Cognitive neuroscience research on semantics has shown that cross-individual variations in representation word meanings can be modeled by the strength of their association with either linguistic or sensory experiences. These variations tend to increase with the abstractness of the words. However, the contributions of linguistic and sensory information have not been dissociated for either abstract or concrete words, partly due to ineffective selection of experiment stimulus. In this study, we separately quantified words' reliance on linguistic and sensory experiences, identified words with varying dependencies on these experiences, and investigated their activation in different brain regions. For each word in the vocabulary, we calculated the “alignment score” among its vector representations in models trained on different corpora, to represent the word’s dependence on linguistic experience. We calculated the alignment score among sensory-motor ratings from different participant samples to represent a word’s dependence on sensory experience. We investigated the relationship between word abstractness and these two types of alignment scores. Three groups of words were selected for the functional MRI experiment: words with high dependence on linguistic experience and low dependence on sensory experience, words with low dependence on linguistic experience and high dependence on sensory experience, and those with intermediate dependence on both. Neural activations of these 90 words were estimated using single-trial beta coefficients in general linear models. We then calculated the inter-subject correlation (ISC) scores in the regions of interest (ROIs) selected from the language network and sensory-motor areas. Variables representing the dependence on linguistic and sensory experiences for each word were used to predict its ISC score in each ROI. The results indicated that words' dependence on linguistic experience was positively correlated with their abstractness, while dependence on sensory experience was negatively correlated with abstractness. The discriminative words selected for the neural experiment exhibited dissociated effects in language-related and sensory-related areas. Specifically, words with higher dependence on linguistic experience showed greater individual differences in sensory-related areas, whereas words with higher dependence on sensory experience showed greater individual differences in language-related areas. To summarize, this study aimed to disentangle the contributions of linguistic and sensory experiences to word representation. We quantified words' alignment in terms of linguistic and sensory experiences, examined their relationship with word abstractness, and identified words that were discriminative in their dependency on these experiences. These discriminative words exhibited dissociated effects in language-related and sensory-related brain areas. Our study provides insights into the complex interplay among language, sensory information, and abstractness and how they affect neural semantic representations.

B55 - Dopaminergic contributions to novel word learning

Peter Su[1], David Copland[1,2], Nadeeka Dissanayaka[1,3], Anthony Angwin[1]; [1]University of Queensland, [2]STARS Education & Research Alliance, [3]UQ Centre for Clinical Research

INTRODUCTION: Word learning occurs across the adult lifespan. It is a computationally complex process, drawing on language, executive, reward, and memory networks. Dopamine is crucial to the function of these networks, as both a neurotransmitter and a neuromodulator. While several studies have found that increasing dopamine availability in healthy adults facilitates contextual word learning, there remain open questions about how these findings translate to associative novel word learning. METHODS: Building on previous work, we investigated the effects of dopamine availability on word learning. Using a placebo-controlled, between groups study.

design, we examined the impact of levodopa VS placebo using an associative novel word learning task, in a group of healthy young adults (placebo n=18; levodopa n=17). The task drew on a stimulus set of 100 picture-word pairs, comprising audio recordings of novel words paired with either a familiar or unfamiliar object. Participants attended an intensive 4-day learning block, where they received levodopa or placebo prior to learning the picture-word pairs. They were assessed for learning via recognition and recall tasks on each day, with further delayed testing at 1 week and 4 weeks. We predicted that levodopa would improve novel word learning performance relative to placebo. Given the tight coupling of hippocampal reward loops with learning, we also predicted that successful word learning would be correlated to reward sensitivity. RESULTS: Analysis of the results revealed that participants receiving levodopa demonstrated higher overall recall accuracy as well as earlier acquisition during the learning block relative to those on placebo. There were no significant between group differences in recall accuracy observed at delayed testing. Recognition accuracy showed a slightly different pattern: while participants receiving levodopa demonstrated higher overall recognition accuracy during the learning block VS their placebo counterparts, they also demonstrated higher recognition accuracy VS placebo during delayed testing. No effect of object familiarity on recall or recognition was observed for either group. CONCLUSION: Interestingly, we noted an increase in accuracy from Day 4 to Week 1 across both recall and recognition for both drug arms, despite the lack of any training sessions in between. One potential explanation for this observation is the use of a combined learning approach (i.e. auditory presentations of novel words accompanying pictured objects), in comparison with previous work employing solely visual presentations for both words and objects. In further contrast to previous work, individual participants' sensitivity to reward did not meaningfully predict novel word learning performance as indexed by our task. We propose that an explicit learning paradigm may produce a strong top-down motivational drive within the task context, which could in turn wash out contributions from reward sensitivity to learning outcomes

B56 - Investigating syntactic attention in the brain

Yushi Sugimoto[1], Ryo Yoshida[2], Hyeonjeong Jeong[3], Akitake Kanno[3], Masatoshi Koizumi[3], Yohei Oseki[2]; [1]Osaka University, [2]University of Tokyo, [3]Tohoku University

[INTRO] In recent computational psycho/neurolinguistics, Transformers have been shown to capture human reading effort more precisely than Recurrent Neural Networks (RNNs), implying the cognitive plausibility of selective attention to the words in the context (Merkx and Frank, 2021). On another stand, Recurrent Neural Network Grammars (RNNGs), the integration of RNNs with explicit syntactic structures, have been shown to achieve better psychometric predictive power than vanilla RNNs, suggesting that the architecture that constructs syntactic structures behind the words is more human-like (Hale et al., 2018; Brennan et al., 2020). However, previous studies do not investigate the integration of these two architectures, i.e., selective attention to the syntactic structures, namely syntactic attention. In this study, we employed Composition Attention Grammars (Yoshida and Oseki, 2022) as the neural architecture of syntactic attention and evaluated them against a novel MEG dataset, to investigate the cognitive plausibility of selective attention to the constructed syntactic structures. [METHODS] We collected MEG data from 41 Japanese speakers. Using rapid serial visual presentation, 20 Japanese newspaper articles selected from the Balanced Corpus of Contemporary Written Japanese were presented segment by segment for 500ms, followed by a blank screen for 500ms. For statistical analysis, the information-theoretic metric surprisal (Hale, 2001; Levy, 2008) was calculated for each segment of the newspaper articles using targeted computational models. We conducted two-stage regression analyses in which the regression model includes one predictor of interest (surprisal from Long Short-Term Memory Networks (LSTMs), surprisal from RNNGs, surprisal from GPT2 small (the model that is available from Hugging Face), or surprisal from CAGs), as well as control predictors of word length, word frequency, segment position, and sentence position. Then, for each regression model, we performed spatio-temporal permutation cluster tests in regions that were defined based on the results of a previous study (Pallier et al., 2011) over a 200-650ms time window. Next, we defined the functional ROI (fROI) based on the results of spatio-temporal cluster permutation regression. Finally, the neural activities were averaged over space and time within the fROI, and the likelihood-ratio tests were conducted for nested model comparisons. [RESULTS] For the results of spatio-temporal permutation cluster tests, there was a significant cluster in the temporal lobe that includes the left middle temporal gyrus (MTG) only for surprisal from CAGs (425-615ms). For the results of nested model comparisons, the regression model that includes surprisal from CAGs as well as all baseline predictors had a statistically significant effect against the baseline regression model in the fROI. Moreover, the regression model that includes all predictors had the above-and-beyond effects against the model that includes all but suprisal from CAGs in the fROI. [DISCUSSIONS] First, our results align with some previous studies where the left MTG is involved in hierarchical complexity, especially in the construction of phrases and sentences (Sheng et al., 2019; Woolnough et al., 2023). Second and more importantly, combining our results with previous studies, sentence processing in this region may be engaged in syntactic attention-like operation—constructing syntactic structures and selectively attending to the constructed representations.

B57 - A Novel Framework for Decoding Continuous Language from Brain Activities Recorded by fMRI

Jingyuan Sun[1], Xinpei Zhao[2], Shaonan Wang[3]; [1]KU Leuven, [2]Insititute of Automation, Chinese Academy of Sciences

Decoding continuous language text from brain activity is a groundbreaking endeavor at the intersection of neuroscience, linguistics, and artificial intelligence. This advancement promises to revolutionize communication, particularly for individuals with speech impairments, and offers profound insights into the brain's language processing. The development of interfaces that seamlessly integrate thought and speech holds immense potential. While invasive technologies like electrocorticography (ECoG) have shown promise, their broad

application is limited due to the scarcity of invasive data and the complexities associated with neurosurgery. Non-invasive brain recordings, such as those obtained from functional magnetic resonance imaging (fMRI), present a more accessible alternative. However, decoding continuous language from these non-invasive recordings remains a significant challenge. This difficulty arises from the intricate and dynamic relationship between language and the neural responses it elicits, compounded by the inherently noisy nature of non-invasive neuroimaging. Previous attempts to address this issue involved a two-step process where brain activity was first encoded from text using a linear model, which then guided text generation by aligning it with predicted brain responses. Although this method showed some improvement over random-level performance, the advancements were marginal, and the effectiveness of such an indirect method using a linear model for continuous text generation was questionable. In response to this challenge, we introduce MapGuide, a novel two-stage framework designed to decode continuous language from brain activities more effectively. In the first stage, MapGuide employs a Transformer-based mapper to map brain activity to text embeddings. To enhance the mapper's resilience to neural noise, we utilize a random mask method for data augmentation and contrastive learning. In the second stage, a pre-trained text generator uses the predicted text embeddings to produce text that closely aligns with these embeddings. This integration of mapping and text generation stages offers a more direct and efficient solution for translating neural signals into coherent text. Experimental results demonstrate that MapGuide achieves a new state-of-the-art in reconstructing continuous language from fMRI-based brain recordings. Our method significantly outperforms previous attempts across four different types of metrics. Additionally, our investigation reveals a crucial contrast in compatibility patterns between frameworks. While previous encoding-based frameworks performed well with linear models, our decoding-based framework shows superior performance with non-linear models. This finding marks a pivotal shift in approach, emphasizing the importance of using non-linear models for optimal results in this context. Furthermore, we identify a clear link between the accuracy of mapping brain activities to text embeddings and improved text reconstruction performance. This insight highlights the importance of refining the brain-to-text embedding mapping process, thereby simplifying the task of reconstructing language from brain activities. Our study underscores the potential of the MapGuide framework to advance the field of brain-computer interfaces and enhance our understanding of the neural basis of language.

B58 - The structural disconnection model of reading-evidence from patients with alexia

Qingchun WANG[1], Lu YU[2], Fang WANG[2], Yang LIU[2], Xinjun WANG[2,3], Wai-Ting SIOK*[1]; [1]The Hong Kong Polytechnic University, Hong Kong SAR, China, [2]The Fifth Affiliated Hospital of Zhengzhou University, Zhengzhou University, Zhengzhou, China, [3]The Third Affiliated Hospital of Zhengzhou University, Zhengzhou University, Zhengzhou, China*

Alexia is an acquired reading disorder, which typically results from neurological diseases. The neuroanatomical characteristics of alexia indicate abnormalities in cortical and subcortical regions or interruption of structural connectivity in the reading system. Recently, the diffusion magnetic resonance imaging (MRI) technique with advanced algorithm has identified several major white matter tracts to support successful reading, including the arcuate fasciculus (AF), inferior longitudinal fasciculus (ILF) inferior frontal-occipital fasciculus (IFOF), and vertical occipital fasciculus (VOF). Yet, the modern understanding of the structural disconnection model of atypical reading has not been examined on brain damaged patients with pure alexia, owing to these cases are rare in clinical settings. Here, we present two cases with pure alexia resulting from hypoxic-ischemic brain damage. Both patients are right-handed, well-educated Mandarin speakers with no previous neurological or psychiatric disorders. Behavioral assessments and neuroimaging were used to examine the disconnection structural model of reading. Language abilities and related cognitive functions of the patients were measured by multiple behavioral tasks. To examine the neural mechanism underlying the atypical reading system, both patients underwent anatomical and diffusion MRI performed by a 3.0 T Philips Ingenia scanner. Ten healthy participants matched in gender, age, and education served as controls. Language related cognitive functions including visuospatial ability and memory were assessed with standardized neuropsychological batteries. Language evaluations included aphasia screening, reading ability tests (single word identification, words identification, phonological awareness, and orthographic awareness) and handwriting ability tests. Initial neuroimaging assessments including computed tomography (CT) and MRI exhibited a similar pathological pattern in both patients, which revealed bilateral structural abnormalities such as degeneration and atrophy of the cortical and subcortical regions. Using Voxel-Based Morphometry (VBM) and the Computational Anatomy Toolbox (CAT12), we observed anatomical brain features. Diffusion metrics reflecting white matter integrity were extracted for target fiber pathways (AF, ILF, VOF, IFOF). Patients received lower scores in visual perception, praxis and visuomotor construction compared to the normative ranges, but memory tasks suggested intact memory function. In reading tasks, patients scored significantly lower than controls in single character identification, word identification, and component search ($p < 0.001$, one-tailed). No significant differences were found in syllable deletion and tone judgment tasks. Handwriting performance was also significantly worse in patients compared to controls ($p < 0.001$, one-tailed). Gray matter atrophy was most obvious bilaterally in the middle occipital gyrus, superior occipital gyrus, inferior parietal lobule, fusiform gyrus, superior temporal gyrus, middle temporal gyrus, and inferior temporal gyrus. White matter atrophy was relatively less severe, involving tissues underneath the parahippocampal gyrus, middle occipital gyrus, fusiform gyrus and inferior temporal gyrus bilaterally. Patients exhibited significant lower FA values in all selected white matter tracts ($p < 0.01$) compared with controls. Our findings highlight the relationship between visual perception and reading based on the behavioral patterns of patients with pure alexia. Neuroimaging revealed interruptions in anatomical connections and cortical computations, underscoring the importance of white matter integrity and cortical structures in

reading. This study provides valuable insights into the neural mechanisms underlying reading disorders.

B59 - The pSTG is associated with prolonged language impairment following neurosurgical resection

Catherine Wang[1], Deborah Levy[1], John Andrews[1], Jon Gauthier[1], Edward Chang[1]; [1]University of California, San Francisco

Despite its long-established role in language, the left posterior superior temporal gyrus/sulcus (pSTG/S) remains an area of much debate. Two questions are of particular interest: first, does the pSTG/S have a specific role in language – i.e., is it functionally different from other regions of the putative language network, such as the middle temporal gyrus (MTG) and the inferior frontal gyrus (IFG)? And second, what is the specific role of the pSTG/S in language – is it sensorimotor transformation, phoneme perception, single word comprehension, syntactic comprehension, or something else? There is broad agreement overall that the pSTG/S region is important for language function; indeed, recent findings in stroke have suggested that the degree of damage and/or dysfunction in the pSTG/S may be the factor most crucially related to chronic aphasia severity. However, the stroke cohort is limited by stereotyped patterns of damage; therefore investigations in complementary populations are of interest. Prior work in neurosurgical cohorts has demonstrated systematic patterns of resection-based language deficits, though these were predominantly described in the immediate post-acute period, as the vast majority of patients recover most of their language function within one month. However, not all patients recover fully to baseline by the one month time point, and in those cases little is understood about the factors that contribute to their prolonged language impairment. Here, we present a series of analyses probing the neural and clinical factors that contribute to prolonged language impairment following left hemisphere resective surgery. 177 patients were included in this study, approximately 10% of whom scored below normal limits on a language evaluation conducted at one month post-surgery. Using VLSM, a small region in the pSTS was identified as associating with prolonged overall language impairment. A follow-up hierarchical linear regression indicated that resection in this pSTG/S region, as well as patient age, were independent contributors to prolonged language impairment, while resection in the MTG and IFG were not (effect of adding age: $F = 7.45$, $p < 0.01$; effect of adding pSTG damage: $F = 3.59$, $p = 0.02$; effect of adding MTG/IFG damage: $F = 1.71$, $p = 0.08$). Correlational analyses between damage in the pSTG and various language evaluation subscores at one month then showed that damage in the pSTG was entirely un-correlated with single word comprehension ($r = 0.01$, $p = 0.92$), while significant negative correlations were observed with repetition ($r = -0.31$, $p < 0.001$) and sentence comprehension ($r = -0.27$, $p < 0.001$). Overall, our findings suggest that the pSTG/S does play a different functional role than other putative language regions, by independently contributing to long-term language impairment while other regions do not. Furthermore, we did not find evidence to suggest that single word comprehension drives the impairment profile of patients with pSTG/S damage. With this and follow-up work, we aim to expand scientific understanding of neural mechanisms that contribute to language processing and recovery, and provide clinically informative findings on factors influencing outcomes following neurosurgical intervention.

B60 - A neuroscientific model of the entropy of qualia for semantics and consciousness

T R Williamson[1,2,3,4], Agustín Ibáñez[5,6]; [1]University of the West of England, Bristol, [2]Southmead Hospital, North Bristol NHS Trust, [3]University of Oxford, [4]University of Southern California, [5]Latin American Institute for Brain Health, Universidad Adolfo Ibanez, Santiago, Chile, [6]Global Brain Health Institute, Trinity College Dublin

Studies of meaning in language and conscious experience are equally ancient, although both have been determined in the past to be too ambiguous or irrelevant for scientific investigation (Bloomfield, 1933; Chomsky & Ronat, 1979; Skinner, 1953; Watson, 1924). This may stem from the impression that they both share a kind of mysterious, opaque, and indeterminate nature (Nagel, 1974; Wittgenstein, 1953) that entails recourse to objective, ontological explanations aiming at characterising what subjective, immaterial experience fundamentally is (Crick & Koch, 1990; Lakoff & Johnson, 1980). We argue that using subjective experiences as the foundation for cognitive and neuroscientific explanation can frequently lead to category mistakes, where subjective properties (in the explanans) are mistakenly taken as true representations of a phenomenon (the explanandum). Our observation is that this mistake arises because semantics and consciousness are rooted, to a certain extent, in the (neural) underpinnings of subjective experience (i.e., qualia). Impossible to encapsulate fully, we propose a novel analytic-synthetic approach that introduces entropy to neuroscientifically explore semantics and consciousness as a first step. While work especially in the last year has explored the neurobiology of consciousness entropically (Carhart-Harris, 2018; Froese, 2024; Ji et al., 2024; Kringelbach et al., 2024), our approach is the first to apply entropy to a neuroscientific understanding of linguistic semantics. We start with defining neuropsychological states encapsulating processes for semantics (production, comprehension, planning, prediction, etc.) and consciousness (sensory perception, inference, motor action, etc.). Then we define how elements of discrete neurobiological representations or substrates that might compose those processes may be modelled entropically. The (information-theoretic) entropy of a given neuropsychological state may be determined by the probability of a given microscopic (in the statistical mechanics sense of entropy) element composing it. We conceive of specific semantic- or conscious-states as vector, containing finite sets of 0s and 1s corresponding to whether a specific neurobiologically determined, constitutive, microscopic element (for picking a red flower in a field, e.g., semantic-state: activation of visual sensorimotor properties of redness, semantic composition of linguistic items; conscious-state: activation of world knowledge of social appropriateness to pick a flower in a meadow vs. a private garden, volitional action initiating motor coordination of the hand or arm muscles, etc.) is involved in producing the qualitative experience associated with that state. Overarchingly,

our proposals aim to highlight the synergy between meaning in language and consciousness that qualia facilitates and to propose a new avenue for studying this aspect of their natures. We conclude that this conceptualisation may enable new kinds of scientific questions, from investigations into what these neuropsychological elements might be to how measurable macroscopic constraints like brain health (Ibanez et al., 2024) may eventually be factors within an information-theoretic model to ask radically cross-disciplinary neurobiological questions.

B61 - The extended language network: A large-scale characterization of language-responsive regions beyond the core fronto-temporal network

Agata Wolna[1,2], Benjamin Lipkin[1], Evelina Fedorenko[1]; [1]Massachusetts Institute of Technology, [2]Jagiellonian University, Krakow, Poland

Research on the neural basis of language has focused on the core left frontal and temporal brain areas and their right-hemisphere homotopic areas. However, brain imaging, intracranial recordings, and patient studies suggest that other areas—cortical, subcortical, and cerebellar—also contribute to linguistic processing. Here, using a large fMRI dataset (n=706), we identify and validate a comprehensive set of brain regions consistently activated during language processing. All participants performed a language 'localizer' task – an extensively validated paradigm which contrasts reading sentences with reading nonwords (Fedorenko et al., 2010). Importantly, this paradigm effectively isolates language processing from both lower-level perceptual and motor processes and from higher-level knowledge and reasoning (for review, see Fedorenko et al., 2024). To search for language-responsive areas outside of the core frontal and temporal areas, we used two approaches. First, we used a group-constrained subject-specific (GSS) approach (Fedorenko et al., 2010; Julian et al., 2012) to search across the brain for areas within which most participants show responses to the language localizer contrast. This approach produces a set of 'parcels' that can be used as masks to identify subject-specific functional regions of interest (fROIs). And second, we used pre-existing anatomical and multimodal brain atlases: the Glasser atlas (Glasser, et al., 2016), the Desikan-Kiliany-Tourville atlas (Klein, Tourville, 2012), and the Harvard-Oxford Cortical and Subcortical atlases (Desikan et al., 2006). In both approaches, subject-specific fROIs were defined within each GSS-based parcel or atlas-based anatomical area as the 10% of the voxels showing the strongest language response. Subsequently, we characterized all the language-responsive fROIs by examining their response to (i) the reading language localizer task (reading sentences vs. nonwords; n = 706; here, we used across-runs cross-validation to ensure independence between the data used to define the fROIs vs. to examine their responses), (ii) an auditory language localizer task (listening to intact vs. acoustically degraded passages; n=116; Malik-Moraleda, Ayyash et al., 2022); and (iii) a spatial working memory task (remembering more vs. fewer locations within a grid; n=422), commonly used as a localizer contrast for the domain-general Multiple Demand network (e.g., Assem et al., 2020). Our analyses replicate previous findings showing robust engagement of a left-lateralized fronto-temporal network in language processing. Critically, we identified a set of additional language-responsive areas, including areas in the medial superior frontal cortex, in the precuneus, and on the ventral temporal surface, as well as several right-lateralized cerebellar regions. The analysis of subcortical regions revealed responses to language within the hippocampus, amygdala, caudate, and thalamus. Many of these areas show responses during both reading and listening to language and selectivity for language relative to demanding non-linguistic tasks. The GSS and atlas-based analyses yield largely convergent results. This work lays the foundation for systematic characterization of the language-responsive areas beyond the core network. Understanding the contributions of these additional language-responsive brain areas can help paint a more complete picture of language processing, including how the core language areas may interact with non-language-selective systems underlying perception, motor control, and cognition.

B62 - Semantic Processing in Deaf Readers: An EEG Study on Verb Constraint and Contextual Integration

Yan Wu[1], Yunxiao Bai[1], Jie Chen[1], Suiping Wang[2]; [1]Northeast Normal University, [2]South China Normal University

This study utilized electroencephalography to investigate verb constraint and sentence context processing in deaf readers. The verb constraint conditions involved verb-object congruency or violation, while the contextual situation included critical words' congruence or violation with prior context. ERP analyses indicated that hearing participants displayed N400 and P600 responses to contextual violation, whereas deaf participants exhibited only N400 responses. Time-frequency analyses showed increased theta power in hearing participants in responses to contextual violation, which was absent in deaf readers. Both groups, however, demonstrated similar N400 responses to verb constraint violation. Furthermore, correlation analysis revealed N400 response to contextual violation significantly correlated to text reading fluency in deaf individuals. These findings imply deaf readers, despite challenges in integrating sentence context, possess comparable abilities to hearing individuals in processing content words, i.e. verb-imposed semantic constraints. Notably, the online semantic processing of deaf readers predicts their reading proficiency, highlighting the importance of semantic processing.

B63 - The Relationship Between Brain Structure and Function During Novel Grammar Learning Across Development

Nina K. Wyman[1,2], Merel E.E. Koning[1], Willeke M. Menks[1,4], Clara Ekerdt[1], Guillén Fernández[1], Evan Kidd[4,5,6], Kristin Lemhöfer[1], James M. McQueen[1,4], Gabriele Janzen[3,4]; [1]Donders Institute for Brain, Cognition and Behaviour, Radboud University and Radboud University Medical Center, [2]Utrecht University, Utrecht, The Netherlands, [3]Behavioural Science Institute, Radboud University, [4]Max Planck Institute for Psycholinguistics, Nijmegen, [5]ARC Centre of Excellence for the Dynamics of Language, Australian National University, [6]School of Literature, Languages, and Linguistics, Australian National University

Age is an important factor for second language learning success. When people start learning a second language in early childhood the path towards proficiency is typically easier and more successful. Though, the ability to master some components of a second language, such as grammar declines with age. The exact timing of this decline in language learning abilities remains uncertain, however it seems to occur between childhood and adolescence. To uncover the neural mechanisms responsible for this developmental shift a recent large scale fMRI study by Menks et al. (2024) explored the effect of age on grammar learning ability and its neural underpinnings. In that study, 165 Dutch-speaking individuals (8–25 years) implicitly learned Icelandic morphosyntactic rules and performed a grammaticality judgment task (GJT) in the MRI scanner. Behaviorally, GJT performance increased steadily from 8 to 15.4 years, after which age had no further effect. Neurally, this age-related GJT performance was related to differential activation levels in working-memory and grammar-related brain areas. The current study follows up on those results by exploring the structural brain data collected during that study (N = 159). We use voxel-based morphometry and regression analyses to investigate changes in gray matter structure across development related to novel grammar learning. Our results show that cortical gray matter volume and cortical thickness were negatively related to age, consistent with the developmental literature. Hippocampal volume was positively related to age-related GJT performance and L2 (English) vocabulary knowledge. Moreover, GJT performance, L2 grammar proficiency and L2 vocabulary knowledge were positively related to gray matter maturation within parietal regions. This structural result were compared to the functional results reported by Menks et al. (2024), which show the parietal regions overlapping with the fMRI clusters that showed increased brain activation in relation to grammar learning. Thus, by combining results from different imaging modalities collected from a large developmental sample we found that age-related change in language learning ability is associated with gray matter changes and brain activation in parietal regions, which may suggest that brain maturation in the parietal lobes plays an important role in second language learning, and novel grammar learning specifically.

B64 - School-aged children with dyslexia showed disrupted adaptation to words in temporal and frontal - but not visual - language network

Marek Wypych[1], Marta Wójcik[2], Katarzyna Jednoróg[2], Agnieszka Dębska[2]; [1]Laboratory of Brain Imaging, Nencki Institute of Experimental Biology, Polish Academy of Sciences, [2]Laboratory of Language Neurobiology, Nencki Institute of Experimental Biology, Polish Academy of Sciences

Reading impairments in dyslexia may result from disrupted neural rapid adaptation in language-specialized brain regions upon repeated stimulus presentation (Glezer et al., 2019). In adults with dyslexia the disrupted adaptation to phonological properties was shown in the left temporoparietal cortex (TPC) but not in higher-level visual area (VOT, Glezer, 2019). However other studies on adults and children with dyslexia showed disrupted adaptation in both orthographic and auditory domains (der Mark et al., 2009, Gertsovski & Ahissar, 2022) also regardless of the stimuli's properties (linguistic or non-linguistic), which would suggest a general neural adaptation deficit in dyslexia (Perrachione et al., 2016). Our study aimed to examine adaptation patterns for orthographic and phonological processing in children with dyslexia (DYS; n = 34) in comparison to typical readers (CON; n = 43) aged 9.7 to 13.18 years. Groups did not significantly differ in sex, age, non-verbal IQ and a socio-economic status. In the fMRI Rapid Adaptation task we repeatedly presented words that shared phonology but differ in orthography (HOMOPHONES, e.g., "pear" – "pair"), shared both (SAME, e.g., "pear" – "pear") or differed in both (OTHER, e.g., "pear" – "game"). Additionally, an oddball task was created for attention control: children were asked to press the button every time they saw a word containing "TA" syllable in any position of the word. We localized region of interests within the left VOT and TPC individually for each participant using a functional localizer task with visual (words, consonants, false fonts) and auditory tasks (words, consonants, words played backwards). Results in the attentional oddball task did not show CON-DYS differences (CON (M = 84%) and DYS (M = 82%)). Region of interest analyses test with linear mixed models revealed disrupted general adaptation for words (OTHER - SAME) in the left temporal area (TPC) in DYS compared to CON, while adaptation in a higher-level visual region (VOT) remained intact in both groups. Whole-brain analysis identified higher activations in CON than DYS in the left inferior frontal gyrus for orthographic processing (HOMOPHONE - SAME), with no whole-brain differences for phonological-specific processing (OTHER - HOMOPHONE). Overall, our findings confirm that school-aged children with dyslexia exhibit disruptions in neural word adaptation within language-related areas of temporal cortices for phonological and multimodal processing and frontal cortices for orthographic processing, while unexpectedly maintaining preserved adaptation to word forms in higher-level visual areas. Our results are partly in line with the study on adults with dyslexia (Glezer, et al., 2019) but in contrast to studies showing a general adaptation deficit in dyslexia (Perrachione et al., 2016).

B65 - Developmental differences in brain activation and functional network connectivity for Chinese handwriting: an fMRI study of children and young adults

Yang Yang[1,2], Huan Ren[1,2], Junjun Li[1,2], Hongyan Bi[1,2]; [1]Key Laboratory of Behavioral Science, Center for Brain Science and Learning Difficulties, Institute of Psychology, Chinese Academy of Sciences, Beijing, 100101, China, [2]Department of Psychology, University of Chinese Academy of Sciences, Beijing 100049, China

Introduction: Handwriting is a unique human skill that plays a crucial role in communication and academic achievement. The development of skilled handwriting requires a prolonged period to mature. Although various brain regions have been identified as being involved in handwriting, how the specific brain systems for handwriting are established remains largely unexplored, especially in logographic writing systems. This study addresses this question by investigating the neurodevelopment of handwriting in Chinese, a representative logographic writing

system. Methods: Using functional magnetic resonance imaging (fMRI), we examined regional brain activation and network-based functional connectivity during copying tasks of Chinese characters in 44 adults (aged 19–30 years) and 80 children (aged 9–13 years). Results: The results revealed that adults, compared to children, exhibited stronger activation in the right lingual gyrus, inferior/middle occipital gyrus, and left inferior parietal lobe, suggesting a functional specification of regional activation in visual and motor cortices associated with handwriting development. Furthermore, functional network analysis demonstrated that children, compared to adults, exhibited stronger global and local efficiency in a functional network, involving intranetwork connectivity within the sensorimotor network (SMN), visual network (VN), and default mode network (DMN), as well as internetwork connectivity between the VN and DMN. The increased network-based connectivity in adults may reflect the robustness and stability of large-scale functional networks supporting skilled handwriting. Alternatively, the differential activation and functional connectivity between children and adults might reflect a decline in brain functional efficiency due to reduced handwriting practice in adulthood. Conclusion: This study is the first to identify changes in regional activation and functional network connectivity associated with the development of handwriting in a logographic writing system. These findings advance our understanding of the neurodevelopment involved in skilled cognitive and motor functions. Keywords: Handwriting, Chinese, fMRI, regional activation, functional network connectivity

B66 - Altered Theta and Beta Oscillations in EEG of Children with ADHD during Naturalistic Story Comprehension

Ruo-Chi Yao[1], Chun-Hsien Hsu[1], Hsin-Chi Wu[2,3]; [1]National Central University, Taoyuan, Taiwan, [2]Taipei Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, New Taipei City, Taiwan, [3]School of Medicine, Tzu Chi University, Hualien, Taiwan

Resting-state EEG studies on children with ADHD typically show altered brain oscillations compared to their typically developing peers. Unlike previous studies which focused on resting-state EEG, this study aimed to evaluate EEG oscillations during an auditory story comprehension task and compare the brain activity in children with ADHD to that of typically developing children. A total of 60 children (mean age = 83.1 months) were recruited, including 32 with ADHD (mean age = 84.8 months) and 28 typically developing (mean age = 81.2 months). Participants listened to 12 audio stories written for children. The mean duration of stories was 96.86 seconds. Following the stories, they were asked to distinguish between nouns they had previously heard ("old" items) and nouns that they had not heard in the stories ("new" items). The EEG data recorded during story comprehension were analyzed using the Hilbert-Huang Transform (HHT) which is an effective method for analyzing non-linear and non-stationary data. The analysis pipeline involves breaking the EEG data into consecutive 5-second epochs, removing epochs with artifacts, and applying HHT to calculate the power spectrum of each epoch. These spectra were then averaged by subject. Statistical analysis was performed using the cluster-based non-parametric permutation test to compare the spectral differences between children with ADHD and typically developing children. The findings indicated significant effects of group in the theta (6-7 Hz) and beta (25-30 Hz) frequency bands. Notably, the ADHD group showed increased power in both theta and beta bands compared to the control group. Additionally, analysis of the theta to beta ratio (TBR) showed a significant interaction between the sequence of the story and the group of subjects. While typically developing children maintained a consistent TBR throughout the task, children with ADHD demonstrated a significant increase in TBR in the latter parts of the listening tasks. This suggests that children with ADHD may face greater challenges with attentional fatigue or sustaining attention as the task progresses. For behavioral performance, typically developing children performed better in the old/new recognition task, indicating higher accuracy rates compared to children with ADHD. These results not only demonstrate altered brain oscillations in children with ADHD during auditory story comprehension but also suggest greater difficulties these children face in cognitive tasks compared to their typically developing counterparts. This study also highlights the potential of using HHT to analyze EEG data in settings that mimic real-life activities. Monitoring and interpreting EEG oscillations during such naturalistic activities could have significant implications in educational and clinical settings, aiding in the development of interventions to better support children with ADHD.

B67 - Predicting the auditory and language abilities of children with hearing loss using naturalistic stimuli-induced fNIRS signals

Yu Zhai[1], Xiangyu He[1], Kexin Jiang[1], Chunming Lu[1]; [1]State Key Laboratory of Cognitive Neuroscience and Learning & IDG/McGovern Institute for Brain Research, Beijing Normal University, China

Congenital hearing loss is a prevalent cognitive impairment affecting approximately 3 per 1000 newborns, resulting in severe deficits in auditory and language functions. While these children exhibit large variability in rehabilitation outcomes and struggle to achieve functional equivalence to their normal-hearing peers, it is crucial to have precise diagnosis and effective assessment of their auditory and language ability. Due to the challenges in measuring the brain functions from these children using traditional imaging techniques such as fMRI and EEG, there are no reliable neural markers established. To address these challenges, this study aimed to establish a novel approach in identifying the neural markers for children with hearing loss. In this study, fNIRS was used to measure brain functions from children under the age of six both with hearing loss (HL) and with normal hearing (NH), alongside their mothers, during a video watching task. The cortical regions covered the language processing system from low to high levels, including the bilateral sensorimotor and auditory cortex (SMAC), inferior parietal lobule (IPL) and prefrontal cortex (PFC). To systematically characterize the neural responses, we extracted three types of brain features: intrapersonal functional connectivity of children or mothers and the mother-child interpersonal neural synchronization (INS). Machine learning models were then employed to classify children between HL and NH and predict the auditory and language abilities of children

with HL based on these brain features. Our findings revealed that for children with hearing loss, auditory and language abilities were more accurately predicted using either mother's brain functional connectivity or mother-child INS compared to those derived from children's brain signals. Moreover, mother-child INS also demonstrated better predictive capability for the improvement in abilities of hearing-impaired children six months later. Additionally, the brain markers for classifying HL vs. NH children were found to be dissociated from those for assessing the abilities of children with HL. Specifically, maternal functional connectivity of the lSMAC-lSMAC exhibited better classification of HL and NH children but could not predict HL children's abilities, whereas the mother-child INS of the lSMAC-lIPL/rPFC and rSMAC-lSMAC displayed the opposite pattern. Therefore, maternal fNIRS signals induced by naturalistic stimuli could serve as reliable index to identify neural markers for classifying hearing deficits and assessing auditory and language abilities during recovery in children with HL. We proposed a "neural mirroring hypothesis", suggesting that mothers' brain function mirrors that of their children, offering a unique avenue for assessment when direct measurement of children's abilities may be challenging. These findings not only provide promising clinical markers for personalized diagnosis and prognosis in hearing-impaired children but also highlight the importance of early mother-child social interaction in supporting children's clinical rehabilitation. Keywords: Hearing loss children, Language development, Mother-child neural synchronization, fNIRS. Acknowledgements: This work was supported by the National Natural Science Foundation of China (62293550, 62293551, 61977008). Conflict of interest: The authors declare no competing financial interests.

B68 *Sandbox Series* - Covert Activation of Lexical tones in Mandarin-English bilinguals: evidence from MEG

Xindong Zhang[1], Judy D. Zhu[2], Paul F. Sowman[3,4], Xin Wang[1]; [1]Department of Linguistics, Macquarie University, [2]School of Psychological Sciences, Macquarie University, [3]School of Clinical Sciences, Auckland University of Technology, [4]Faculty of Medicine, Health and Human Sciences, Macquarie University

Lexical tone is a crucial cue constraining spoken word recognition in tonal languages. Wang et al. (2017) showed that Mandarin-English bilingual listeners co-activated both languages in a visual world paradigm, and that lexical tones were critical in cross-language activation and competition. Using the same set of stimuli in Wang et al (2017), we investigated the neural basis of cross-language competition and the role of lexical tones with Magnetoencephalography (MEG). Continuous recording with whole-head MEG was carried out during a picture-word matching task, where a target picture was displayed for 1000ms followed by an auditory word. Participants were required to indicate whether the word they heard matched (YES) or mismatched (NO) the picture via button-press. The picture remained on the screen until participants made a response. All the auditory words were monosyllabic English words, which consist of 35 easily imageable nouns as targets, each appearing on an equal number of matched and mismatched trials. The mismatch trials were allocated into four experimental conditions based on the phonological relationship between the Mandarin translation of an English auditory word and the name of a picture in Mandarin. Take the auditory word 'rain' (/yu3/ in Mandarin) as an example. In the Segmental + Tone condition, the Mandarin translation of the auditory word (e.g., rain) shared both phoneme and tone of the Mandarin name of the picture 'feather' (/yu3/ in Mandarin); in the Segmental condition, the Mandarin translation of the auditory word shared all phonemes but not tone with the Mandarin name of the picture 'fish'(Mandarin /yu2/); in the Rime condition, the Mandarin translation of the auditory word shared tone and vowels, but not the onset with the Mandarin name of the picture 'wheat' (Mandarin /gu3/); in the baseline, there is no phonological relationship between the word and picture ('bear'; Mandarin 'xiong2'). We hypothesize that the amplitudes of bilinguals' brain waveforms can be driven by varying types of phonological overlap between the target and picture (i.e., segment + tone overlap vs. only segments overlap vs. rime overlap vs. baseline) in brain areas related to lexical tone processing or language inhibition and conflict resolution (i.e., left inferior frontal gyrus, anterior cingulate cortex). Twenty participants' MEG data were collected, and preliminary analysis was conducted. Here, cross-language competition is driven by phonological overlap through covert lexical access to Mandarin, and lexical tone plays a crucial role in lexical activation. Thus, we predicted that the Segmental + Tone mismatch condition could elicit the largest brain activity compared with the other three mismatch conditions. Segmental condition and Rime condition may elicit similar brain amplitudes. So far, we have observed a significant difference between match trials and mismatch trials. We are currently conducting ROI-based analysis to compare across the four mismatch conditions. Wang, X., Wang, J., & Malins, J. G. (2017). Do you hear 'feather' when listening to 'rain'? Lexical tone activation during unconscious translation: Evidence from Mandarin-English bilinguals. Cognition, 169, 15–24.

B69 - Naturalistic sign language differently synchronizes frontotemporal language network and parietal areas in the brain.

Maria Zimmermann[1], Piotr Tomaszewski[2], Olga Kolosowska[3], Marcin Szwed[3], Marina Bedny[1]; [1]Johns Hopkins University, [2]University of Warsaw, [3]Jagiellonian University

Sign languages, which are perceived through the visual modality, offer important insights into the origins of language neurobiology. What aspects of the canonical 'language network' are modality independent and which are specific to audition vs. vision? Here we investigate this question by using fMRI to study comprehension of naturalistic stories. Naturalistic fMRI approaches offer complementary insights to controlled experiments, which have used single words or simple sentences and sometimes remove essential parts of sign languages, such as facial grammar and classifier constructions. Naturalistic fMRI opens a novel path for studying a broad range of linguistic processes, including the discourse process. Prior studies using controlled experiments find an activity for sign-language comprehension and production in frontotemporal networks (Emmorey, et al. 2020) However, there is also some evidence of increased superior parietal involvement in the production and

comprehension of spatial component of sign language (Emmorey, et al. 2021). Here, congenitally deaf native signers (n=20) viewed a naturalistic story in Polish Sign Language (PJM). The story was generated by a deaf native signer who interpreted Edgar Allan Poe's 'The Fall of the House of Usher.' The story contains rich structure at many levels of the linguistic hierarchy, from phonology to compositional syntax, semantics, and discourse. Following prior naturalistic fMRI work with spoken languages, participants viewed control stimuli, which were increasingly scrambled versions of the same story (Lerner, et al., 2011). A scrambled sentence condition removes discourse structure, while a scrambled words condition also interferes with sentence-level grammar. We also introduced a novel control condition: a meaningless story composed of pseudo-signs. To facilitate individua-subject analysis of language regions, the language network was localized in each deaf participant using a PJM language localizer experiment (Newman et al., 2015; Fedorenko, et al. 2010). Participants watched sentences in PJM and a perceptually matched control condition consisting of backward sentences overlaid upon each other, thus containing faces and movement but not interpretable. Both whole-cortex and individual-subject ROI analysis revealed synchrony for the intact story throughout the classic frontotemporal language network, bilaterally, including in inferior frontal and lateral temporal areas as well as the ventral occipitotemporal cortex. Frontotemporal areas showed higher synchrony for sentences than words and for words than the non-linguistic control condition, as in prior naturalistic story studies of spoken languages. By contrast, parietal cortices showed enhanced synchrony for stories than all other conditions. This pattern held when we focused specifically on language-responsive voxels in the parietal cortex. This evidence supports the hypothesis that parietal cortices play a unique role in discourse-level processing for sign languages, including processing of some classifier types (Emmorey, et al. 2021).

B70 - Time-Course in the Morphological Processing of Irregular Nominal Stems and Phi-Features in French

Gustavo Estivalet[1], Fanny Meunier[2]; [1]Federal University of Paraiba, National Council for Scientific and Technological Development, Brazil, [2]Université de Nice, Centre National de la Recherche Scientifique, France

Abstract: A consistent amount of evidence from research in language processing has shown that morphologically complex words are decomposed for lexical access and word recognition. In Romance languages, nominal inflection is typically characterized by the suffixes of gender (masculine or feminine) and number (singular or plural) (den Dikken, 2011). Then, it has been proposed that the activation of the of the morphosyntactic features from the inflectional morphemes is a necessary step for the full lexical access during word recognition (de Vega et al., 2010). Therefore, the two objectives of the present work were: i. Investigate the behavioral and ERP differences in the processing of gender and number suffixes in irregular nominal stems, and ii. track the EEG time-course in the processing of irregular nominal stems, exploring the single word processing without any kind of phonological, morphological, or semantic violations. Our hypothesis were i. differences in N400 or P600 related to gender and number morpheme processing, and differences in P2 and/or ELAN related to stem irregularity processing. For this purpose, twenty speakers of French as native language performed a lexical decision task on visual modality coupled with EEG. The experimental stimuli were manipulated in function of the type of nominal stem irregularity, and inflectional suffixes of gender and number as dependent variables: a. type (ami[0/e][0/s], locut[eur/euse][0/s], abrasi<f/ve>[0/s], nation<al/aux/ale/ales>), b. gender (MASC-FEM: ami[0]-ami[e]; locut[eur]-locut[euse]; abrasi<f>-abrasi<ve>; nation[aux]-nation[ales]), c. number (SING-PLUR: nation[al]-nation[aux]; nation[ale]-nation[ales]). All stimuli were controlled by means of frequency, length in number of letters and number of syllables, and phonological and orthographic neighborhood. As expected, the behavioral results presented a significant main difference of number and frequency, suggesting differences between singular and plural words, as well as between high and low frequency words .The EEG event-related potentials (ERP) yielded a significant difference in the N400 related to number inflection; plural words presented a N400 with greater amplitude and more left and anterior activation than singular words, suggesting the activation of specialized areas in the processing of the plural morphosyntactic feature. Also, the results showed a significant difference in gender processing in the ELAN and P600; both components presented greater amplitude and more left lateralized activations in the processing of the feminine morphosyntactic feature, reflecting specificity in the activation and integration of the gender suffix. These results suggest morphological decomposition in nominal inflection: first, the inflectional suffixes are decomposed; second, these functional morphemes activate the morphosyntactic features; third, the morphemes are recombined for lexical access (Fruchter & Marantz, 2015). Keywords: Morphological Processing; Irregular Stem; Phi-Features; Electroencephalography (EEG). References: de Vega, M., Urrutia, M., & Dominguez, A. (2010). Tracking lexical and syntactic processes of verb morphology with ERP. Journal of Neurolinguistics, 23(4), 400–415. https://doi.org/10.1016/j.jneuroling.2010.03.003. den Dikken, M. (2011). Phi-feature inflection and agreement: An introduction. Natural Language & Linguistic Theory, 29(4), 857–874. https://doi.org/10.1007/s11049-011-9156-y. Fruchter, J., & Marantz, A. (2015). Decomposition, lookup, and recombination: MEG evidence for the Full Decomposition model of complex visual word recognition. Brain and Language, 143, 81–96. https://doi.org/10.1016/j.bandl.2015.03.001.

B71 - Reading in English: German in childhood and Latin in adolescence

Arturo Hernandez[1], My V. H. Nguyen[1], Yinan Xu[1], Kevin Brown[2]; [1]University of Houston, [2]Oregon State University

To date, few studies have looked at the role of word etymology in lexical access. To fill this gap, we created a database of over 20,000 English words that included reaction times and other variables that are important for word recognition. Three different results will be presented. First, analysis of age of acquisition shows that early learned words have mostly Germanic origins whereas later learned words have mostly Latin origin. Second,

results from behavioral data reveal that etymology accounts for reaction times and accuracy during a word reading task in native and nonnative English speakers. Third, phonological network analyses revealed that the giant component (largest connected subgraph) had an overrepresentation of Germanic words. Furthermore, there was additional segregation into Germanic majority and Latin majority communities. Finally, Latin-based words, on the other hand, were in several smaller clusters. Taken together these findings support a bidialectal view of English in that Germanic words serve as the base of lexical processing starting in childhood and persist until adulthood. Implications for models of the behavioral and the neural bases of reading in English will be discussed.

Poster Session C

Friday, October 25, 4:30 - 6:00 pm, Great Hall 4

C1 - Decoding personal mental images with an fMRI model of sentence semantics

Andrew Anderson[1], Leonardo Fernandino[1], Bill Gross[1], Hernan Rey[1], Jeff Binder[1]; [1]Medical College of Wisconsin

People simulate personal experiences through imagination and understand descriptions of other peoples' experiences via language. Although both processes are anchored in experience, it remains unclear whether autobiographical simulations and language comprehension are encoded in common brain systems. For instance, automated meta-analyses and popular renditions of the brain's language or semantic network often exclude medial cortical zones that underpin autobiographical simulations, whereas other fMRI studies have implicated these medial cortices in encoding semantic features of language. However, demonstrating semantic feature encoding in medial cortices does not entail that the same features underlie the content of autobiographical imagery. We hypothesized that this would be the case and that the encoding of autobiographical-imagery and sentence semantics would overlap in a shared neural feature space. To test the above hypothesis, we reanalyzed a mental imagery fMRI dataset: Outside the scanner fifty participants read twenty generic scenario cues (e.g. party, exercising, wedding) and vividly imagined themselves personally experiencing each scenario. Because different people have different experiences, it was reasonable to expect that they would bring different mental images to mind for the same cue. Participants rated each mental image on 20 sensory, motor, affective, social, cognitive and spatiotemporal features of experience (0-6 scale). Participants then underwent fMRI as they re-imagined the same scenarios in random order on written prompt. Preprocessing produced a single fMRI volume for each mental image per person. We then evaluated whether participants' personal feature ratings could be decoded from the mental imagery fMRI data using a pre-trained cross-participant decoder built from a separate sentence reading fMRI data set. Such decoding would not be possible if autobiographical imagery and sentence semantics were encoded in separate neural systems or different feature spaces. The sentence fMRI data was collected from 14 different participants who read 240 sentences. The sentences were third person and 3-9 words long, e.g. "The child broke the glass". Sentence semantics were modeled via crowd-sourced ratings of the same 20 features above. The semantic feature decoder was trained using ridge regression to map the entire cross-participant sentence fMRI dataset to reconstruct the 20 crowdsourced ratings for corresponding sentences. We then applied the pre-trained semantic feature decoder to reconstruct personal feature ratings from fMRI scans of mental images. We found that: (1) 11/20 feature ratings could be reconstructed from fMRI data in "autobiographical" medial cortices. This was evaluated by computing the correlation between reconstructed and observed features. (2) The reconstructed features reflected individual-differences in participants' ratings. This was evaluated by selecting participant pairs and correlating their rating reconstructions with both their own and the other participants' observed ratings, then testing which correlation coefficient was greatest. Participant pairs were discriminated with 70% accuracy, p<1e-4 (permutation test). Repeating this with individual feature vectors revealed that social- and speech-related features contributed most to discrimination. These results: (1) Indicate that experiential content of language semantics is encoded in the same cortical areas with the same representational codes as autobiographical simulation. (2) Demonstrate "zero-shot" decoding of personal mental states from fMRI data.

C2 - Temporal predictions guide attention to linguistically focused words during spoken language comprehension.

Eleonora Beier[1], Assaf Breska[2], Lee Miller[1], Yulia Oganian[3], George R. Mangun[1], Tamara Y. Swaab[1]; [1]University of California, Davis, [2]Max Planck Institute for Biological Cybernetics, [3]University of Tübingen

Introduction. Spoken language rapidly unfolds over time. Listeners are thought to predict the timing of upcoming critical information, pre-allocating attention to those points in time to facilitate processing. However, to date the field has mostly focused on temporal prediction via oscillatory entrainment to the rhythmic patterns of speech. Less is known about whether non-rhythmic linguistic cues guide attention to the timing of relevant upcoming information, similarly to cue-based temporal predictions for single intervals observed in non-linguistic studies. Prior behavioral research suggests that linguistic focus cues may direct attention towards upcoming focused words, leading to faster reaction times and greater memory recall (Cutler & Fodor, 1979; Beier & Ferreira, 2022). Here, we test the hypothesis that these linguistic focus cues guide attention through non-rhythmic temporal prediction, by measuring EEG neural dynamics associated with attention pre-allocation. Method. Data was collected for forty right-handed, native English speakers with no hearing or language impairments. Stimuli consisted of 80 question-answer pairs. On each trial, participants heard either an Early Focus question ("Which man was wearing the hat?") or a Late Focus question ("What hat was the man wearing?"), focusing either an Early Target or a Late Target word in the following sentence ("The man on the CORNER was wearing the DARK hat"; target words in all caps). Participants were instructed to answer the question out loud at randomly presented filler trials (28% of total trials), to ensure that participants used the question to attend to each target word.

Memory for the target words was measured through a memory test at the end of each block of 18 trials. Results. Behaviorally, we replicate prior findings of greater memory recall for words focused by the preceding question. Event-related potentials (ERPs) time-locked to the onset of the Early and Late target words revealed a larger frontal negative component when the word had been focused, suggesting greater engagement of working memory resources. Critically, we performed a time-frequency analysis of oscillatory dynamics prior to the onset of each target word, as a function of focus. We find overall higher power in alpha oscillations at occipital electrodes during the auditory presentation of the stimulus relative to baseline, suggesting suppression of visual information in favor of auditory processing. This effect was larger for focused target words, consistent with greater attention pre-allocation leading up to the timing of upcoming focused information. Conclusions. Overall, these results suggest that temporal predictions based on linguistic focus cues guide attention towards the timing of upcoming focused information. These non-rhythmic temporal predictions provide a compelling alternative to the debated role of rhythm-based predictions through oscillatory entrainment.

C3 - The neural underpinnings of time comprehension: evidence from 85 left-hemisphere stroke survivors

Nicoletta Biondo[1,2], Maria V. Ivanova[2], Alexis L. Pracar[2], Juliana Baldo[3], Nina F. Dronkers[2,4]; [1]BCBL, Spain, [2]UC Berkeley, USA, [3]VA Northern California Health Care System, Martinez (CA), USA, [4]UC Davis, USA

People with post-stroke aphasia often struggle to convey temporal information through language. Many studies have focused on the inability of producing correctly inflected verbs (in sentences such as e.g., Tomorrow night the lady … will go to the movies), but time comprehension can also be impaired (e.g., Wenzlaff & Clahsen, 2004; Clahsen & Ali, 2009; Faroqi-Shah & Dickey, 2009; Jonkers & de Bruin, 2009). Crucially, previous studies have investigated time comprehension impairment just behaviorally, by grouping small cohorts of patients based on aphasia type. In this study, we conducted lesion-symptom mapping (LSM) and indirect structural disconnection analyses focusing on the time comprehension abilities of 85 left-hemisphere stroke survivors. To our knowledge, no lesion-symptom mapping study has ever investigated time comprehension. However, based on previous fMRI studies on the comprehension of inflected verb forms by unimpaired individuals (e.g., Tyler et al., 2005; Wright et al., 2011) we expected parts of the left temporal (superior and temporal gyri, MTG and STG) to be involved during time comprehension. Time comprehension abilities were assessed through specific subtests of the CYCLE-R test (Curtiss & Yamada, 1988). In the subtests, participants heard sentences that included a past, present, or future tense verb phrase (e.g., The boy will pour the juice) and had to select the matching picture among 3 line drawings depicting past, present, and future actions (e.g., a boy about to pour juice in a glass; a boy pouring juice; a boy done pouring juice). Neural correlates of successful time comprehension were assessed using univariate LSM with lesion size, age, education, and time post-stroke as covariates (Ivanova et al., 2021). The role of white matter integrity was assessed through correlation analyses (Bonferroni-corrected alpha = 0.0038) between performance in the behavioral test and tract-level disconnection severities calculated via Indirect Structural Disconnection Mapping (Lesion Quantification Toolkit, Griffis et al., 2021). Results of the LSM analysis identified the left mid to posterior MTG and posterior superior temporal sulcus (STS) as crucial for successful time comprehension. Correlation analyses showed that time comprehension was affected by the disconnection of the inferior longitudinal fasciculus in the left hemisphere and corpus callosum (posterior division). Findings from this study provide novel evidence on successful time comprehension relying primarily on spared left posterior temporal regions (STS, MTG) and underlying white matter pathways. These findings also support accounts proposing the involvement of the STS for the processing of complex phenomena such as syntactic ambiguity or anaphora resolutions (e.g., Matchin & Hickock, 2020; Hagoort, 2013) that, similarly to time processing, lie at the interface between syntax and semantics.

C4 - Revisiting the assumption of homotopic transcallosal suppression in language

Tali Bitan[1,2]; [1]University of Haifa, Israel, [2]University of Toronto, Canada

The interactions between the two cerebral hemispheres and their implications for language performance have been the focus of interest in numerous studies. One popular model is that of transcallosal suppression between homotopic regions in the two hemispheres. This model has first emerged from the domain of spatial attention (Kinsbourne, 1982), and was adopted into the language domain to explain the increase in right hemisphere (RH) involvement after left hemisphere damage in aphasia, as a result of release from transcallosal suppression (Heiss et al. 2003). This assumption gained popularity following evidence that patients' language performance improved after neuromodulatory suppression of their RH language homologs (Naeser et al. 2005). However, while these findings have alternative interpretations, there is no direct neuroimaging evidence for transcallosal suppression in the language network, like there is in the motor domain (Gerfkes et al. 2008). Here we show functional connectivity results from four fMRI studies in healthy children and adults, and post-stroke patients with aphasia, using a variety of tasks and languages, showing no evidence for transcallosal suppression, but rather excitatory connections, among homotopic language areas. In study 1 (Bitan et al. JNS, 2010) children (9-15) were scanned during performance of a rhyming task on pairs of spoken English words. Effective connectivity analysis showed reciprocal excitatory connectivity between left and right superior temporal gyri. The strength of this connectivity was modulated by word type, and was negatively associated with language abilities in females, but showed no inhibition. In study 2 (Mizrachi et al. Cortex, 2024) adults were scanned during performance of semantic relatedness judgment of ambiguous and unambiguous written Hebrew words. Effective connectivity analysis showed reciprocal excitatory homotopic connections between left and right inferior frontal gyri (IFG) pars opercularis and pars orbitalis for unambiguous words. Moreover, these connections were

modulated by word type in ambiguous words, and differentially contributed to performance, but in no case was there inhibition between homotopic regions. In study 3 (Mizrachi et al. unpublished) adults were scanned during rest, after learning a set of novel words. Resting state functional connectivity in the language network showed excitatory connectivity between bilateral homotopic regions including IFG opercularis and triangularis, superior and middle temporal gyri. No inhibitory connectivity was found between homotopic regions. In study 4 (Chu et al. Cortex, 2018) healthy adults and post-stroke patients with aphasia were scanned during performance of a semantic sentence judgment task. Effective connectivity results showed no connectivity between right and left IFG in neither patients nor healthy controls, with excitatory right to left connectivity in primary auditory cortex correlated with language outcome. Altogether these results, drawn from a variety of tasks, as well as rest, in varied populations, do not support the popular assumption that left hemisphere language areas suppress their right homologs during rest or during task performance. There is also no evidence of suppression in the other direction in left-hemisphere stroke patients. In contrast interhemispheric homotopic connections in the language network are excitatory during rest and during some tasks, and this excitatory connectivity is contributing to language performance.

C5 - Neural bases of speech categorization sensitive to articulatory perturbation

Olivia Bizimungu[1], Lucie Ménard[2], Sylvain Baillet[1]; [1]McGill University, [2]Université du Québec à Montreal

Despite large acoustic variability between spoken utterances, our brains rapidly transform sound waves into meaningful phonetic categories. This process of categorical perception facilitates our understanding of speech in challenging listening environments, although it is itself sensitive to context contingencies. Numerous studies have demonstrated that perturbing speech articulators, such as the lips, tongue, and jaw, during active listening modifies the auditory-to-perceptual mapping of sounds produced using the affected articulator (Ito et al., 2009, Möttönen & Watkins, 2009). This phenomenon suggests that sensorimotor articulatory representations may play a role in the perceptual processes underlying speech categorization, even in the absence of overt articulation. While the involvement of sensorimotor systems in speech and other types of auditory perception has been documented, the underlying neurophysiological mechanisms remain to be elucidated. We recorded magnetoencephalographic (MEG) brain responses from 17 healthy, young adults (mean age = 22.29 years, SD = 3.70; 13 women) as they classified sounds from an acoustic continuum synthesized between the vowels /u/ (small lip area) and /œ/ (large lip area). Participants performed the task both at baseline and while holding a 2.5cm tube between the lips, intended to expand their lip aperture (mimicking the production of /œ/). We trained MEG signal decoders using a support vector machine (SVM) design to predict the phonetic category that participants assigned to each speech sound on a single-trial basis from the corresponding MEG recordings. The SVM classifier successfully predicted behavioral responses with an accuracy of up to 65%. The SVM decoders were trained exclusively on trials corresponding to stimuli with a clear phonetic identity, specifically the continuum endpoints. When applied to intermediate stimuli along the phonetic continuum, we found that SVM predictions closely mirrored participants' perceptual reports. The decoding probability of /œ/ increased across the phonetic continuum, correlating significantly with psychometric response curves ($r = .61$, $p < .001$). We then investigated whether the decoders would generalize in the presence of the articulatory perturbator. Outcomes of trials performed with the articulatory perturbation were better predicted by models trained on data collected under the same perturbation condition than by models trained on baseline (non-perturbation) data ($p = .048$), and the reverse was true for trials performed without perturbation ($p = .043$). This experiment demonstrates that the brain processes underlying categorical speech perception are sensitive to sensorimotor perturbations, even in the absence of overt speech production. We interpreted the decoders' weights applied to the MEG sensor data (N=272) and found that the brain regions with greater importance in phonetic decoding included the primary auditory cortex and superior temporal sulcus, and to a lesser degree, the inferior frontal gyrus, pre- and post-central gyri, and the temporo-parietal junction. Taken together, our data contribute to clarifying categorical speech perception processes, demonstrating that they emerge rapidly across multiple brain regions involved in language processing. Future analyses will determine whether internal, articulatory representations, primarily involving sensorimotor brain regions, modulate perceptual processes and contribute to altered phonetic perception due to articulatory perturbation.

C6 - Predictive Language Processing in Preschool Children: Naturalistic EEG Data Reveal Individual Differences in Surprisal Effects

Ina Bornkessel-Schlesewsky[1], Sophie Jano[1], Chloe Dziego[1], Imogen Weigall[1], Jonathan Kum[2], Jerome Mak[2], Brian Caswell[3], Matthias Schlesewsky[1]; [1]University of South Australia, [2]MindChamps PreSchools, Singapore, [3]MindChamps Applied Integration Research (AIR)

Predictive coding is a prominent contemporary theory of brain function, positing that the human brain actively generates predictions about its sensory input. Through its unified account of human information processing across a range of cognitive domains, it provides a parsimonious explanation for language processing. In addition, predictive-coding-based approaches are appealing for the neurobiology of language, since there are detailed proposals regarding their neurobiological implementation. There has been considerable discussion about the possible relation between predictive coding and neurophysiological correlates of language processing like the N400. However, considerably less is known about how predictive processing matures during language acquisition, particularly under ecologically valid language processing conditions. Here, we examined predictive processing in preschool children using a naturalistic paradigm. We recorded EEG data from thirty-five children (mean age: 5:6; range: 4:8–6:4) as they performed music exercises in one-on-one sessions

with a teacher at a Singaporean preschool (language of instruction: English). Sessions lasted approximately 30 minutes and consisted of a structured sequence of successively more complex tasks targeting rhythm, pitch and melody. Resting-state EEG data was collected in a two-minute eyes-closed session prior to the main task. We calculated regression-based event-related potentials (rERPs) for the instructions provided by the teacher during approximately the first 5–6 minutes of the test session, using the onset of each word as a time-locking point (mean number of epochs: 593; range: 485-684). rERP predictors included prestimulus amplitude, log-transformed word frequency and GPT2-based lexical surprisal, taking the entire preceding session as the context window. We estimated individual peak alpha frequency and aperiodic activity (slope and offset) from the resting-state recordings. rERP data from 20 children (audio transcriptions are ongoing for the remaining 15 participants) revealed word frequency and surprisal effects in the N400 time window (300–500 ms post word onset), with most pronounced amplitudes over left-anterior channels. Linear regression analyses revealed larger surprisal effects for participants with higher aperiodic offsets even when age was controlled for. The current findings indicate that it is possible to examine predictive processing in preschool-aged children under highly naturalistic conditions. In addition, our results suggest that individual differences in the maturity of predictive language processing may correlate with resting-state metrics. The aperiodic offset is associated with aggregate population spiking activity and correlates with the fMRI BOLD response. Interestingly, previous developmental research has shown that aperiodic offsets decrease over the course of childhood development, in parallel to a flattening of the aperiodic slope (Hill et al., 2022). However, in younger and older adults, higher resting aperiodic offsets and steeper aperiodic slopes correlate with a higher adaptability of predictive models in response to novel language input (Bornkessel-Schlesewsky et al., 2022). Tentatively, in spite of the general age-based flattening of aperiodic activity, children with higher aperiodic offsets in comparison to their age cohort may be more sensitive to the predictability of language input. If this relationship is confirmed in future research, aperiodic metrics could potentially serve as age-independent predictors for the maturity of language processing.

C7 - Why does laughter make spoken words seem funnier?

Ceci Q. Cai[1], Nadine Lavan[2], Sinead H.Y. Chen[1], Claire Z.X. Wang[1], Ozan Cem Ozturk[1], Roni Man Ying Chiu[3], Sam J. Gilbert[1], Sarah J. White[1], Sophie K. Scott[1]; [1]University College London, [2]Queen Mary University of London, [3]City University of Hong Kong

Why does laughter make spoken words seem funnier? We previously found that adding laughter to jokes made the jokes seem funnier to participants, and the more spontaneous the laughter, the funnier it made the joke. The same effects were found in both neurotypical and autistic people. Human conversations are immersed in laughter, with spontaneous and conversational laughter carrying different socio-emotional meanings in daily interaction and various social contexts. Although we found that neurotypical and autistic adults process laughter in a similar way, similar behaviours between autistic and neurotypical adults can be underpinned by different patterns of brain activation. To explore the neural mechanisms underlying this, we used fMRI to study the implicit processing of different types of laughter, and the differences between autistic and neurotypical adults. To shorten the duration of scanning, we used funny words instead of jokes in this study. We asked autistic and neurotypical adults (comparable for age, gender and IQ) to passively listen to funny words, followed by spontaneous laughter, conversational laughter, or noise-vocoded vocalizations. Behaviourally, words presented with spontaneous laughter were rated as funnier than words presented with conversational laughter, for both neurotypical and autistic adults. Neuroimaging results indicated an increased widespread activation when the funny words were presented with laughter compared to the presentation of single spoken words. Specifically, we found increased activation in the mPFC for neurotypical adults during implicit processing of words presented with conversational laughter than spontaneous laughter, but this difference is not found in autistic adults. Additionally, autistic adults showed greater activation in the SMA, a part of the sensorimotor cortex, when listening to words presented with either type of laughter. The study also identified a role for the precuneus in the interaction of words and laughter. Together, these findings suggest the critical roles of the mPFC, sensorimotor cortex and precuneus in the implicit processing of laughter and words, emphasizing a role for mentalizing in understanding laughter. This study sheds light on the complex interplay between spoken language and laughter, enhancing our understanding of how laughter serves both as an emotional expression and a sophisticated social signal during social communication.

C8 ***Sandbox Series*** - Readers Extract Some Grammatical Information In A Single Fixation, Across Sentence Structures

Dustin A. Chacón[1], Donald G. Dunagan[2], Tyson Jordan[2]; [1]UC Santa Cruz, [2]University of Georgia

The visual system can extract detailed information extremely rapidly (e.g., Huang & Staub 2024). Short sentences seen for 200ms ('the man can run') are recalled more accurately than ungrammatical, scrambled counterparts ('run can man the') (Snell & Grainger 2017); and evoke greater activity in language regions 200–400ms (EEG: Wen et al. 2019; Dunagan et al. 2024; MEG: Dufau et al. 2024; Flower & Pylkkänen 2024). This 'Sentence-Superiority Effect' (SSE) may diagnose rapid, parallel language processing. But, these experiments involve many trials, often comparing a small number of sentence types against many ungrammatical contrasts. Our question: Does the SSE depend on habituation to specific visual stimuli (i.e., 'the noun aux verb') in the experimental context? Or, does the SSE arise even if participants don't know which structures to expect? [METHODS] [Materials] We built a context-free grammar (CFG) that generated 17 5-word sentence types, with a vocabulary of 10 words (3–6 letters) per lexical category. We generated every lexicalization that did not repeat words, then generated every 2-word transposition and reversal of each sentence, excluding permutations that resulted in grammatical sentences. From this distribution (~950 million stimuli), we sampled without

replacement 170 grammatical (10/type), 147 transposed, and 160 reversed sentences per subject. [Procedure] Sentences were displayed for 300ms, centered on a screen, followed by a 500ms blank screen, then followed by a probe sentence. Participants judged whether the sentences matched. EEG data were recorded with a 128ch BrainVision actiChamp+ system. [RESULTS] [Behavioral] Participants were more accurate for Grammatical vs. Reversed trials ($p < 0.001$; 85.4% vs. 81.0%), but not for Grammatical vs. Transposed trials ($p = 0.19$; 85.4% vs. 83.3%). [EEG] Spatio-temporal cluster-based permutation tests on sensor data (800ms epochs), comparing Grammatical vs. Reversed and Grammatical vs. Reversed vs. Transposed did not yield any clusters. We then conducted RSA analyses, constructing representational dissimilarity matrices (RDMs) for surprisal values and syntactic categories of each word, frequency and semantic association for each bigram, and internal parser states of a bottom-up chart parser using the CFG, quantifying the length of each phrase in the most complete analysis. We conducted an RSA searchlight analysis (50ms, 30mm) for each predictor for each subject, then conducted group-level t-tests to determine which correlations differed from 0, in a broad 'SSE' time window (100–500ms). Significant correlations were identified between the RDM for word 2-word 3 semantic association ($p = 0.02$), 100–217ms; word 2 surprisal ($p < 0.05$), 190–500ms in right parietal sensors and word 3 surprisal ($p = 0.03$), 320–500ms in frontal sensors; and VP length, 120–388ms in posterior sensors. Marginal correlations were observed for syntactic categories of word 1, 227–500ms ($p=0.11$), and word 2, 187–419ms ($p=0.08$), in right lateral sensors, and object NP length, 128–346ms ($p = 0.08$) in posterior sensors. [CONCLUSION] With only 300ms presentation time, readers' brain activity suggests they extract semantic and syntactic features of words 1–3, which likely fall near the foveal center. We provide further evidence of rapid activation of grammatical information in short fixations, with unanticipated sentence structures, and without a neural 'SSE'.

C9 - Unraveling reading comprehension in Chinese ADHD: insights from individual fixation-related potentials analysis

Pei-Chun Chao[1], Jou-An Chung[1,2], Jie-Li Tsai[3], Chia-Ying Lee[1,2,3]; [1]Academia Sinica, Taiwan, [2]National Central University, Taiwan, [3]National Chengchi University, Taiwan

Successful reading comprehension requires multiple cognitive processes, such as retrieving a word's orthographic, phonological, and semantic information, maintaining and integrating it into working memory, constructing contextual information, and predicting subsequent words to promote comprehension. While people with Attention Deficit/Hyperactivity Disorder (ADD / ADHD) can decode words, their sustained attention deficits, limited working memory, and inhibition problems may hinder reading comprehension. However, existing evaluation methods heavily depend on subjective observation and standardized paper-and-pencil literacy tests, failing to identify the specific cognitive deficits underlying the reading comprehension difficulties in ADD/ADHD. This study simultaneously recorded eye movements and fixation-related potentials (EMFRPs) to objectively assess online reading comprehension in adults with ADD or ADHD. Previous research has used the effects of word frequency and predictability on N400s to evaluate the capacity for retrieving lexical information and contextual processing during reading comprehension. Therefore, we collected a normative EMERP database from forty-seven college students with normal reading ability, who read 2504 words across twenty-two articles in traditional Chinese. Each word's predictability was estimated using a cloze test with 32 readers, and its frequency was calculated as log-transformed occurrences per million from the Academia Sinica Corpus of Contemporary Taiwan Mandarin (ASCCTM). Linear mixed-effects models (LMMs) were applied to single-trial fixation-related potentials (FRPs). The word predictability effect and its interaction with frequency (WP*WF) occurred on N400s between 375-475ms in central-parietal regions. The reduction in N400 amplitude with increasing predictability was observed only for infrequent words, indicating that most adults can efficiently use contextual clues to comprehend unknown words. This study further assembled the EMFRP data in four adults with ADHD and another four with ADD. The ADHD group showed a significant WF effect but null WP and WP*WF effects in the frontal electrodes between 425-525 ms. Evidence suggests that although people with ADHD retain intact word decoding skills, they struggle to integrate contextual information for prediction. On the other hand, the ADD group demonstrated the delayed and frontal shifted WP effect and WP by WF interaction on N400, implying a more demanding reading comprehension process. These findings suggest differential cognitive deficits in vocabulary retrieval and contextual prediction for reading comprehension in ADHD and ADD. Additionally, these variations in WF, WP, and WP*WF effects on N400s can be estimated in individual EMFRP data. Through EMFRP profiles, we can uncover distinct reading processes and effectively evaluate the reading proficiency of people with ADD and ADHD.

C10 - Exploring grammatical aspect impairment in French-speaking people with aphasia: insight from different tasks and cognitive predictors

Natacha Cordonier[1], Marion Fossard[1]; [1]University of Neuchâtel, Neuchâtel, Switzerland

Introduction. Verbal inflection is often impaired in people with aphasia (PWA), with aspect – expressing event completeness – particularly vulnerable (e.g., Fyndanis et al., 2012). Surprisingly, aspect remains underexplored in this population, with limited investigation beyond the Greek and Russian languages and inconsistent findings (Dragoy & Bastiaanse, 2013; Fyndanis & Themistocleous, 2019). Factors that may contribute to this inconsistency include language specificities, the conflation of tense and aspect within tasks, and the use of different tasks that potentially engage distinct cognitive processes (Fyndanis & Themistocleous, 2019; Nanousi et al., 2006). Therefore, the present study aimed to clarify aspect impairment in French-speaking PWA across different tasks, taking into account underlying cognitive mechanisms. Methods. Twenty-one French-speaking participants with fluent and non-fluent aphasia and twenty-one matched healthy controls (HC) completed three tasks manipulating aspect (perfective for a completed event versus imperfective for an ongoing event) while maintaining

stable tense (past tense). Task 1 (T1) required producing inflected verbal forms in a perfective or imperfective past tense according to a temporal adverb (e.g., "Eat - Last Monday, the boy___in ten minutes" - expected: ate). Task 2 (T2) included a first source sentence with an aspectual frame differing from that presented in a subsequent gap sentence (e.g., "In two weeks, the girl has read stories once. Write - For the past month, she____ poems every day" - expected: wrote). Task 3 (T3) involved completing gap sentences with a specified aspectual frame, using forced-choice temporal adverbs (e.g., "___, the boy walked until noon"; forced choices: last Tuesday or every Tuesday). Participants also underwent standardized tests assessing verbal and nonverbal working memory, flexibility, and inhibition. Generalized linear mixed models analyzed performance on each task, with groups (PWA, HC) as a fixed effect, and for PWA performance, aspect (perfective, imperfective) and cognitive variables as fixed effects. Results. Likelihood ratio tests revealed group effects in all three tasks, with poorer performance in PWA (T1: $\chi2(1) = 46.14$, $p < .001$; T2: $\chi2(1) = 14.63$, $p < .001$; T3: $\chi2(1) = 18.01$, $p < .001$). Among PWA, an aspect effect, with poorer performance for the imperfective, was found only in T1 ($\chi2(1) = 5.34$, $p < .03$). Results for the cognitive predictors showed a significant effect of working memory on T1 ($\chi2(1) = 6.08$, $p < .02$), inhibition on T2 ($\chi2(1) = 3.92$, $p < .05$), and a marginally significant effect of nonverbal working memory on T3 ($\chi2(1) = 3.32$, $p = .069$). Discussion. Our results confirm aspect impairment in PWA (e.g., Dragoy & Bastiaanse, 2013) and extend it to French for the first time. They also reconcile previous findings, suggesting that tasks assessing aspect may involve different cognitive processes, such as the inhibition of a previous aspectual frame or the involvement of nonverbal working memory in forced-choice tasks. Notably, the aspect effect was observed only in T1, which was associated with working memory. This suggests that tasks that sufficiently tax verbal working memory are more likely to reveal an aspect effect, as demonstrated for tense (Cordonier et al., 2024).

C11 - Frequency-based category learning in the brain and behavior

Davide Crepaldi[1], Mara De Rosa[1], Elena Greatti[1,2], Claudia Ruzza[1], Maria Ktori[1]; [1]International School for Advanced Studies (SISSA), Trieste, Italy, [2]International School of Advanced Studies (ISAS), Camerino, Italy

The highly sophisticated structure of human language generates statistical regularities in the linguistic signal, which can potentially be captured to reverse-engineer the underlying system. One prominent example is the distinction between content and function words; since the latter are substantially more frequent than the former, sensitivity to the number of encounters with each word might potentially underlie the acquisition of this categorical distinction. De Rosa, Ktori, et al. (2022) devised a Fast Periodic Visual Stimulation (FPVS) paradigm that, coupled with EEG, tracks frequency-based category learning at the neural level. Skilled readers were shown sequences of stimuli at a fast rate (6Hz). An arbitrary subset of stimuli was shown less frequently, once every five higher-frequency items (6/5=1.2Hz). Hence, stimuli differed only in terms of their relative frequency within the stream. In one original (N=41) and one self-replication (N=43) experiment, we asked whether this neural grouping surfaces in behavior. Frequency-domain EEG analyses revealed robust neural responses to the oddball frequency, thus replicating De Rosa, Ktori et al. (2022). This effect also emerged with non-linguistic stimuli, showing that the mechanism is not language-specific. Despite the strong neural signal, participants' memory for frequent and infrequent items was indistinguishable. These data raise important questions about the nature of frequency-based neural grouping, and particularly the conditions that render such grouping consistent and durable over time. In a second set of experiments, we checked whether the FPVS signal interacts with a concurrent task. In a first study (N=39), we engaged participants in a 3-back color matching task while they were concurrently presented with the FPVS stream in the background. This stream was either random; or statistically structured, so that it would induce neural grouping. If grouping attracts attention/cognitive resources, we would expect performance in the 3-back matching task to be worse in this latter condition. Conversely, in a second study (N=40), we varied the attentional demand of the main task – a simpler color change detection vs. a more demanding 3-back color matching – to examine its effects on the capture of statistical regularities in the FPVS stream. The findings indicate that neural grouping is largely independent of attentional load and/or cognitive demand. We discuss these data in the context of the debate regarding the connection between statistical learning and language processing. In the era of large language models, there are suggestions that language structure can be learned simply based on language-agnostic algorithms that are sensitive to probabilistic regularities in the linguistic signal. Here we provide a new look into this question, based on cognitive skills rather than on the performance of AI. We show that the brain does feature non-linguistic learning mechanisms that potentially underlie fundamental linguistic knowledge. There are, however, many open questions around the way that these mechanisms might unfold in the language learning process.

C12 - White matter architecture associated with speech production outcomes following surgical removal of brain tumours

Greig de Zubicaray[1], Kate Drummond[2], Emma Murton[2], Benjamin Ong[3], Rosalind Jeffree[4], Katie McMahon[1]; [1]Queensland University of Technology, [2]Royal Melbourne Hospital, [3]Princess Alexandra Hospital, [4]Alfred Hospital

Introduction: Brain tumours are associated with an increased risk of aphasia. Post-operative impairments may occur due to surgical removal of tissue, residual tumour or both.[1] Brain tumours may also result in destruction, displacement and/or deformation of adjacent white matter tracts due to their mass effect.[2] Using diffusion imaging fibre tractography, we explored whether the shape features of 6 language tracts are associated with speech production outcomes post-operatively: arcuate (AF), uncinate (UF), frontal aslant (FAT), inferior longitudinal (ILF), inferior frontal occipital (IFOF) and third subdivision of the superior longitudinal (SLF-III) fasciculi. Methods: 39 patients who underwent surgery to remove a primary left-hemisphere

tumour 6 to 24 months previously were scanned with either single-shell high angular resolution diffusion imaging (HARDI; N = 24) or dual shell neurite orientation dispersion and density imaging (NODDI; N = 15) acquisition sequences. Language function was assessed with the Comprehensive Aphasia Test (CAT) which revealed 54% and 32% of patients, respectively, scored below the aphasia cutoff on the verb naming and spoken picture description subtests. Tract shape metrics (total volume, number of streamlines, curl, elongation, surface area, span, mean length and irregularity) were extracted using DSI Studio.[3] Acquisition-specific effects were harmonised using empirical Bayes estimation via neuroCombat,[4] with the parameters estimated from the unaffected right hemisphere applied to the left-hemisphere data. We performed exhaustive regression model searches to identify subsets of tract/shape metrics that predicted scores on the two CAT production tests, followed by k-fold cross-validation to select the best model to avoid overfitting. We then entered sex, age, education, WHO tumour grade and radiotherapy (treated vs. none) as control variables, followed by the best-fitting shape model in a separate step to determine their unique contribution to predicting performance. Results: 37% of the variance in verb naming was significantly predicted by tract features: performance was positively associated with AF volume, FAT curl and IFOF surface area, and negatively associated with IFOF volume, ILF curl and AF surface area. Conversely, 90% of the variance in spoken picture description was predicted by multiple tract features: Performance was positively associated with AF and IFOF volume, FAT and UF length, AF, IFOF, ILF and SLF-III curl, FAT surface area, IFOF, ILF and SLF-II span, and IFOF, ILF number of streamlines. Negative associations were observed with FAT volume, AF, ILF, SLF-III, and UF surface areas, AF and SLF-III number of streamlines, AF, IFOF and ILF length. Conclusions: These results illustrate the patterns of white matter tract architecture responsible for spoken language production outcomes following surgical resection of primary brain tumours. They extend previous reports of lesion deficits by revealing the tract characteristics associated with better outcomes, which may prove useful for prognoses and planning appropriate language therapies following surgery. References: [1] de Zubicaray, G. et al. (2023). Brain and language, 239, 105244. [2] Lucci, G., et al. (2022). Biomechanics and Modeling in Mechanobiology, 21(5), 1483–1509. [3] Swinburn, K., et al., (2004). NY: Psychology Press. [3] Yeh F. C. (2020). NeuroImage, 223, 117329. [4] Fortin, J. et al. (2017). NeuroImage, 161, 149–170.

C13 - From wordforms to meaning: understanding the neurobiology of word learning using experimental pain.

Natalia Egorova-Brumley[1], Marie Spehar[1], Bradford Moffat[1]; [1]The University of Melbourne

Abstract words, denoting ideas, qualities, or states such as courage, education, or pain, have been notoriously difficult to study due to the subjectivity and variability of their meanings across individuals. Yet, understanding how these words are represented in the brain once just learned would shed light on the extent to which their neural representations are disembodied in heteromodal language cortices or embodied in the physical experiences that comprise their meanings. Twenty-seven right-handed participants (8 male, mean age = 25.4 ± 6.7 years) studied 6 pseudowords and underwent behavioural testing and 7 Tesla magnetic resonance imaging the following day. The novel word learning paradigm in this study, which utilised experimental pain methods, enabled the creation of pseudowords with controlled meanings denoting painful and non-painful sensations. It involved the presentation of written pseudowords with heat stimuli of varying intensities applied to the arm and leg. Presenting only words in the scanner (previously learned and completely novel), we were able to delineate brain correlates of (a) wordform learning, by comparing novel pseudowords vs. learned pseudowords; (b) the effect of meaning, by contrasting pseudowords learned with and without meaning; and (c) the representation of specific semantic features (e.g., painful vs. nonpainful sensations to the arm vs. to the leg). Accuracy and reaction times on the semantic judgement task, as well as free recall task accuracy, confirmed that all the pseudowords were learned, further revealing significantly better learning for words with meaning vs. no meaning and better retention of words denoting pain, with no difference between leg and arm sensation words. All pseudowords demonstrated activation in the bilateral fusiform gyrus. Learned wordforms elicited increased activation in the left posterior superior temporal sulcus and the angular gyrus. Pseudowords paired with sensory/painful stimulation showed increases in sensory-motor and insula activation, while the leg and arm relatedness was encoded in largely overlapping regions in the superior frontal and parietal cortex. In addition to demonstrating that word meanings can be acquired from sensory contexts, these results provide preliminary evidence of rapidly emerging cortical activation consistent with abstract word meanings being both disembodied and embodied in sensory experiences.

C14 - Skilled deaf, but not hearing, readers exhibit neural tuning in the right Visual Word Form System

Karen Emmorey[1], Stephen McCullough[1], Brennan Terhune-Cotter[1], Laurie S. Glezer[1]; [1]San Diego State University

Neuroimaging studies indicate that successful visual word recognition relies on a hierarchical organization in left ventral occipitotemporal cortex in which neurons are tuned along a posterior-to-anterior gradient to increasingly complex word features (e.g. from oriented bars, to letters, to bigrams, etc.). The hierarchical nature and neural selectivity of this region, termed the 'visual word form system' (VWFS), appears to be specific to the left hemisphere in hearing adult readers. In addition, both hearing and deaf skilled readers exhibit selectivity to whole words in an anterior location of the VWFS, termed the visual word form area (VWFA). However, unlike skilled hearing readers, skilled deaf readers also appear to engage the right VWFA. Although recruitment of the right hemisphere has been implicated in poor reading for hearing people, this does not appear to be the case for skilled deaf readers. For example, the N170 ERP response to printed words (likely generated by the VWFS) is bilateral for skilled deaf readers, and the amplitude of the right hemisphere N170 is positively correlated with reading and spelling ability for deaf readers, suggesting that recruitment

of the right hemisphere is not maladaptive for these readers. We aimed to examine the hierarchical organization to written words in the VWFS bilaterally for skill-matched deaf and hearing readers to determine whether deafness (and phonological ability) modulates the laterality of word-selectivity gradients. Using fMRI, we employed the same design used in other studies of the VWFS, presenting stimuli that represented a scale of orthographic regularity: consonant strings, pseudowords, and real words. Participants performed a low-level task (detect a color change) that imposed a constant strategic processing load across all stimuli. Our results replicate previous findings showing a hierarchical structure solely in the left VWFS in skilled hearing readers. In skilled deaf readers, we find this same hierarchical structure in the left VWFS. As the deaf readers in this study had relatively limited knowledge of spoken phonology, this result shows that orthographic tuning in the VWFS is not altered by imprecise phonological representations. Importantly, we also find the same hierarchical structure in the right VWFS only for deaf readers. Unlike studies that show right hemisphere activation in people with dyslexia, the bilateral processing and tuning to written words seen here is not maladaptive since all participants were skilled readers. These results add critical information to our understanding of the neural architecture for reading. Our findings support the hypothesis that in hearing people, both the right and left VWFS are initially engaged in written word reading, but with strong phonological processing, successful reading development shifts to the left hemisphere. We show here that deaf skilled readers exhibit hierarchical organization bilaterally, which suggests a potential unique neural signature for reading in deaf adults. Moreover, the bilateral engagement of the VWFS in single word reading indicates that a shift to the left hemisphere does not need to transpire for successful reading to occur. Our study provides evidence for a strong role for spoken phonology in determining laterality for reading in hearing people.

C15 - Neural selectivity for sign-based phonological units: Evidence from fMRI adaptation

Stephen McCullough[1], Karen Emmorey[1]; [1]SDSU

Linguistic and psycholinguistic studies have amply demonstrated that sign languages exhibit phonological structure that is parallel, but not identical to spoken languages. The manual parameters of handshape, place of articulation (location), and movement constitute phonological units that must be retrieved and assembled during sign production, and sign perception involves the detection and segmentation of these visual-manual phonological units. However, very little is known about how the brain recognizes and represents phonological structure in a sign language. We used fMRI adaptation to investigate neural selectivity for sign-based phonological units ¬– handshape and place of articulation (POA) on the body – in American Sign Language (ASL). Given that signers exhibit categorical perception effects for handshapes (in contrast to non-signers), we hypothesized that neural regions involved in the perception of body parts (e.g., the extrastriate body area, EBA) become selectively tuned to ASL handshapes in signers. It is less clear whether neural adaption effects will be found for POA because categorical perception effects have not been observed for sign location. We used an adaptor-probe, event-related design in which each trial consisted of two consecutively presented video clips of signs. The adaptor and probe signs were presented in four conditions: identity (e.g., BIRD BIRD), handshape only overlap (e.g., NEWSPAPER BIRD), location only overlap (e.g., ORANGE BIRD), and no phonological overlap (e.g., WEST BIRD). None of the adaptor-probe signs were semantically related, and all videos were the same length (2 seconds). The participants' task was to detect an occasional grooming gesture (e.g., adjusting clothing, rubbing eyes). This task was chosen because it can be performed accurately by both signers and nonsigners and grooming gestures do not engage sublexical or lexical processing by signers. Thus far, 11 deaf ASL signers and 4 hearing non-signers have participated (data collection is on-going). Preliminary whole brain results from the ASL signers revealed repetition suppression (reduced BOLD response) for handshape overlap (compared to no phonological overlap) in parietal cortex (left superior parietal lobule (SPL), right inferior parietal lobule, IPL) and surprisingly in the left anterior temporal lobe (ATL). Repetition suppression for place of articulation was observed bilaterally in the EBA and right fusiform gyrus. Repetition suppression for identical sign probes (compared to no phonological overlap) was found in bilateral SPL and in the EBA and fusiform gyri, bilaterally. This pattern of results suggests that neuronal assemblies within parietal cortex (the dorsal stream) and in inferior temporal cortex (the ventral stream) become tuned to linguistically relevant handshapes and places of articulation, respectively. We hypothesize that non-signers process signs relatively holistically and have more coarse neural selectivity for specific handshapes or locations, and we predict that the non-signers will exhibit weak or no adaptation for sign pairs with sublexical overlap. Contrary to our predictions for signers, our preliminary results suggest that the EBA becomes neurally tuned to where the hands are positioned on the body (place of articulation) rather than to hand configurations. Neural representations of linguistic handshapes appear to reside in parietal cortex (and possibly in left ATL).

C16 - Reduced functional activation in the right Crus II is coupled with increased cerebral connectivity in processing linguistic violations—A study based on the auditory language localizer task

Manson Cheuk-Man Fong[1], Jiaxin Chen[1], Matthew King-Hang Ma[1], Yun Feng[1], Fangfei Li[1], Nga-Yan Hui[1], Xavreila Sheung-Wa Ng[1], William Shiyuan Wang[1]; [1]The Hong Kong Polytechnic University

Research has demonstrated that the posterolateral cerebellum, especially right Crus II, operate synergistically with the cerebral networks over many linguistic tasks. The cerebellum is also part of the extended language networks identified by language localizer tasks (see Fedorenko et al., 2024, Nature Reviews Neuroscience). Recent studies (e.g., LaBel & D'Mello, 2023, Current Opinion in Behavioral Sciences) have called for the incorporation of the cerebellum into the neuroscientific models of language processing, even though its precise role has remained under active investigation. The present study aimed to provide further evidence for characterizing the nature of the

cerebellar involvement, by conducting both functional activation and generalized psychophysiological interaction (gPPI) analysis in an auditory language localizer task. 117 cognitively normal participants uniformly sampled from the age range 18-81 were recruited. A set of 120 syntactically, lexically, and semantically valid [Syn+ Lex+ Sem+] sentences, all 12-syllable long in Cantonese, were first composed. Three conditions were constructed by progressively removing semantic [Syn+Lex+Sem-], lexical [Syn+Lex-Sem-], and syntactic [Syn-Lex-Sem-] information, yielding four conditions in total: (1) Valid, (2) Semantic violation, (3) Jabberwocky, and (4) Randomized Syllables. A speech synthesizer was used to construct the auditory stimuli. Participants were asked to covertly repeat the final syllable of each sentence. T1-weighted structural scans were acquired using an MPRAGE sequence. Functional images were acquired with a multi-band EPI sequence (TR = 800 ms, TE = 37 ms, and flip angle = 52°), covering the whole brain with 72 interleaved axial slices (2×2×2 mm3). The functional data were analyzed using the Conn toolbox and custom-made Nilearn scripts. As expected, widespread functional activation was found between valid sentences and randomized syllables, with valid sentences eliciting stronger activation predominantly the left-hemispheric core language areas. In support for a substantial role of the cerebellum in linguistic processing, the right Crus II was more strongly activated by valid sentences than randomized syllables. Interestingly, the opposite pattern was found for left Crus I and II, as well as for a similarly broad activity in the right hemisphere (the lateral and medial superior frontal gyrus, middle frontal gyrus, anterior cingulate cortex, and superior temporal gyrus). GPPI analysis revealed that, during the processing of randomized syllables, there was increased functional connectivity between right Crus II and left superior and middle frontal gyrus, bilateral precentral gyrus, and left postcentral gyrus. Thus, although the right Crus II was less activated by randomized syllables, that was accompanied by increased connectivity with the frontoparietal regions. Convergent evidence was observed for semantic violation and Jabberwocky conditions. Taken together, such connectivity pattern, elicited by linguistic anomalies, likely represents the neural basis of an error-monitoring and error-correction mechanism that is mediated by the right Crus II region, in combination with the language control network. Further research is required to elaborate whether the right Crus II region is a major hub in this cerebrocerebellar network. This research has been supported by HKRGC-GRF 15601718 and 15609423.

C17 - Tracing adults' word segmentation abilities: A comparison between younger and older bilinguals

Patricia Fuente-García[1], Julián Villegas[2], Irene de la Cruz-Pavía[3,4]; [1]University of the Basque Country, [2]University of Aizu, [3]University of Deusto, [4]Basque Foundation for Science, Ikerbasque

Breaking down continuous speech into meaningful units is not a trivial task, yet humans accomplish this feat effortlessly. A wealth of work has shown that adults and infants automatically integrate a number of cues available in the signal and has revealed important changes in their relative weight and interplay across development (e.g., Mattys et al., 2005). However, a single study to date has examined whether their use remains constant throughout adulthood (Palmer et al., 2018). Similarly, the handful of studies available investigating the segmentation abilities of bilingual populations have exclusively focused on infants and young adults. In this study, we investigate whether adults' segmentation abilities remain constant in healthy aging. Additionally, we explore bilinguals' word segmentation abilities of a second language. Viewing bilingualism as a multifaceted construct and a continuum (Dash et al., 2022), our study seeks to understand whether and how four key dimensions of bilingualism—age of acquisition, language proficiency, language use and frequency of language switch—determine older bilinguals' use of semantic, syntactic and phonological information in word segmentation. We tested 72 healthy older (60-79) and 87 young (18-35) Spanish-Basque bilinguals that varied greatly in their knowledge, use and age of acquisition of Basque, and two control groups of Basque-Spanish bilinguals (n=26; n=37, respectively). We assessed these factors using self-report and objective measures and controlled for fluid intelligence in both groups and for cognitive health and cognitive reserve in older bilinguals. Participants completed a segmentation task in Basque, adapted from Sanders and Neville (2000), which comprised 240 sentences of three types: (1) natural sentences, i.e. fully grammatical and meaningful; (2) jabberwocky sentences, where content words were replaced with nonsense words, but functors were preserved (i.e., grammatical, but not meaningful); and (3) phonological sentences comprising only nonsense words, but preserving all phonological information (i.e., neither grammatical, nor meaningful). Each sentence contained a target phoneme and participants' task was to indicate whether it occurred word-initially or word-medially. Multiple regression analysis revealed that accuracy in the segmentation task was significantly above chance (all $p \leq .001$) in all three conditions—natural, jabberwocky, phonological—and in both target positions—word-initial and word-medial—. Importantly, adding age as a fixed effect or in interaction with other factors did not improve model fitness. Conversely, frequency of language switch, proficiency, and fluid intelligence (all $p \leq .01$) predicted segmentation accuracy. Further, proficiency interacted significantly with sentence type ($p < .0001$), as proficiency-related gains were greatest in natural sentences, followed by jabberwocky, and lastly by phonological sentences. Proficiency also interacted significantly with target position ($p \leq .001$), as accuracy increases related to proficiency were larger in word-initial targets. These results evidence thus the stability of our segmentation abilities throughout adulthood and align with Palmer et al's (2018) findings on statistical learning resilience to aging in speech segmentation. They also identify the role of specific bilingual dimensions in achieving native-like segmentation of a second language and suggest a particular role of proficiency in modulating word segmentation in adult bilinguals.

C18 - White Matter Microstructure Predicts Language Outcome in Moderate to Late Preterm and Early Term Infants

Xiujuan Geng[1], Peggy HY Chan, Winnie CW Chu, Hugh S Lam, Patrick CM Wong; [1]Chinese University of Hong Kong

INTRODUCTION Moderate to late preterm birth (MLPT) has found to be associated with language developmental delay or deficits. It is not clear how the preterm-related neural pathologies are linked to language development. Previous studies reported white matter differences in very preterm and MLPT infants and white matter microstructure correlations with later language outcomes in very preterm children. We have recently showed that hypomyelination is linked to worse speech encoding in preterm and term babies. In the present study, we further hypothesize that language-associated white matter pathways are affected by prematurity. Importantly, maturation levels around birth are prospectively correlated with later language ability. METHODS One hundred and seven healthy Chinese MLPT and term infants (mean [range] gestation age (GA) at birth: 36.6 [32.0-39.1] weeks) were recruited. Subjects were scanned at approximate two months of chronological age (mean [range]: 9.7 [3.0-18.6] weeks) and during natural sleep on a Siemens Magnetom Prisma scanner. Diffusion-weighted sequences were collected with 46 volumes at multiple b-values (500-2000 s/mm2) and a voxel size of 1.6x1.6x1.8 mm3. Fractional anisotropy (FA) was estimated and spatially normalized to standard space using unbiased nonlinear registration. Tract-based spatial statistics (TBSS) was conducted and statistical analysis was applied on entire brain. Randomise with threshold-free cluster enhancement was used to correct for multiple comparisons and FWE-corrected p-values were reported. Infant's language ability, including expressive, receptive and composite scores were assessed at 12 months old using Bayley Scales of Infant and Toddler Development III. RESULTS We analyzed the correlations between white matter and language scores controlling for sex and age at scan. Results show that expressive language scores at 1-year-old were significantly positively correlated with FA values in areas along several white matter tracts including left external capsule, uncinate fasciculus, inferior fronto-occipital fasciculus, posterior and retrolenticular part of internal capsule, bilateral superior corona radiata, genu, body and splenium of corpus callosum. To investigate the preterm effect on white matter, we further conducted a GLM with FA=Sex+GA+Age+GA*Age, where GA was the GA at birth. We found that most of the major white matter tracts showed positive correlation between GA and FA. There was also significant negative interaction of GA and Age on FA on bilateral minor forceps, left superior coronal radiata and arcuate fasciculus. CONCLUSIONS We identified that language outcomes at one year of age were associated with white matter integrity/maturation estimated by FA on several tracts including language pathways such as external capsule, superior corona radiata, uncinate fasciculus, inferior fronto-occipital fasiculus measured around 2 months of age. The positive correlation between FA and GA suggests that preterm birth is a risk factor for the maturation of white matter. Moreover, the interaction effect of GA and Age on FA, i.e., the lower the GA, the higher the slope between Age and FA, indicates that preterm babies have a faster maturation speed compared to term babies. Our next step is to test the further hypothesis that the preterm babies who fail to reach term equivalent white matter maturation status are the ones with language developmental delays/deficits.

C19 - Disfluencies reduce the effect of uh word surprisal during narrative comprehension

Laura Giglio[1], Peter Hagoort[2,3], Eleanor Huizeling[2]; [1]University of South Carolina, [2]Max Planck Institute for Psycholinguistics, Netherlands, [3]Donders Institute for Brain, Cognition and Behaviour, Netherlands

Disfluencies in speech most frequently occur before the production of longer and more complex speech content. There is some evidence to suggest that listeners use the distribution of disfluencies in the comprehension of speech to inform their predictions. A disfluency in speech may prepare the listener to hear a word that is more challenging to produce, such as a lower frequency word or a word with a higher surprisal. Here, we investigated whether the presence of disfluencies in speech affects word processing in naturalistic listening conditions, using a dataset openly shared on OpenNeuro (Zadbood et al., 2017). Participants (n = 36) listened to the spoken recall of the events of a TV series they had previously watched, while undergoing fMRI. The spoken recall was fully spontaneous, and as such included several disfluencies, such as silent and filled pauses, discourse markers and repairs. The speech was annotated for word length, word frequency, word index in the sentence and in text, entropy and surprisal (from GPT2). In addition, the presence of disfluencies was annotated by marking silent pauses between words longer than 0.25 seconds and fillers such as "uhm", "uh" and "like". Disfluencies occurred more often at sentence boundaries and after the first word in a sentence. Word surprisal was on average higher after disfluencies than for words not preceded by a disfluency. We modelled word processing effort using parametric modulations for baseline predictors, as well as surprisal and presence/absence of a disfluency. To investigate the effects of disfluencies on word processing, we tested the interaction between disfluency and frequency, and disfluency and surprisal. Word processing was associated with increased BOLD activity in the left and right superior temporal gyrus (STG) and sulcus (STS) and in the left inferior frontal gyrus (IFG). Words preceded by a disfluency were associated with increased activity in the left and right STG. Decreased word frequency was associated with an increase in activity in the left mid STG, while the effect of frequency did not interact with the presence of disfluencies. Increased word surprisal elicited a similar distribution of activity, with bilateral superior temporal activation and a left inferior frontal cluster. The interaction between disfluency and surprisal was associated with a cluster in the posterior temporal lobe, where the effect of surprisal was reduced after a disfluency. The results held when classifying disfluencies as filled pauses only. The results therefore show that the presence of disfluencies is associated with increased brain activity in response to words, while the response to surprisal is reduced following disfluencies in a posterior temporal cluster. The presence of a disfluency may thus prepare the listener for higher complexity in the upcoming speech, by potentially allocating increased attention resources or enhancing top-down modulation.

C20 - Musical rhythm impairments are a risk factor for developmental speech, language, and reading disorders: epidemiological and polygenic associations

Reyna Gordon[1,2], Srishti Nayak[1], Eniko Ladanyi[1], Else Eising[2], Yasmina Mekki[1], Rachana Nitin[1], Catherine Bush[1], Daniel Gustavson[3], Manuel Anglada-Tort[4], Hope Lancaster[5], Cyrille Magne[6], Simon Fisher[2,7], Nori Jacoby[4]; [1]Vanderbilt University Medical Center, [2]Max Planck Institute for Psycholinguistics, [3]University of Colorado, [4]Max Planck Institute for Empirical Aesthetics, [5]Boys Town National Research Hospital, [6]Middle Tennessee State University, [7]Radboud University

Impaired musical rhythm abilities and developmental speech-language related disorders are biologically and clinically intertwined. Prior work examining their relationship has primarily used small samples; here, we studied associations at population-scale by conducting the largest systematic epidemiological investigation to date (total N = 39,092). Based on existing theoretical frameworks, we predicted that rhythm impairment would be a significant risk factor for speech-language disorders in the general adult population. In the current study, we analyzed multiple independent datasets and rhythm subskills (including beat synchronization and rhythm discrimination) in relation to retrospective reporting of developmental speech, language, and reading disorders. Results were consistent with hypotheses, and aggregate meta-analyzed data showed that rhythm impairment is a modest but consistent risk factor for developmental speech, language, and reading disorders (OR = 1.32 [1.14 – 1.49]; p < .0001). Further, cross-trait polygenic score analyses suggested for genetic pleiotropy between rhythm and language-related phenotypes. We then examined potential relationships between behavioral musical rhythm scores, genetic predispositions for musical rhythm abilities, and speech-language disorder outcomes, by testing a mediation model in one of the cohorts (N=1792). Results showed that the association between behavioral musical rhythm scores and speech-language disorder outcomes was significantly mediated by rhythm polygenic scores, providing further evidence in favor of shared neurobiological or genetic underpinnings between rhythm and speech-language traits. Results will be discussed in light of potential neurobiological mechanisms and other other recent work showing shared genetic architecture between rhythm and language traits.

C21 - Lack of Evidence for the Neural Noise Hypothesis in Dyslexia: Insights from EEG and 7T MRS Excitation-Inhibition Balance Biomarkers

Agnieszka Glica[1], Katarzyna Wasilewska[1], Julia Jurkowska[2], Jarosław Żygierewicz[2], Bartosz Kossowski[3], Katarzyna Jednoróg[1]; [1]Laboratory of Language Neurobiology, Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland, [2]Faculty of Physics, University of Warsaw, Warsaw, Poland, [3]Laboratory of Brain Imaging, Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland

The neural noise hypothesis of dyslexia posits an imbalance between excitatory and inhibitory (E/I) brain activity as an underlying mechanism of reading difficulties, specifically suggesting increased glutamate (Glu) levels in individuals with dyslexia. Although the hypothesis was proposed seven years ago, the body of research validating its predictions remains scarce. This study provides the first direct test of the neural noise hypothesis using both indirect EEG power spectrum measures – exponent, offset, and beta power – in 120 Polish adolescents and young adults (60 with dyslexia, 60 controls) and direct Glu and GABA concentrations from magnetic resonance spectroscopy (MRS) at a 7T MRI scanner in half of the sample. Previous work has shown associations between a flatter slope of the EEG power spectrum (lower exponent) and greater dominance of excitation over inhibition, and between greater GABAergic activity and increased EEG beta power. Hence, in line with the neural noise hypothesis, we expected to find higher Glu levels, lower exponent, and lower beta power in participants with dyslexia. Our results, supported by Bayesian statistics, show no evidence for group differences in the indirect EEG measures of the E/I balance tested both at rest and during a spoken language task. Similarly, no evidence for group differences was found in the MRS-derived Glu and GABA concentrations in the individually localized language-sensitive left superior temporal cortex. Overall, our results challenge the prediction that cortical hyperexcitability is an underlying causal factor for developmental dyslexia and suggest that alternative mechanisms must be explored.

C22 - The roles of maturation and experience in linguistic integration during Chinese reading comprehension

Danni He[1], Qing Cai[1]; [1]School of Psychology and Cognitive Science, East China Normal University, China, Shanghai

Reading comprehension involves the intricate integration of multiple linguistic levels, shaped by factors such as maturation and extensive language experience. However, the extent to which these developmental factors contribute to the neural processes underpinning linguistic integration during narrative reading comprehension remains unclear. In this study, we aim to investigate how maturation (age in months) and experience (language ability) affect the brain responses during linguistic integration. Forty-two adults (11 males) and sixty-one children (31 males, 9-11 years old) were recruited in our study. They performed the sentence and word processing tasks using functional Magnetic Resonance Imaging (fMRI). The individual areas responsible for linguistic integration were defined based on the positive effect of the sentence versus word contrast across adults and children, including the general high-level language area and some subareas in the parietal cortex. A subset of these participants (36 adults and 47 children) also completed a natural text-reading task. During this task, the neural response was extracted to calculate the inter-subject correlation within each age group and the neural maturity was evaluated by the children-to-adults correlations in the defined integration-related areas. Additionally, Children's verbal and non-verbal abilities were assessed using subtests from the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). Other demographic information was also collected outside

the scanner. Our findings revealed that verbal ability, after adjusting for gender and non-verbal abilities such as working memory, significantly predicted neural responses in the pars opercularis (IFG-Op) and the pars triangularis (IFG-Tr) of the left inferior frontal gyrus, without a corresponding effect in the right IFG. Conversely, age was a significant predictor of neural responses in the right Tri-IFG and Oper-IFG, showing increased neural maturity associated with ageing, but not in the left counterparts. Moreover, verbal ability, but not age, presented a significant positive prediction on neural maturity across extensive areas of the parietal and temporal networks. In addition, no child-unique (child-child > adult-adult) responses were observed in the areas for linguistic integration. These findings indicate that the impact of maturation and experience exhibits hemispheric differences, reflecting distinct developmental trajectories in neural processes underlying reading comprehension. Furthermore, verbal ability's effect on neural maturity transcends age-related changes, prominently influencing neural development in broad parietal and temporal regions. This highlights the critical role of experience in developing neural functions essential for reading comprehension in children.

C23 - Temporal Modulations of Listening Fatigue on Predictive Processing during Speech Comprehension: An ERP N400 Study

Cheng-Hung Hsin[1], Chia-Ying Lee[2], Yu Tsao[1]; [1]Biomedical Acoustic Signal Processing Lab, Research Center for Information Technology Innovation, Academia Sinica, [2]Brain and Language Laboratory, Institute of Linguistics, Academia Sinica

Listeners utilize linguistic context to predict upcoming speech information. However, the influence of listening fatigue resulting from sustained attentive listening on lexical predictions remains unclear, particularly under varying speech clarity conditions. This study investigated the temporal modulations of listening fatigue on the predictability effect on the N400 under clear and noisy conditions, examining changes in amplitude, latency, and topographic distributions over time. A between-subjects design was employed, with two age- and hearing-matched groups (N=70) comprehending clear or noise-masked spoken sentences ending in high- or low-predictability words for approximately 30 minutes during electroencephalogram (EEG) recordings. The stimuli included 128 sentences, with a quarter of trials requiring participants to respond to comprehension questions. The data were divided into two blocks to investigate the effects of listening fatigue over time. Cluster-based permutation tests revealed that in the clear condition, Block 1 exhibited a significant predictability effect on the N400 from 300-700 ms, whereas in Block 2, the effect was present from 300-900 ms with a more anterior spread scalp distribution without amplitude reductions or onset delays. In the noisy condition, Block 1 showed a significant but discontinuous effect from 400-500 ms and 700-900 ms, while in Block 2, the effect was delayed but consistent from 500-900 ms, with a posterior distribution relative to Block 1. Difference wave analysis revealed no significant differences in the N400 effects between clarity conditions in Block 1. However, in Block 2, the noisy condition exhibited a significantly reduced, delayed, and posteriorly distributed effect on the N400 compared to the clear condition. The findings demonstrate that listening fatigue differentially modulates semantic processing under clear and noisy conditions. In clear speech, listeners maintain processing efficiency by recruiting frontal resources over time. In contrast, noisy speech compromises processing efficiency and integrity without evident frontal recruitment. The results suggest that listening fatigue can develop in the absence of sensory distress, and reserved frontal resources can be recruited to maintain efficient semantic processing. However, noisy speech rapidly depletes attentional resources, leaving few to support efficient semantic processing over time. Despite listening fatigue, noise adaptation seems to occur concurrently. Temporal modulations of the predictability effect on the N400 provide valuable insights into the relationship between listening fatigue and resource availability that ultimately determines semantic processing efficiency.

C24 - Electrophysiological Evidence for Hemispheric Coordination during Reading Emotion

I-Ling Hsu[1], Chia-Lin Lee[1,2,3,4]; [1]Graduate Institute of Linguistics, National Taiwan University, [2]Department of Psychology, NTU, Taiwan, [3]Graduate Institute of Brain and Mind Sciences, NTU, Taiwan, [4]Neurobiology and Cognitive Science Center, NTU, Taiwan

Emotion is highly contextualized. During reading, emotional responses are co-constituted by lexical items and the preceding context. In particular, beyond the immediate attention allocation and emotional responses prompted by the emotionality of the words themselves (as indexed by enhanced P200 and Late Positive Potential (LPP) responses), linguistic emotional context triggers additional attention and evaluative processes for the perceived words (indexed by overall positive responses starting from the N400 time window and continuing to the LPP time window). However, how different brain resources collaborate to achieve these emotional responses is not well understood. Prior literature has shown that while both cerebral hemispheres are involved in processing emotion, the left hemisphere (LH) plays a dominant role in efficiently extracting gist from sentence context to modulate subsequent lexical processing. This raises an empirical question of how context-driven emotional responses during reading emerge across the two hemispheres. To address this, our study manipulated the emotionality of the context and the sentence-final target word, yielding four sentence types: (1) emotional contexts ending with emotion words, (2) emotional contexts ending with neutral words, (3) neutral contexts ending with emotion words, and (4) neutral contexts ending with neutral words. The sentence contexts were displayed word by word at the center of the screen, while the sentence-final words were shown either to the right visual field (RVF) or the left visual field (LVF), and were preferentially processed by the contralateral hemisphere. Participants silently read these sentences and made a valence judgment at the end of each sentence. Event-related potentials (ERPs) were obtained from 28 young native speakers of Taiwan Mandarin in Taipei, Taiwan (14 males; mean age 23.3 years, range: 20–29 years). ERP results showed that, following a neutral context,

emotional sentence-final words elicited more positive responses during the P200 time window (100–300 ms) and LPP time window (600–900 ms) when presented to the LVF, but not the RVF. By contrast, within emotional contexts, while words elicited overall more positive responses regardless of VF presentation, the effect was longer-lasting when presented to the RVF. In addition, behavioral valence judgment results showed that while both emotional context and emotional ending words contributed to higher valence endorsement with both VF presentations, the overall valence endorsement rate was higher with RVF presentation. Overall, these findings highlight the joint contribution of both hemispheres and their coordination in processing emotions during reading. While both hemispheres are involved in appreciating the overall emotional message, our results suggest an RH advantage in processing the emotionality of individual lexical items and an LH advantage in evaluating the emotional context.

C25 - Aging by naming performance: Semantic network structure differences in the young and older adults

Jinyi Hung[1], Yuya Huang[1]; [1]MacKay Medical College, New Taipei City, Taiwan

The semantic system is crucial in supporting our naming ability. Since it is a dynamic network that changes across the lifespan, we investigated whether and how differences in the properties of the semantic network contribute to older adults' naming performance. We hypothesized that older adults' naming performance is related to the structure of the semantic network regardless of its degradation. Sixteen healthy older adults (age range 55-72 years, mean age = 63.7 years, mean education = 12 years) completed the Boston naming task (BNT) and a semantic relatedness judgment task. Participants were subgrouped into three (low, mid, high) based on their naming performance in the BNT. The semantic relatedness task was constructed based on four different semantic categories, within each 3 most common and 3 least common exemplars were selected (Banks & Connell, 2022). Participants made semantic relatedness judgement of all possible pairings between two different exemplars, resulting in a total of 276 individual judgments, on a Likert scale ranging from 0 (unrelated) to 10 (very much related). These 24 x 24 semantic relatedness judgments were studied as an adjacency matrix of a weighted, undirected network in which nodes represented the exemplars, and edges represented the averaged relation between two exemplars. Network properties and sub-communities were constructed and compared among three naming sub-groups. Their results were also compared with that of a group of college undergraduate students (N=7, mean age = 21 years) for discussion. All analyses were performed using the igraph R package. Overall, older adults' semantic network had lower cluster coefficient than young adults' (young = 0.74, old = 0.65). Network random walk results showed that both young and older adults had three major network communities, corresponding to animal/fruit, tool, and musical instrument categories (modularity young = 0.52, old = 0.51). The animal/fruit community in the older adults' semantic network can further parse out a smaller community constituted mainly by low frequency exemplars, such as 'butterfly' and 'ant', whereas the communities of the young adults' remained the same. Subgroup network analyses based on older adult's naming performance showed that the Low performance group had relatively low connectivity among nodes and cluster coefficient (0.60). Network random walk results showed that both High and Mid performance groups had the same three major community structure as the young adults (modularity high = 0.34, mid = 0.50); however, the Low performance group had four major community structure corresponding to category membership (modularity low = 0.44), except that one low frequency exemplar (i.e., fish) was not included in the animal category. The preliminary findings showed that the network analysis captures semantic representation in the young and older adults, and the constructed network structures are in general consistent with the typical category boundary. Moreover, older adults with different naming performance could have different network structures. A semantic network with sparser connectivity and lower cluster coefficient is observed in older adults with poorer naming performance.

C26 - Enhanced BCI speller with hybrid framework

Myung Yung Jeong[1], JunHyun Kim[2], Mailk M Naeem Mannan[3]; [1]Pusan National University

Steady-state visual evoked potentials (SSVEPs) are extensively used in brain-computer interfaces (BCIs) due to their robustness, high classification accuracy, and impressive information transfer rates (ITRs). However, multiple flickering stimuli can cause significant user discomfort, including tiredness and fatigue. To address these issues, we propose a novel hybrid speller design integrating electroencephalography (EEG) and eye-tracking to enhance user comfort while managing numerous flickering stimuli. Our BCI speller reduces the number of required frequencies by using only six different frequencies to classify forty-eight targets, significantly improving ITR efficiency. A canonical correlation analysis (CCA)-based framework supports the system's effectiveness, accurately identifying target frequencies with just 1 second of flickering signal. In tests, our system demonstrated an average classification accuracy about 90% in cued-spelling tasks. It achieved an average ITR of 184.06 ± 12.761 bits per minute in cued-spelling and 190.73 ± 17.849 bits per minute in free-spelling tasks. These results highlight the superior performance of our hybrid speller compared to existing spellers in terms of target classification, accuracy, and ITR. By integrating eye-tracking technology with EEG, the cognitive load on users is reduced, and the intended target is identified more precisely. This hybrid approach leverages the strengths of both EEG and eye-tracking, creating a more responsive and user-friendly BCI system. Our speller's performance in both cued and free-spelling tasks demonstrates its practical applicability and potential for real-world use. High ITR and classification accuracy enable faster and more accurate communication, especially beneficial for individuals with severe physical disabilities relying on BCIs for communication. Acknowledgement This study was supported by the Institute for Defense Technology Planning and Advancement for their support through the Defense Venture Innovation Technology Support Project (V220021) and National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT)

(No. 2022R1A2B5B01002377) REFERENCES 1. Vidal, J.J. Toward direct brain-computer communication. Annu. Rev. Biophys. Bioeng. 1973, 2, 157–180. 2. Farwell, L.A.; Donchin, E. Talking off the top of your head: Toward amentalprosthesis utilizing event-related brain potentials. Electroencephalogr. Clin. Neurophysiol. 1988, 70, 510–523. 3. Li, Y.; Pan, J.; Long, J.; Yu, T.; Wang, F.; Yu, Z.; Wu, W. Multimodal BCIs: Target detection, multidimensional control, and awareness evaluation in patients with disorder of consciousness. Proc. IEEE 2016, 104, 332–352. 4. Xie, J.; Xu, G.; Luo, A.; Li, M.; Zhang, S.; Han, C.; Yan, W. The Role of Visual Noise in Influencing Mental Load andFatigue in a Steady-State Motion Visual Evoked Potential-Based Brain-Computer Interface. Sensors 2017, 17, 1873.

C27 - Online summarization of the past information in the human brain during natural language comprehension

Jiahao Jiang[1], Tengfei Zhang[1], Shaonan Wang[2,3], Xinran Xu[1], Chunming Lu[1]; [1]State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China, [2]State Key Laboratory of Multimodal Artificial Intelligence Systems, Institute of Automation, CAS, Beijing, China, [3]School of Artificial Intelligence, University of Chinese Academy of Sciences, Beijing, China

One striking ability of the human brain is to comprehend the current input by incorporating past information, even for long stimuli that lasts for hours. Although the large language models (LLM) that simulate functions of the human brain can employ all (or long) information in prior contexts, this is unlikely to be the case for the human brain due to our limited cognitive resource. Thus, here we hypothesized that online summarization of the past information is the potential mechanism of our brains in integrating previous context into the current input. We predicted that the high-order brain areas might compress information based on meaningful boundaries (“Summary at Boundary”, SB), rather than on fixed amounts of stimuli or fixed length of time (“Summary at Fixed amount or time”, SF). To test the above hypothesis, we analyzed the Sherlock dataset (Chen et al., 2017). In this dataset, 17 participants were requested to watch a video and then freely recall as detailed as possible, while fMRI data were collected. There were 998 annotations (mean = 3.9s) describing the content of each video segment, and they were divided into 50 events according to meaningful boundaries (SB). As a comparison, we evenly divided these annotations every 20 segments (SF). After retrieving summaries for each chunk with GPT-4, we concatenated SB/SF summaries or equivalent length of previous annotations (“No Summary”, NS) to every annotation, and obtained contextualized semantic representations with a pretrained LLM Mistral-7B. With these three sets of representations, we separately built encoding models for each brain parcel with 10-fold linear regression, and obtained encoding performance by averaging correlation coefficients in test sets, which reflected how well each parcel represented the information. Finally, the encoding performance of each parcel was compared between SB, SF and NS conditions by paired T-test. We also tested the functional role of summarization by conducting Spearman correlation between encoding performance and the precisely recall ratio of participants (available in the dataset). The results showed that the encoding performance of SB was significantly better than NS in precuneus and visual cortex, and better than SF additionally in left MTG. For SF condition, however, there was no parcels encoded better than SB, and only one parcel encoded better than NS in right MTG. Moreover, encoding performance of SB and SF in precuneus was significantly associated with precisely recall ratio among participants, whereas NS did not. These results can be replicated with the traditional GPT-2 model. In conclusion, we found evidences that compressing previous contexts at meaningful boundaries by summarization is probably the mechanism of how human brain efficiently encode mass information. Participants that better integrated previous summaries could better memorize the content in detail, which indicated the functional role of online summarization.

C28 - An exploratory investigation of changes in cerebro-cerebellar white matter tracts and naming improvement after cerebellar tDCS and aphasia treatment

Micah A Johnson[1], Zafer Keser[2], Patrick Sadil[1], Martin A Lindquist[1], Rajani Sebastian[3]; [1]Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA, [2]Mayo Clinic, Rochester, NY, USA, [3]Johns Hopkins University School of Medicine, Baltimore, MD, USA

Cerebellar transcranial direct current stimulation (tDCS) combined with language therapy can aid in chronic aphasia recovery (DeMarco et al., 2021; Marangolo et al., 2018; Sebastian et al., 2017, 2020). However, it remains unclear which neural mechanisms are associated with treatment efficacy. We investigated whether naming improvements after cerebellar tDCS and computerized aphasia therapy are related to white matter changes in cerebro-cerebellar tracts. Thirteen participants (2 women, age range: 44–89) with chronic left hemisphere stroke and aphasia were included in this study (ClinicalTrials.gov ID: NCT02901574). In a randomized, double-blind, within-subject, cross-over design, participants received 2 interventional periods of 15 treatment sessions with cerebellar tDCS + computerized aphasia therapy and sham + computerized aphasia therapy, separated by a 2-month wash-out period. The primary outcome variable was confrontational naming assessed via the Philadelphia Naming Test (PNT; Roach et al., 1996) at four time points for each intervention: pre-treatment, post-treatment, 2 weeks, and 2 months post-treatment. tDCS was administered for 20 minutes to the right cerebellum (reference electrode over the right shoulder). Diffusion MRI was acquired at pre- and post-treatment time points for active and sham conditions. Diffusion preprocessing and tractography of cerebro-cerebellar tracts was performed in DSI Studio (version 2024.05.22) following procedures from Keser et al. (2023). Tract measures included fractional anisotropy (FA), mean diffusivity (MD), and volume. Analyses involved nonparametric t-tests and correlations, correcting for false discovery rate. Relative to pre-treatment, naming improved after active tDCS at post-treatment ($W = 9.50$, $p = 0.013$, biserial $r = 0.79$) and gains persisted at 2 weeks ($W = 9.50$, $p = 0.074$, biserial $r = 0.66$) and 2 months ($W = 4.50$, $p = 0.021$, biserial $r = 0.84$). Although improvements were not significantly different from sham at post-treatment ($W = 54.50$, $p = 0.239$, biserial $r = 0.40$), 2 weeks ($W = 29.50$, $p = 0.441$, biserial $r = 0.31$), or 2

months (W = 29.50, p = 0.477, biserial r = 0.289), the overall pattern is consistent with our larger study (Sebastian, 2020). There was no reliable evidence of active tDCS effects on white matter tracts relative to sham. However, naming improvements after 2 months showed trend-level associations (and large effect sizes) with increased MD in the left middle cerebral peduncle (MCP: tau = 0.70, p = 0.107, Fisher's z = 0.88, SE = 0.15) and bilateral parietopontocerebellar tracts (left PPC: tau = 0.78, p = 0.107, Fisher's z = 1.05, SE = 0.16; right PPC: tau = 0.65, p = 0.107, Fisher's z = 0.77, SE = 0.17) as well as decreased FA in the left MCP (tau = 0.65, p = 0.160, Fisher's z = 0.77, SE = 0.17) and left PPC (tau = 0.78, p = 0.160, Fisher's z = 1.05, SE = 0.16). Our findings suggest that language improvements after cerebellar neuromodulation may be associated with longitudinal changes of cerebro-cerebellar tracts. These preliminary findings, pending replication in larger studies, support the potential for white matter correlates and biomarkers of cerebellar tDCS efficacy.

C29 - Neural contributions to the speech disorder in Huntington's disease

Elaine Kearney[1,2], Matthew O'Donohue[3], Katie L. McMahon[3], Greig I. de Zubicaray[3]; [1]University of Queensland, [2]Princess Alexandra Hospital, [3]Queensland University of Technology

Introduction. Over 90% of individuals with Huntington's disease (HD) develop a speech disorder that has a devastating impact on their quality of life, yet little is known about the brain mechanisms underlying the speech disorder. Speech has become an important biomarker in HD, as speech changes occur in the premanifest stage (i.e., in those with the gene expansion for HD but prior to clinical diagnosis). To date, a single neuroimaging study has linked structural brain changes to speech measures in HD (Skodda et al., 2016), however, the findings were limited as the participants were not classed as having speech impairment and the study was insufficiently powered to detect effects in subcortical structures. The current work aims to identify cortical and subcortical differences in the speech production network in individuals with premanifest HD with and without speech impairment (HDSI, HDN), compared to age- and gender-matched controls (CON). Based on the Directions Into Velocities of Articulators (DIVA) model (Guenther, 2016) and pathophysiology of HD, we hypothesise that the ventral premotor cortex and basal ganglia motor loop will show atrophy in the HDSI group, compared to the HDN and CON groups. Method. Demographic, clinical, and neuroimaging data were accessed from the PREDICT-HD study, a longitudinal study of early disease prediction in premanifest HD (Paulsen et al., 2020). Speech impairment was determined based on the dysarthria question in the United HD Rating Scale (0 = no speech impairment; >=1 = speech impairment). Fifty-two individuals with premanifest HD were classed as having speech impairment and had neuroimaging data available (mean age 49.5 years +/-8.7; 27 female); an additional 52 age- and gender-matched HDN and CON participants were pseudo-randomly sampled from the larger cohort. T1-weighted images were processed using Freesurfer. Processing of the cortical data is ongoing, and cortical thickness and local gyrification index will be extracted for regions of interest in the speech production network. The subcortical and cerebellar data were automatically segmented in Freesurfer, with grey matter volume extracted for the caudate, putamen, pallidum, thalamus, and cerebellum. Group differences in grey matter volume were examined using ANCOVAs, controlling for total intracranial volume and scanner field strength. Significant main effects were evaluated using pairwise comparisons and results were FDR-corrected. Results. Both HDSI and HDN groups showed reduced grey matter volume in the caudate, putamen, pallidum, and thalamus bilaterally compared to the CON group (ps < .05, small-large effects). In addition, HDSI exhibited reduced volume in the right cerebellum, relative to the control group (p = .045, small effect), and the caudate, putamen, and pallidum bilaterally compared to the HDN group (ps < .05, medium-large effects). Conclusion. Changes in speech production in premanifest HD are primarily associated subcortically with atrophy in the basal ganglia structures of the caudate, putamen, and pallidum. These findings are in line with the DIVA account of speech production that posits that the basal ganglia motor loop is implicated in the feedforward control of speech production. Additional analyses will reveal the cortical contributions to the speech disorder in premanifest HD.

C30 - Investigating ambiguity processing in multi-referent situations: insights from event-related potentials

Yi-Chun Ko[1], Kara D. Federmeier[2], Chia-Lin Lee[1]; [1]National Taiwan University, [2]University of Illinois Urbana-Champaign

Establishing coherent referential interpretations is pivotal for language comprehension, given that natural language often presents the challenge of multiple eligible antecedents for an anaphor. In the event-related potential literature, referential ambiguity has consistently been linked with a sustained anterior negativity—the Nref. However, the precise nature of the Nref effect remains elusive. This study aims to adjudicate between two prominent functional accounts, probing whether the Nref effect reflects the detection of ambiguity or the maintenance of potential antecedent representations. We presented stories featuring one, two, or three characters followed by a sentence containing a pronoun. Participants read each story in its entirety and the critical sentence word-by-word, and then answered comprehension questions at the end of each story. This setup created conditions in which the pronoun was either unambiguous (Unambiguous) or temporarily linked to two or three potential referents (2-referent; 3-referent). In the critical sentence, referential ambiguity was resolved with subsequent character names. This design allows us to examine the sensitivity of the Nref effect to referential load during ambiguity and downstream brain responses by time-locking the analysis to the pronoun and the disambiguating name, respectively (e.g., If the rain continues, … (Unambiguous) he / (2-referent) he thinks that Teddy / (3-referent) he thinks that Teddy and Jack … will feel very upset at work tomorrow). At the pronoun, the detection account predicts similar magnitudes of the Nref effect for both ambiguous conditions relative to the unambiguous condition. In contrast, on the maintenance account there should be a greater Nref effect as referential load increases, for the 3-referent versus the 2-referent condition. At the disambiguating name (e.g., Teddy), the detection account predicts no Nref effect because

the referent is unequivocal, leaving no additional ambiguity to be detected. In contrast, on the maintenance account there should also be an Nref effect at this position, but only in the 3-referent condition. This is because, although the appearance of the disambiguating name reduces the number of potential referents for the pronoun, there is still more than one potential referent in the 3-referent condition, requiring continued maintenance of multiple referent options. Our results revealed significant Nref effects for both the 2-referent and 3-referent conditions on the pronoun. Surprisingly, the effect was larger in the 2-referent condition. Additionally, an Nref effect was observed in the 3-referent condition upon encountering the first disambiguating name. Collectively, these real-time observations of how referential ambiguity evolves with additional disambiguating information provide intriguing insights into referential processing. The findings are largely, though not entirely, consistent with the maintenance account. Specifically, our results indicate that the Nref may not solely reflect the number of potential participants formally associated with the referentially ambiguous expression. Rather, it may signify participants' elaborative referential inferences and strategic use of the context to allocate general working memory resources in referential processing and to alleviate working memory demands.

C31 - Subcortical Modulation of Speech Production Network.

Anna Korzeniewska[1], Noah Lu[1], Alan Bush[2,3], Nathan Crone[1], Mark Richardson[2,3]; [1]Johns Hopkins University, [2]Massachusetts General Hospital, [3]Harvard Medical School

Rationale: While the dynamics of cortical networks engaged in speech production have been well described, the role of subcortical regions remains under-explored. Using direct intracranial recordings, we investigated causal interactions between eloquent cortex and subthalamic nucleus (STN, known to modulate human behavior). Methods: High-density electrocorticographic recordings were made simultaneously with depth-recordings from STN in eight patients performing a syllable triplets repetition task during deep brain stimulation surgery (DBS). We used an event-related causality (ERC) method (Korzeniewska et al., 2022), based on the concept of Granger causality, to estimate the direction, intensity, and spectral content of direct propagation of neural activity during the task. For precise embedding of statistical significance in the time-frequency space, we used a newly developed bivariate smoothing model based on a two-dimensional moving average, which is optimal for reducing random noise while retaining a sharp step response. Results: Using our ERC approach, we recapitulated expected connectivity patterns at the cortical level. For example, we observed strong mutual causal interactions between auditory cortex (superior temporal gyrus, STG), Broca's area (inferior frontal gyrus, IFG), and sensorimotor cortices (precentral and postcentral gyri) during both speech perception and speech production. Interestingly, we also observed strong mutual causal interactions between subthalamic nucleus (STN) and all the other investigated regions of the eloquent cortex, including Broca's area and STG, during both speech perception and speech production. Remarkably, the strongest propagations of neural activity within the investigated subcortical-cortical network were observed during production of the last (third) syllable. Nevertheless, we also observed strong increases in neural propagation at the beginning of each syllable's perception, and in the middle of each syllable's perception. Conclusions: This study provides new empirical evidence that STN plays an important neurophysiological role in speech perception and production through mutual propagation of neural activity to and from eloquent cortex, including Broca's and Wernicke's areas. Korzeniewska A, Mitsuhashi T, Wang Y, Asano E, Franaszczuk PJ, Crone NE. Significance of event related causality (ERC) in eloquent neural networks. Neural Netw. 2022;149:204-216. Supported by: NINDS- U01NS117836 & NINDS-R01NS115929

C32 - Using Unsupervised Dimensionality Reduction to Identify Lesion Patterns Predictive of Post-Stroke Aphasia Severity

Emerson Kropp[1], Maria Varkanitsa[1], Nicole Carvalho[1], Isaac Falconer[1], Anne Billot[2], Swathi Kiran[1]; [1]Boston University, [2]Harvard University

Lesion volume and location are known to impact aphasia severity in stroke patients, particularly in left hemisphere regions (Døli et al., 2021). To investigate these impacts, we used non-negative matrix factorization (NMF), a data-driven approach that identifies representative patterns of lesioned brain regions (Bonkhoff et al., 2021; Kernbach et al., 2023) and explored associations with aphasia severity. Lesions were segmented using T1 structural MRIs for 98 left hemisphere stroke patients with aphasia. The Western Aphasia Battery - Revised Aphasia Quotient (WAB-R AQ) was used to quantify aphasia severity (mean age=61.9, mean WAB-R AQ=74.7). Left hemisphere percent spared tissue was calculated in 83 AAL3 grey matter regions and 36 white matter tracts from BCBToolkit (Rolls et al., 2020; Foulon et al., 2018). NMF is a dimensionality reduction method which, unlike principal component analysis, generates interpretable components by creating a parts-based representation of the information. By applying NMF to the region-wise tissue spared data, we reduced the dataset into a small number of lesion atoms which represent prototypical patterns of regions which tend to be damaged together across patients. The number of atoms was picked to minimize deviation between the original and reconstructed datasets (Kim & Tidor, 2003). Percent tissue spared was multiplied by region volumes to identify spared volume, then weighted based on relative region contributions to each atom and normalized (Thakallapalli et al., 2021); these weighted averages were used as aggregate values of each patient's percent spared tissue within each spatially distributed lesion atom. Atom-wise spared tissue data was then used in linear regression models predicting WAB-R AQ (Marchina et al., 2011). Models were adjusted for gender, age, months post onset, education, and total lesion volume. 4 lesion atoms were identified. Atom 1 contained subcortical/posterior regions and was least associated with WAB-R AQ (Atom 1 partial-R2=.050, $p<.05$). Atom 2 contained mainly fronto-parietal regions such as the pre/postcentral gyri and superior longitudinal fasciculus (Atom 2 partial-R2=.086, $p<.01$). Atoms 3 and 4 both bordered the Sylvian fissure with

overlap including the insula, Rolandic operculum, supramarginal, and Heschl's gyri. Atom 3 had more contribution from frontal lobe regions, while atom 4 was localized mainly to the temporal lobe (Atom 3 partial-R2=.12, p<.001; Atom 4 partial-R2=.15, p<.0001). Atom 4's model was most associated with WAB-R AQ overall (adjusted-R2=.30, p=1.7e-6). When comparing region-wise contributions, the highest increases in contribution to atom 4 versus atom 3 were in the superior temporal, middle temporal, and Heschl's gyri, the Rolandic operculum, and the posterior arcuate fasciculus. Atoms 3 and 4 were the most associated with aphasia severity, and each contained classical language regions in the left MCA territory. However, the improved performance of atom 4 compared to 3 conveys the importance of temporal lobe white and grey matter over other regions in predicting aphasia severity. Each atom is a representative pattern of damage, suggesting that atom 4 is a natural lesion pattern particularly relevant to aphasia. Better understanding of this pattern's etiology may provide insight into the mechanisms of language dysfunction in stroke.

C33 - Representation of verbal thought in motor cortex and implications for speech neuroprostheses

Erin M. Kunz[1], Benyamin Meschede-Krasa[1], Foram Kamdar[1], Samuel R. Nason-Tomaszewski,[2], Nicholas S. Card[3], Brandon Jacques[2], Payton Bechefsky[2], Nick Hahn[1], Carrina Iacobacci[3], Leigh Hochberg[4,5,6,7], David M. Brandman[3], Sergey Stavisky[3], Nicholas AuYong[2], Chethan Pandarinath[2], Shaul Druckmann[1], Jaimie Henderson[1], Francis R. Willett[1,8]; [1]Stanford University, [2]Emory University, [3]University of California, Davis, [4]Brown Universty, [5]VA Medical Center, Providence RI, [6]Massachusetts General Hospital, Boston MA, [7]Harvard Medical School, [8]Howard Hughes Medical Institute

Brain-Computer Interfaces (BCIs) have recently demonstrated a viable path forward toward restoring speech to people who have lost the ability due to paralysis [1-2]. Increased electrode count and optimized decoding algorithms have yielded a level of Signal-to-Noise-Ratio (SNR) and stability necessary for long-term use of a conversational open-ended speech BCI [3]. However, as the performance of these intracortical systems has increased rapidly in decoding speech, so too has concern regarding their potential to decode private verbal thought [4]. In three research participants, each with microelectrode arrays placed along the precentral gyrus of the motor cortex, we studied different types of verbal behavior including: attempted vocalized speech, mimed speech, listening to speech, silently reading text, and three types of auditory or motor imagery of speech ("inner speech."), We found that all behaviors, including the three inner speech conditions, showed distinct representations of individual words, with overt movement conditions generally showing the strongest modulation, as expected. The strongest modulation for perceived and inner speech was found in Area 55b and the inferior region of Area 6v (as defined by the Human Connectome Project cortical parcellations [5]). Notably, a simple classifier could decode neural signals during listening and speech to distinguis between 7 words above chance in all participants, with up to 94% accuracy for listening and 71% for inner speech. Additionally, we found these word-level representations were largely shared across perceived, inner and produced speech, differing primarily in relative strength of modulation from rest. We also demonstrate the first online speech neuroprosthesis for decoding continuous inner speech from three dysarthric individuals, achieving a word error rate as low as 14% for a 50 word vocabulary. All participants found inner speech easier, more comfortable, and aesthetically preferable as compared to actually attempting to vocalize, as is the typical paradigm for state-of-the-art speech neuroprostheses. Finally, to understand whether verbal thought might be decodable when it occurs naturally, we ran a follow-up research session that elicited the natural use of inner speech as a memory aid in a non-speech task (drawing symbolically-cued sequences). We found that the content of the inner speech in this task was discernible using a decoder trained on attempted vocalized speech. This brings to light some important questions regarding decoding intention and privacy that future design of speech neuroprostheses must take into account. 1. Willett, F.R., Kunz, E.M., Fan, C. et al. A high-performance speech neuroprosthesis. Nature 620, 1031–1036 (2023). 2. Metzger, S.L., Littlejohn, K.T., Silva, A.B. et al. A high-performance neuroprosthesis for speech decoding and avatar control. Nature 620, 1037–1046 (2023). 3. Card, N.S. et al. An accurate and rapidly calibrating neuroprosthesis. Medrxiv (2023). 4. Soldado-Magraner, J. et al. Applying the IEEE BRAIN neuroethics framework to intra-cortical brain-computer interfaces. J. Neural Eng. 21 022001 (2024).

C34 - Comparing the neural correlates and effective connectivity of different types of syntactic movements in Mandarin Chinese: An fMRI study.

Tingwu Lee[1], Shiaohui Chan[1]; [1]National Taiwan Normal University

Filler-gap dependencies, or syntactic movements, involve a relation between a moved filler and the gap that it left. Previous neuroimaging studies generally assume that the left inferior frontal gyrus (L-IFG) and the left posterior superior/middle temporal gyrus (L-pS/MTG) play crucial roles in processing syntactic movements. However, whether the brain tells the subtle differences of movement types and distinguishes them remains unclear. For instance, Europa et al. (2019) adopted the fMRI technique and found that object clefts and passives in English only differ in the intensity of the L-IFG activity, while both structures share the same neural connectivity network. This result suggests that the human brain may not distinguish movement types when they are processed. Several fMRI studies on Chinese passives also have similar results supporting the view of the movement of the Patient object to the subject position (Feng et al., 2015; Want et al., 2021). However, the dominant formal syntactic account for deriving Chinese passives is the null operator movement analysis, involving a base-generated subject with the Patient role, a null operator moved sentence-internally, and a post-verbal gap left by the operator (Huang, 1999). The operator (OP) serves a deictic sign bridging the Patient subject and the post-verbal gap ([e]), as in nanhai bei nuhai [OP] pian-le [e] 'The boy was deceived by the girl.' The theoretical account is incompatible with the movement hypothesis from the fMRI studies, but it raises a new question about the neural foundation of null operators. Thus, the aim of

this fMRI study is twofold. First, I compared the neural correlates of two movement types in Mandarin Chinese, particularly the passive and topic constructions. The latter was chosen because it represented a typical case of object movement to the sentence-initial position. Second, I attempted to draw inferences from the neural activity results to examine the validity of the operator movement account. By adopting the whole-brain analysis and the region of interest analysis, it was found that both passive and topic constructions triggered the L-IFG and the L-pMTG equally intensively. However, the dynamic causal modeling analysis showed that the Chinese passive construction failed to trigger the modulatory effect from the L-IFG to the L-MTG as the Topic construction successfully did. Such a modulatory effect is argued as crucial evidence reflecting the processing of filler-gap dependency: the L-IFG is activated to maintain and retrieve the information of the filler and then pass the information to the posterior temporal region for establishing filler-gap integration. As a result, the object movement analysis of Chinese passives is called into question, but there is no direct evidence for the neural correlates of operator movement found in this study. We assume that the strong activations of the L-IFG and the L-MTG are to deal with the structural complexity and the non-canonical thematic role order. The result also suggests that the brain does not process all structures with non-canonical word orders equally.

C35 - Understanding the shared coding of speech and language between deep neural network models and the human brain

Yuanning Li[1], Peili Chen[1], Shiji Xiang[1], Edward Chang[2]; [1]ShanghaiTech University, [2]University of California San Francisco

Recent computational cognitive neuroscience advances highlight the parallel between deep neural network (DNN) processing of speech/text and human brain activity. However, most studies have examined how single-modality DNN models (speech or text) correspond with activity in particular brain networks. Yet, the critical factors driving these correlations remain unknown, especially whether DNNs of different modalities share these factors. It is also not clear how these driving factors evolve in space and time in the brain language network. To address these questions, we analyzed the representation similarity between self-supervised learning (SSL) models for speech (Wav2Vec2) and language (GPT-2), against neural responses to naturalistic speech captured via high-density electrocorticography from 16 participants. We developed both a time-invariant sentence-level and a time-dependent single-word-level neural encoding models. These models helped delineate the overall correspondence and fine-grained temporal dynamics in brain-DNN interactions respectively. Our results indicate high prediction accuracy of both types of SSL models relative to neural activity before and after word onsets. We observed distinct spatiotemporal dynamics: both models showed high encoding accuracy 40 milliseconds before word onset, especially in the mid-superior temporal gyrus (mid-STG), with Wav2Vec2 also peaking 200 milliseconds after word onset. Applying clustering analysis to the timecourse of word-level encoding score of the SSL models, we found two distinct clusters that mainly correspond to mSTG and pSTG. The mSTG cluster contributed to the -40ms peak, while the pSTG cluster contributed to the 200ms peak. Using canonical correlation analysis, we discovered that shared components between Wav2Vec2 and GPT-2 explain a substantial portion of the SSL-brain similarity. Further decomposition of DNN representations indicated that contextual information encoded in SSL models contributed more to the brain alignment in mid-STG and before word onsets (-40ms), while acoustic-phonetic and static semantic information encoded in SSL models contributed more to the brain alignment in post-STG and after word onsets (200ms). In summary, we demonstrate that both speech and language DNNs share neural correlates driven by context and acoustic-phonetic cues, aligning with distinct neural activity patterns over space and time. Our findings suggest that key aspects of neural coding in response to speech are captured by self-supervised DNNs of different modalities, reflecting a convergence of artificial and biological information processing systems.

C36 - The causal role of the mPrCG in speech-motor sequencing

Jessie R. Liu[1], Lingyun Zhao[1], Patrick W. Hullett[1], Edward F. Chang[1]; [1]University of California San Francisco

Fluent speech production requires the planning and articulation of accurately sequenced speech sounds. Though Broca's area has traditionally been thought to facilitate speech sequencing, recent studies have shown that damage to Broca's area does not often cause chronic speech production deficits. This has left the question of what neural populations causally control speech-motor sequencing unresolved. To address this, we used high-density direct cortical recordings while participants spoke utterances with varying syllabic sequence complexity. We identified a distributed cortical network with sustained activity modulated by the complexity of the sequences, across multiple speech areas including Broca's area and the posterior superior temporal gyrus, but strongest in the middle precentral gyrus (mPrCG). Only neural activity in the mPrCG both scaled with sequence complexity and predicted reaction time, suggesting that while other areas may be involved in higher level speech processing, the mPrCG may play a role in the motoric aspect of speech sequencing. To test whether the mPrCG is causally involved in speech-motor sequencing, we applied direct electrocortical stimulation to several areas whose neural activity was modulated by sequence complexity, while participants spoke a variety of speech sequences. We found that only stimulation in the mPrCG, and not Broca's area, caused speech disfluencies only when participants spoke complex speech sequences (like "catastrophe"), but not during simple sequences (like "papapa"). Disfluencies included increased syllable durations, increased syllable segmentation, distortions, and stuttering. Control trials ruled out other stimulation effects, such as anomia or speech arrest, as drivers of these errors. Together, these results show that stimulation of the mPrCG results in speech disfluencies resembling those of apraxia of speech, a clinical speech disorder of speech-motor sequencing and programming. In summary, we demonstrate the critical role of the mPrCG in speech-motor sequence planning and establish a

neurophysiological link between speech sequencing, the mPrCG, and apraxia of speech. These results further our understanding of speech-motor sequencing and stress the necessity of accounting for the mPrCG in models of speech production.

C37 - Modelling late positivities by large language models

Yiming Lu[1]; [1]University of California, Irvine

Background: Large language models (LLMs) have been increasingly applied to model event-related potentials (ERPs) in sentence processing. Researchers have extensively used LLMs to predict human N400. However, the later components, P600 and post-N400 frontal positivity (PNP), received much less attention. This study aims to reveal the predictive power of two information-theoretic measures estimated from LLMs, i.e., surprisal and entropy, for these two components. Previous ERP experiments showed that N400 is modulated by word predictability, but the later components could be more sensitive toward sentence constraints. As such, we anticipated that LLM surprisal should predict N400 fairly well. LLM entropy should predict the later components well. Methods: to validate these hypotheses, we used LLMs to model a recently published large-scale EEG experiment reported by Stone et al., (2023). Stone and colleagues examined the influence of sentence constraints in modulating frontal PNP and P600, where 64 participants were exposed to 56 sets of sentences differing in sentence constraints and final-word predictability. In the present work, we used LLM to calculate final-word surprisal and context entropy (masking the final critical words). To do so, we used the transformer language model, GPT-2. The specific models were the pre-trained versions of GPT-2 models accessed from the huggingface library (Wolf et al., 2020), including GPT-2 base (124M), GPT2-medium (355M), GPT-2 large (774M), and GPT-2 xl (1.5B). These models differ in the number of parameters, but they have the same training size (80M web pages) and vocabulary size (50257 words). Linear mixed effect models with by-subject and by-item intercepts were constructed for N400, P600, and frontal PNP separately. The Akaike Information Criteria (AIC) were extracted from models for comparison. Results: we found that surprisal was a good predictor for N400, replicating previous studies. Surprisal did not have predictive power over PNP and only smaller models report marginal significance for P600. For entropy, small models could not predict N400, but larger GPT-2 models could, contrary to previous results. Moreover, no LLM-entropy could predict P600 and PNP, which was the most surprising. Despite so, as model parameters increased, Akaike information criteria decreased for entropy, meaning that increasing parameter size provides a better trade-off between model fit and complexity. In conclusion, human entropy is markedly different from LLM entropy, but why is this the case? Several factors could be at play. Firstly, the LLM lexicon could be much larger than human participants. Also, the candidates that humans activate in next-word prediction were arguably much fewer than LLMs. Hence, GPT-2 entropy could be much larger than humans. Secondly, GPT-2 models are autoregressive models with perfect memory over the entire context window. This might not be the case for human comprehenders. Thirdly, not every word in the context was necessarily relevant. Human readers could selectively attend to the pertinent words, to activate the right situation model. In contrast, LLM entropy was calculated from every word in the preceding context. It is an open question whether LLM could develop selective attention to filter out irrelevant words in contexts.

C38 - Motor experiences rather than sensory errors mediate the update in speech production

Yuhan Lu[1,2], Xing Tian[1,2]; [1]New York University Shanghai, [2]NYU-ECNU Institute of Brain and Cognitive Science

Introduction: The ability to produce speech accurately is a fundamental adaptive behavior and vital in communication. The efficient control of speech production requires detecting sensory errors in speech feedback and generating motor compensatory responses to correct the errors. It remains in debate whether the past sensory errors or the history of motor compensation are weighted more in regulating naturalistic speech production. Methods: Using a serial-dependency paradigm, we introduce auditory feedback perturbation with random amounts in a sequence of trials. We quantified the systematic biases of the motor compensation amount in the current trial as a function of auditory feedback perturbation or motor compensation in the preceding trial. Results: In the first experiment when participants consistently produced the /a/ sound throughout trials, the motor compensation in the current trial was systematically attracted toward the compensation in the preceding trial rather than auditory feedback perturbation. The relationship between the current compensation and the last compensation formed a derivative-of-Gaussian-shaped curve. Next, we investigated whether this attractive bias occurred between different vowel categories. In the second experiment, participants produced different vowels in each trial. The attractive bias of motor compensation was significant even when adjacent trials were different vowels. The effect was smaller than that when the same vowels were in adjacent trials. Finally, we tested the attractive bias of motor compensation both within and across syntactic boundaries. Participants produced a four-syllable sentence with a noun phrase in the first two syllables followed by a verb phrase in the last two syllables. In the within-boundary condition, auditory feedback perturbation was applied to the first or third syllable, and we measured the attractive bias in the next syllable within the same phrase. In the across-boundary condition, perturbation was applied to the second syllable, and we measured the attractive bias in the next syllable across phrases. The attractive bias of motor compensation was stronger within boundaries than across boundaries. Summary: Collective results from a series of speech production studies that vary at phonological and syntactic levels consistently support that motor experiences mediate the adaption in subsequent vocal production. The attractive bias from past compensation depends on adjacent vowels and syntactic boundaries.

C39 - Modeling the trajectory of language processing in neural state space

Zhengwu Ma[1], Jixing Li; [1]City University of Hong Kong

Introduction. In recent years, dynamical system models have been increasingly adopted to explain neural population dynamics involved in functions such as decision-making, timing, and motor control (refer to Vyas et al., 2020 for a review). Language processing can similarly be conceptualized within a dynamical systems framework, where the lexicon is seen as regions within a state space, and grammar functions as attractors or repellers that constrain movement within this space (Elman, 1995). As demonstrated by Elman (1995), a simple recurrent neural network (RNN) can learn to differentiate lexical items as distinct regions within the hidden unit state space. The sequential dependencies among words in sentences are reflected by movement through this space as the network processes each word sequentially. These dependencies are encoded in the network's weights, mapping inputs (the current state plus a new word) to subsequent states. These weights effectively implement grammatical rules that facilitate the processing of well-formed sequences, enabling the network to form valid predictions about upcoming words. The generality of these rules means that the network weights form attractors in the state space, allowing the network to respond appropriately to novel inputs, such as unfamiliar words in known contexts. Since Elman's initial proposal of the language system as a dynamical system, empirical studies to validate this hypothesis have been limited. In this study, we adopt a dynamical systems approach to model sequential dependencies among words in sentences by tracking movement through the neural state space during naturalistic listening. Methods. We used a previously published magnetoencephalography (MEG) dataset where 36 participants (21 females, mean age = 24.2 years, SD = 10.4 years) listened to a 12-minute narrative in the scanner. We utilized LLaMA2 (Touvron et al., 2023), a widely-used open-source LLM, to extract the word embeddings for each word in the stimuli, along with the probability of each word given the preceding context. We then performed ridge regression to correlate these embeddings with source-localized MEG data within a left-lateralized language network. Subsequently, we averaged the MEG data across subjects, time-locked to each word from the significant spatiotemporal clusters. We reduced the dimensionality of both the word embeddings and the MEG data for each word to a two-dimensional state space using Principal Component Analysis (PCA). Finally, we used differential equations to model the temporal evolutions as the LLM and the brain process each word sequentially. Results. Our preliminary results revealed distinct clusters where auxiliary verbs, degree adjectives, and adverbs occupy different regions in the neural state space. Additionally, the transitions between words within the neural state space for each sentence, reflected as displacements in the neural state space, demonstrate similar patterns for similar grammatical rules. These findings provide initial evidence supporting Elman's (1995) hypothesis of a dynamic systems approach to language processing in the brain.

C40 - Testing different metrics for syntactic complexity in spontaneous speech: a cross-genre comparison

Simona Mancini[1,2], Jorge Hidalgo Chagoya[3], Roel Jonkers[3], Maddi Carrera[1], Xabi Ansorena[1]; [1]BCBL, Basque Center on Cognition Brain and Language, [2]Ikerbasque, Basque Foundation for Science, [3]University of Groningen

A commonly noted characteristic of aphasic discourse is the simplification of syntactic complexity (Ulatowska et al., 1990). Various methods and measures have been designed to evaluate this deficit, making discourse assessment a crucial component of aphasia evaluation, treatment, and research. Four elicitation genres of discourse are typically employed: descriptive, procedural, conversational, and narrative. However, aphasiology studies have shown that linguistic outcomes in discourse are often genre- and task-specific (Stark & Fukuyama, 2021). This research analyzes discourse samples collected during the validation of a digital neurolinguistic battery for the assessment of aphasia in Spanish (Ansorena et al., 2020). The study aims to determine which of the four administered tasks, corresponding to the four discourse genres, is most sensitive in detecting syntactic complexity deficits. Additionally, it investigates which task is most sensitive in detecting morphological complexity deficits, taking advantage of the morphological richness inherent in the Spanish language. Finally, we compare two approaches to measuring the morphosyntactic characteristics of discourse—using syntactic proxies versus directly metrics measuring 'syntactic structures' (as defined by Agmon et al., 2024)—to identify the most accurate set of variables for discriminating group membership. The spontaneous speech of twenty native speakers of Spanish with aphasia and fifteen sex- and age-matched, non-brain-damaged individuals was recorded while engaging in four different elicitation genres: the Cookie Theft Picture Description (Goodglass & Kaplan, 1972) and three newly developed tasks in Spanish: the Sandwich procedural task, a semi-structured Interview, and the Hare and the Tortoise Story Retelling. Data were preprocessed using manual transcription, parsing and error tagging, in addition to automated morphological tagging and variables extraction (CLAN; MacWhinney, 2000). We measured morphosyntactic complexity using syntactic proxies such as mean length of utterance (MLU), noun-verb ratio, and verbs per utterance, in addition to the 'syntactic structures' metric. Such metric included variables that measure the use of subordination, relative clauses, left-branching clauses, and word integration. Morphological complexity was assessed through an inflectional index based on Bastiaanse and colleagues (1996). Analyses of variance showed that the Cookie Theft Picture Description and the Hare and the Tortoise Story Retelling brought out the most differences across syntactic complexity metrics between the groups: while the descriptive task evoked significant differences in the use of relative clauses between the two groups, the narrative task evidenced stronger differences in the use of left branching clauses. Moreover, the story retelling task effectively captured the morphological deficits present in aphasic speakers. Binomial logistic regression models demonstrated that the 'syntactic structures' and morphological metrics best discriminated the output of the two groups compared to syntactic proxies. Overall, the data suggest that a comprehensive assessment of the syntactic complexity simplification in aphasia can be obtained with the administration of both descriptive and narrative discourse samples. These findings provide valuable guidance for clinicians and researchers seeking to assess morphosyntactic complexity in Spanish discourse, contributing to the improvement of the accuracy and effectiveness of language assessment and

treatment strategies.

C41 - Are the Time-reversed Syllables Perceptible ? Unraveling the question through MEG responses

Yuting Meng[1], Hua Fan[1], Hongwei Bian[1], Ziyi Zhang[1], Ling Liu[1]; [1]Beijing Language and Culture University

Time-reverse speech/ backward speech refers to a temporal reversal of natural speech signals, characterized by acoustic-phonetic distortions. As a non-speech tool, time-reverse speech is widely used in research on early stages of speech perception (acoustic-phonological processing). However, the neural mechanisms underlying the perception of reverse speech, especially at the syllabic level, remain unclear. Therefore, we employed magnetoencephalography (MEG) to investigate the dynamic perception of consonants, vowels, and lexical tones in time-reversed syllables. In the experiment 1, 27 participants (mean age 23) completed a speech perception discrimination task, in which they were asked to determine whether two consecutively presented forward/ backward syllables were identical. The forward syllables consisted of eight Mandarin Chinese syllables, each 250ms long, constructed from vowels /i/ and /u/, consonants /b/ and /d/, and tones 1 and 4. The backward syllables were generated by temporally reversing the forward syllables. MEG data were analyzed using multivariate pattern analysis (MVPA) to understand the decoding of different phonemes in the brain at various time points. The results indicated that all three phonemes of the forward syllables could be decoded within 100-500ms after sound onset, whereas consonants in the backward syllables either had very low decoding accuracy or could not be decoded at all. Comparatively, it was found that for the syllable_1, backward consonant decoding became more difficult between 280-330ms, while backward lexical tone decoding became easier between 100-220ms. Additionally, we observed bilateral brain involvement in processing for both forward and backward conditions. Given that children with autism may pay different attention to non-speech sounds compared to other children, it is possible that autistic children perceive time-reversed syllables differently. To account for different age groups and special populations, we designed Experiment 2. The experiment 2 employed an oddball paradigm with 20 participants (mean age 23). The same speech materials were used as in Experiment 1. For the forward condition, the syllable bi1 was the standard stimulus, while the other three syllables (di1 with consonant variation, bu1 with vowel variation, and bi4 with lexical tone variation) served as deviant stimuli. Results showed that in the forward syllable condition, vowel variation elicited both an early N200 effect and a late P300 effect, while lexical tone variation only elicited an N200 effect, with a smaller effect size compared to vowel variation. Consonant variation elicited only a P300 effect, smaller than that elicited by vowel variation. In the backward syllable condition, all deviant conditions elicited mismatch negativity (MMN) effects, with the largest MMN effect elicited by lexical tone variation, followed by vowel variation, and the smallest by consonant variation. In summary, both experiments indicate that at the early stage of speech perception, the brain shows differences in timing and perceptual sensitivity to different phonemes.

C42 - Neural geometry of speech preparation in ventral premotor cortex

Benyamin Meschede-Krasa[1], Erin Kunz[2,5], Foram Kamdar[3], Nicholas S. Card[10], Maitreyee Wairagkar[10], Carrina Iacobacci[10], Samuel R. Nason-Tomaszewski[13], Payton H. Bechefsky[13], Leigh R. Hochberg[7,8,9], David M. Brandman[10], Sergey Stavisky[10], Nicholas AuYong[12], Chethan Pandarinath[11,12,14], Jaimie M. Henderson[3,5], Francis R. Willett[2,3,5], Shaul D. Druckmann[4]; [1]Neurosciences Graduate Program, Stanford University, Stanford, CA, USA, [2]Department of Electrical Engineering, Stanford University, Stanford, CA, USA, [3]Department of Neurosurgery, Stanford University, Stanford, CA, USA, [4]Department of Neurobiology, Stanford University, Stanford, CA, USA, [5]Wu Tsai Neurosciences Institute, Stanford University, Stanford, CA, USA, [6]Howard Hughes Medical Institute, [7]School of Engineering and Carney Institute for Brain Sciences, Brown University, Providence, RI, USA, [8]VA RR&D Center for Neurorestoration and Neurotechnology, VA Providence Healthcare, Providence, RI, [9]Center for Neurotechnology and Neurorecovery, Department of Neurology, Massachusetts General Hospital, Harvard Medical School, Boston, MA, [10]Department of Neurological Surgery, University of California Davis, Davis, CA, USA, [11]Department of Cell Biology, Emory University, Atlanta, Georgia, USA;, [12]Department of Neurosurgery Emory University, Atlanta, Georgia, USA;, [13]Department of Biomedical Engineering, Emory University and Georgia Institute of Technology, Atlanta, Georgia, USA;

Recent speech decoding brain-computer interfaces have shown impressive performance by predicting sequences of phonemes from ventral premotor cortex (area 6v)[1, 2]. However, the neural representations underlying the preparation and production of speech in these areas remains poorly understood. The GODIVA model [3] predicts that ventral premotor cortex, including parts of area 6v, encodes a speech sound map which serves as a high level representation of sequences of speech sounds. Here we provide empirical evidence that 6v encodes whole sequences of phonemes before speech onset using neural representations that are shared across phoneme positions and task epochs (cue perception, preparation, and execution), consistent with 6v playing a higher level role in speech production that goes beyond feedback control of the speech articulators. Microelectrode arrays were placed in inferior 6v in three Braingate2 participants. In an instructed delay task, participants were cued with audio recordings of nonsense words composed of balanced sequences of three consonants separated by a repeated vowel. An example sequence of K-N-T was cued with the ARPABET phoneme sequence K-AH-N-AH-T. After a delay period, participants attempted to reproduce the cue. LDA models were fit to predict consonant phonemes individually for each position from delay period neural activity. All 3 phoneme positions were reliably decoded (classifier AUROCs consonant 1: 0.98, consonant 2: 0.89, consonant 3: 0.97) indicating that 6v can simultaneously encode phonemes in all positions. Models were then used to predict phonemes outside of the fitted position to assess similarity in phoneme encoding across position. Decoders fit between future consonants (positions 2 and 3) could generalize across context. Projecting held out trials into

LDA coding dimensions revealed a shared neural geometry for future phoneme encoding. Next we fit decoders to each of 3 contexts (cue listening, delay, and execution) and found that decoders could generalize across context, revealing a representation of speech sounds not strictly limited to motoric preparation and execution of speech. These results demonstrate that in the speech planning hierarchy, area 6v encodes a generalized preparatory representation of sequences of speech sounds. [1] Willett, F.R., Kunz, E.M., Fan, C. et al. A high-performance speech neuroprosthesis. Nature (2023). [2] Card, N.S. et al. An accurate and rapidly calibrating neuroprosthesis. Medrxiv (2023). [3] Bohland, JW., Bullock, D., & Guenther, F. H. (2010). Neural representations and mechanisms for the performance of simple speech sequences. Journal of cognitive neuroscience.

C43 - Recruiting the "right" hemisphere in foreign language learning in ageing brain—Evidence from diffusion-MRI

Xavreila Sheung-Wa Ng[1], Manson Cheuk-Man Fong[1], Matthew King-Hang Ma[1], Fangfei Li[1], Jiaxin Chen[1], Nga-Yan Hui[1], Cloris Pui-Hang Li[1], William Shiyuan Wang[1]; [1]The Hong Kong Polytechnic University

Introduction. The hemispheric asymmetry reduction in older adults (HAROLD) refers to a less lateralised frontal activity during cognitive performance (Cabeza, 2002), in response to age-related neurocognitive decline. Anatomical evidence for such compensation was observed in our previous study on foreign language learning (FLL; Fong et al., 2022). In the present experiment, we sought to obtain converging evidence on such compensatory processes based on diffusion-weighted imaging and examine the hypothesis that the commissural (specifically corpus callosum, CC) or right-hemispheric association fibres (arcuate fasciculus, AF; uncinate fasciculus, UF) are more strongly associated with FLL performance in older than younger adults. The CC is crucial for its role in interhemispheric communication, and has been shown to grant older adults a performance advantage in tasks that entail both hemispheres (Reuter-Lorenz & Stanczak, 2022). Thus, if FLL similarly recruits both hemispheres, it is plausible that FLL performance is partially mediated by the microstructure of CC. Similarly, as the left AF and UF are major pathways supporting language, under the HAROLD hypothesis, their right-hemispheric counterparts would also be associated with FLL performance. Method. Participants were 47 (older: 12F/12M; younger: 12F/11M) cognitively normal, right-handed, Cantonese-English bilinguals matched in education. Following a three-month Italian learning programme, diffusion data were acquired using a multi-shell sequence (b=1500 and 3000s/mm2; direction=99; voxel size=1.5mm). The data were analysed using DSI studio. Specific focus was placed on number of tracts (NumTract) and fractional anisotropy (FA). The vocabulary and grammar learning performance were evaluated every three lessons and through a final test. Accuracy served as the main performance metric while reaction time (RT) a supporting metric since it is often muddled by processing speed. Result. For CC, in older learners, FA was correlated with vocabulary accuracy (lessons, Spearman's rho=.42, p=.040; test, rho=.43, p=.035), vocabulary RT (lessons, rho=-.56, p=.004), and grammar accuracy (lessons, rho=.43, p=.037). In younger adults, only association with vocabulary RT was found, and only for NumTract (lessons, rho=-0.51, p=.014). For AF, NumTract was positively correlated with older learners' vocabulary accuracy for the right hemisphere (RH) (lessons, rho=.65, p=.015). For younger learners, NumTract was positively correlated with their grammar accuracy for LH (test, rho=.48, p=.026). For UF, FA correlated positively with older learners' vocabulary accuracy for LH (lessons, rho=.49, p=.015), while NumTract correlated with grammar accuracy for RH (lessons, rho=.54, p=.006). Discussion. In older adults, vocabulary acquisition is benefitted by an intact CC, while grammar accuracy is associated with a more bundled right UF. As for AF, although the NumTract is a significant predictor of accuracy for both age-groups for LH, only older adults exhibited a positive correlation with the vocabulary accuracy for RH. One should be cautioned that the AF is thinner on the RH on average, making it prone to unsuccessful reconstruction. Nonetheless, significant association could still be found at this smaller effective sample size. Taken together, our results lend further support to the HAROLD model. As such, the right hemisphere should be incorporated in future neurolinguistic studies on ageing. This research was supported by HKRGC-GRF 15606119.

C44 - Prediction of reading processing time in adults using auditory event-related potentials

Eunbi Park[1], Yukihide Horiguchi[1], Fumitaka Homae[1,2]; [1]Depeartment of Language Sciences,Tokyo Metropolitan University, [2]Research Center for Language, Brain and Genetics, Tokyo Metropolitan University

Reading involves various cognitive processes, resulting in variations in individual reading times. In this study, we explored whether processes that differ between individuals with dyslexia (who have specific reading difficulties) and non-dyslexic controls could also explain reading processing times in non-dyslexics. Two types of auditory processing, speech sounds and temporal changes, have been reported to be difficult for dyslexics, and are reflected in neurophysiological indices (Goswami, 2011; Sharma et al., 2006). Herein, we investigated the relationship between reading processing speed and auditory event-related potentials (AERPs) elicited by speech sounds and temporal changes. Data from 50 native Japanese speakers (23 females, mean age: 20.6 ± 1.7) who did not report difficulty in reading were analyzed. Electroencephalography (EEG) recording was performed while two types of oddball sessions were conducted: 1) speech sound condition: foreign phoneme contrast of English /la/ and /ra/, and 2) pure tone condition: different interstimulus intervals of the same pure tone stimulus. The mean amplitude differences between the standard and deviant stimuli in two time windows (mismatch negativity, MMN: 145 – 297 ms; late discriminative negativity, LDN: 297 – 600 ms) were calculated for each condition. After EEG recordings, participants performed a reading assessment designed for Japanese speakers (STRAW-R; Uno et al., 2017), which included four different tasks: Rapid Automatized Naming (RAN), word reading, nonword reading, and sentence reading. Subsequently, we examined the relationship between electrophysiological indicators (MMN and LDN) and the time of each reading task in

the STRAW-R using multiple linear regression analyses. We observed significant regression models for RAN and word-reading tasks. For the RAN task, the MMN amplitude of the standard /la/ and deviant /ra/ predicted reading time, indicating that participants with larger MMN amplitude for speech sounds have poorer RAN scores ($R2 = 0.12$, $F(4,45) = 2.67$, $p = 0.04$; $\beta = -0.35$, $p = 0.02$). In the word reading task, the LDN amplitude of the standard /la/ and deviant /ra/ predicted that participants with larger LDN amplitudes had slower reading times ($R2 = 0.13$, $F(4,45) = 2.86$, $p = 0.03$; $\beta = -0.38$, $p < 0.01$). The regression results revealed that AERPs elicited by speech sound differences can predict reading processing time. Phonological processing difficulties have previously been suggested to predict learning the read in children (Snowling, 1995). The current findings suggest that individual phonological processing differences can also affect reading processing speed in non-dyslexic adults. The opposite polarity of the current results compared to prior studies reporting attenuated MMN and LDN amplitudes in dyslexics (Hommet et al., 2009; Gu and Bi, 2020) likely stems from the use of a foreign phoneme contrast in this study. The MMN amplitude induced by speech sounds is reduced when stimuli are distant from the typical phonemes of the native language (Näätänen et al., 1997). Accordingly, participants with larger AERPs to foreign phoneme contrasts in this study may have had unstable native phoneme representations. Overall, we propose that neurophysiological responses to foreign phoneme contrasts represent a novel index for investigating reading processes in adults.

C45 - Bilingualism modulates domain-general functional connectivity: insights from resting-state electroencephalogram

Christos Pliatsikas[1,2], Alex Sheehan[1], Doug Saddy[1]; [1]School of Psychology and Clinical Language Sciences, University of Reading, [2]Universidad Nebrija, Spain

Bilingualism impacts cognition, brain structure, and function. This is expressed as effects in behavioural tasks in the language and executive control domains(1–3),changes to brain structure in regions associated with language and executive control(4–6), and alterations to brain function and connectivity in resting-state electroencephalography(EEG) studies(7–9). These findings include increased posterior activity compared to monolinguals, increased interhemispheric connectivity, and increased long-distance communication as the bilingual experience increases. The Bilingual Anterior to Posterior and Subcortical Shift(BAPSS) model suggests that these patterns indicate that bilinguals rely less on frontal regions and more on posterior and subcortical regions as experience increases(10). The aim of this study was to determine how degree of bilingualism interacts with domain-general task demands to impact whole-brain functional connectivity. The study used a novel task-driven resting-state EEG paradigm, using the short-term variability of resting-state connectivity to measure the patterns of connectivity pre- and post- a cognitively demanding task. We used the Language and Social Background Questionnaire(LSBQ) to assess demographics and degree of bilingualism(11). We used a serial reaction-time artificial grammar learning task designed to assess hierarchical structure representation and implicit statistical learning. This is a very generalised higher cognitive ability so is considered to be cognitive domain-general, with bilinguals having been found to perform better than monolinguals(12). We used a binary Lindenmayer grammar which follows the Fibonacci sequence(13), presented to participants as red or blue circles to which they must respond indicating which colour they were just shown(14). We analysed the data using Generalised Additive Models, modelling the LSBQ composite score against connection strength between multiple regions of interest. The connectivity patterns were then compared to assess any differences between the at-rest and post-task states. Pre-task, level of bilingualism showed a significant relationship with the connectivity strength between long-distance(e.g.,frontal-parietal), inter-hemispheric, and intra-hemispheric connections – a total of 4 significant connections affected by level of bilingualism. Our post-task recordings yielded 10 significant bilingualism-modulated connections – involving multiple long-distance (e.g.,parietal to frontal; central to occipital), inter-hemispheric, left temporal, and medial occipital region connections. Crucially, the post-task connectivity analysis revealed new bidirectional interhemispheric temporal connections, and an increase in the number of total connections to occipital and left temporal areas. These findings are compatible with the BAPSS model, indicating that linguistic experience affects the brain regions recruited to complete the task at hand – involving greater occipital, temporal, and interhemispheric connectivity, particularly during task-based cognition. We propose that this is due to the increased control demands in bilingualism, leading to increased efficiency of automatic monitoring processes, and thus greater strength of functional connections in regions enlisted for these demands. The clustering of connections around the left temporal region post-task is particularly unexpected. This suggests strong language network activation despite no language being present in the task. 1. Calvo & Bialystok, Cognition, 130, 278–288 (2014). 2. Akhtar & Menjivar, Chapter 2, Advances in Child Development and Behavior, vol.42, 41–78(2012). 3. Prior & Macwhinney. Biling. Lang. Cogn., 13, 253–262 (2010). 4. Pliatsikas, Biling. Lang. Cogn. 23, 459–471 (2020). 5. Korenar et al.(in prep), https://doi.org/10.21203/rs.3.rs-1017465/v1 (2021). 6. Olsen et al., Brain Res., 1612, 128–139 (2015). 7. Grundy et al., NeuroImage, 159, 280–288 (2017). 8. Bice et al., Neurobiol. Lang., 1, 288–318 (2020). 9. Pereira Soares et al., Brain Lang., 223, 105030 (2021). 10. Grundy et al., Ann.N.Y. Acad. Sci., 1396, 183–201 (2017). 11. Anderson et al., Behav. Res. Methods, 50, 250–263 (2018). 12. Vender et al., Front. Psychol. 10, (2019). 13. Krivochen, ArXiv210401363 Cs (2021). 14. Schmid et al. (in prep), https://doi.org/10.31234/osf.io/fp5zb (2022).

C46 - Disconnections Related to White Matter Hyperintensities Predict Semantic Memory Impairments in Post-Stroke Aphasia

Ida Rangus[1], Natalie Busby[1], Rebecca W. Roth[2], Janina Wilmskoetter[3], Julius Fridriksson[1], Leonardo Bonilha[4]; [1]Communication Sciences and Disorders, University of South Carolina, Columbia, SC, USA, [2]Department of Neurology, Emory University, Atlanta, GA, USA, [3]Department of Rehabilitation Sciences, College of Health Professions, Medical

University of South Carolina, Charleston, SC, USA, [4]School of Medicine Columbia, University of South Carolina, Columbia, SC, USA

Background: Semantic memory impairments in post-stroke aphasia refer to difficulties in accessing or retrieving knowledge about the world, including understanding the meaning of words, concepts, and facts. These impairments can manifest as challenges in naming objects, comprehending spoken and written language, and using appropriate vocabulary, significantly affecting communication and daily functioning. Such deficits may arise from damage to white matter pathways caused by stroke lesions that disrupt connections between critical language and memory regions. The presence of white matter hyperintensities (WMH), a marker of reduced brain health, may exacerbate these disconnections and potentially worsen semantic memory impairments. Our aim was to assess whether semantic memory performance is better explained by combined disconnections from stroke lesions and WMH, compared to disconnections from stroke lesions alone. Methods: Seventy-two individuals with chronic left-hemisphere stroke (mean age at testing: 58.4 ± 13.1 years, mean stroke lesion volume: 133.2 ± 95.6 cc; 31 females [43.1%]) underwent MRI and behavioral assessments. Stroke lesions were manually delineated on T2-weighted images, and WMH were identified from FLAIR images using FSL's automated segmentation tool BIANCA. Using the Lesion Quantification Toolkit, we quantified the percentage of disconnection within association tracts relative to the whole tracts due to stroke lesions and WMH, respectively. Semantic memory was assessed using the Pyramids and Palm Trees Test (PPTT). To determine whether stroke- and WMH-related disconnections together explained more variance in semantic memory performance than disconnections due to stroke lesions alone, we ran two multiple linear regression models with PPTT as the dependent variable: 1.) the Stroke Lesion Model included only disconnections due to stroke lesions, controlling for age, sex, education, lesion volume and aphasia severity (measured by Western Aphasia Battery revised Aphasia Quotient - WAB-R-AQ), 2.) the Combined Lesion and WMH Model included both disconnections due to stroke lesions and WMH, with the same covariates. Adjusted R^2 values of the two models were compared using ANOVA to determine whether adding disconnections due to WMH significantly improved the model fit. Results: Stroke Lesion Model explained 8.9% of the variance in semantic memory performance (Adj. $R^2 = .089$, $F(6, 66) = 2.169$, $p = .057$), with only WAB-R-AQ as a significant predictor ($t = 2.443$, $p = .017$). The Combined Lesion and WMH Model explained 24.9% of the variance in semantic memory performance (Adj. $R^2 = .249$, $F(7, 65) = 4.412$, $p < .001$), with disconnections from WMH as the only significant predictor ($t = -3.884$, $p < 0.001$). Including disconnections from WMH significantly improved model fit over disconnections from stroke lesions alone ($\Delta F(1, 65) = 15.089$, $p < .001$). Discussion: White matter disconnections from WMH significantly impact semantic memory performance in individuals with post-stroke aphasia. Incorporating WMH disconnections substantially enhances the ability to explain variance in semantic memory deficits, beyond the effects of disconnections caused by stroke lesions alone. This finding emphasizes the importance of considering overall brain health in understanding cognitive-communication impairments in post-stroke aphasia.

C47 - Comprehending semantic and syntactic anomalies from an LLM versus human interlocutor: An ERP study

Xiaohui Rao[1], Hanlin Wu[1], Zhenguang Cai[1]; [1]The Chinese University of Hong Kong

As large language models (LLMs) increasingly engage in human-like conversations, it is crucial to know how people comprehend language produced by LLMs compared to humans. When processing sentences, people would evaluate the input against their world, lexical-semantic and grammatical knowledge, with semantic anomalies eliciting an N400 effect and syntactic anomalies eliciting a P600 effect. The N400 and P600 effects can be modulated by our expectations about the interlocutor's identity (e.g., Hanulíková & Carreiras, 2015; Van Berkum et al., 2008). However, it remains unclear whether people have similar expectations when interacting with LLM interlocutors and with human ones. LLMs are known for their superb grammatical competence, but may sometimes subject to illusion, producing nonsensical responses (Rawte et al., 2023). If so, people may exhibit reduced sensitivity to semantic anomalies (a smaller N400 effect) and increased sensitivity to syntactic anomalies (a larger P600 effect) when interacting with LLM interlocutors compared to human interlocutors. To address this question, we conducted two ERP experiments to investigate how people process semantic anomalies (Experiment 1) and syntactic anomalies (Experiment 2) when they were introduced that these sentences are produced by an LLM versus a human interlocutor. Experiment 1 used 40 semantically coherent/anomalous Chinese sentences (e.g., 小玲调完闹钟/月亮就睡觉了. Xiaoling set the clock/moon and went to bed), with 80 semantically coherent fillers, presented word by word at a fixed rate, followed by a sentence sensibility judgement task. Linear mixed-effects models showed a main effect of Sentence Type at the critical word (e.g., clock/moon), an N400 effect to semantic anomalies ($p<.0001$). There was a significant interaction between Sentence Type and Interlocutor Type ($p<.05$), such that participants exhibited a reduced N400 effect when interacting with perceived LLM versus human interlocutors. This indicates people are less sensitive to semantic anomalies produced by LLMs, potentially due to expectations of LLMs' higher chance of illusion. Experiment 2 was similar but focusing on syntactic anomalies, using 40 syntactically well-formed/anomalous sentences (e.g., 昨天/明天，小明吃过汉堡了，今天就不了.Yesterday/Tomorrow Xiaoming has eaten a hamburger, so today he doesn't want to), with 80 well-formed fillers. Results showed a main effect of Sentence Type at the critical segment (e.g., has eaten) ($p<.05$) and an interaction with Interlocutor Type ($p<.05$), such that a P600 effect was only observed for syntactic anomalies from LLMs, not humans. This suggests insensitivity to syntactic anomalies from humans but increased sensitivity to those from LLMs, possibly because people don't expect LLMs to produce syntactically deviant sentences and are more tolerant to humans in this regard. Our findings provide novel insights into how people

process language produced by LLM interlocutors compared to human interlocutors. The reduced N400 to semantic anomalies and increased P600 to syntactic anomalies potentially reflect people's awareness of LLMs' potential hallucinations and near-perfect grammatical competence, respectively. This aligns with previous findings that people's expectations about their interlocutors can modulate the N400 and P600 effects.

C48 - Establishing and evaluating the gradient of item naming difficulty in post-stroke aphasia and semantic dementia

Rahel Schumacher[1,2], Erling Nørkær[3], Ajay D. Halai[2], Anna Woollams[4], Matthew A. Lambon Ralph[2]; [1]Neurocenter, Luzerner Kantonsspital, Lucerne, Switzerland, [2]MRC Cognition and Brain Sciences Unit, University of Cambridge, Cambridge, United Kingdom, [3]Department of Psychology, University of Copenhagen, Copenhagen, Denmark, [4]Division of Neuroscience and Experimental Psychology, University of Manchester, Manchester, United Kingdom

Anomia is a common consequence following brain damage and a central symptom in semantic dementia (SD) and post-stroke aphasia (PSA), for instance. Picture naming tests are often used in clinical assessments and experience suggests that items vary systematically in their difficulty. Despite clinical intuitions and theoretical accounts, however, the existence and determinants of such a naming difficulty gradient remain to be empirically established and evaluated. Seizing the unique opportunity of two large-scale datasets of semantic dementia and post-stroke aphasia patients assessed with the same picture naming test, we applied an Item Response Theory (IRT) approach and we (a) established that an item naming difficulty gradient exists, which (b) partly differs between patient groups, and is (c) related in part to a limited number of psycholinguistic properties - frequency and familiarity for SD, frequency and word length for PSA. Our findings offer exciting future avenues for new, adaptive, time-efficient, and patient-tailored approaches to naming assessment and therapy.

C49 - Neural substrates of phonology-to-orthography consistency on Chinese character and Japanese Kanji reading based on fMRI investigations

bingfeng shan[1], ayumi seki[2]; [1]Hokkaido University Graduate School of Education, [2]Hokkaido University Faculty of Education

Both Chinese and Japanese utilize Chinese characters (kanji in Japanese), which share many similarities in orthography and semantics. However, they differ in phonology-to-orthography consistency. In Chinese, each character typically has one pronunciation, whereas most kanji in Japanese have multiple possible readings depending on the context. This consistency difference suggests different neural mechanisms of phonological processing across the two languages. It remains unclear whether the consistency difference alone can fully explain the divergence in Chinese characters reading between Japanese and Chinese. Therefore, this study employed functional magnetic resonance imaging (fMRI) to compare the neural activations associated with Chinese characters/kanji reading under varying consistency conditions, aiming to investigate the relationship between cross-linguistic differences and phonology-to-orthography consistency. The study recruited 12 Chinese and 12 Japanese university students as participants. Chinese character/kanji stimuli were divided into four consistency conditions (low, medium, high, fully consistent) based on the proportion of the most frequent pronunciation relative to all possible pronunciations. Participants silently read the presented Chinese character/kanji stimuli and judged whether a specified syllable was included, while their neural responses were recorded using 3T Siemens MRI scanner. In the analysis, whole-brain analysis compared neural activations across all consistency conditions between the two languages. Additionally, a two-way ANOVA with language and consistency as factors identified brain regions modulated by consistency level. These consistency-related regions were defined as regions of interest (ROIs). Percent signal change was extracted from the ROIs for each consistency condition. In addition to these consistency-related ROIs from the ANOVA, the left inferior frontal gyrus (IFG) and middle frontal gyrus (MFG) were also included in the ROI analysis, as previous studies have implicated these regions in consistency effects. The whole-brain analysis showed broad bilateral brain network engagement during reading in both Chinese and Japanese, with no significant differences between the two language groups. The ANOVA revealed a main effect of consistency level in bilateral fusiform gyri (FG), left inferior parietal lobule (IPL), and left postcentral gyrus (PG). A main effect of language was found in noncritical regions like the cuneus, posterior cingulate, and left cerebellum. No interaction between language and consistency emerged. In the ROI analysis, the bilateral FG, left IPL, and left PG exhibited a similar inverted U-shaped pattern across languages, peaking at medium condition. However, in the left IFG and MFG, the modulation of activity by consistency levels differed between the Chinese and Japanese. After controlling for consistency level, no significant differences were observed between Chinese character and kanji reading, suggesting highly overlapping neural networks for phonological processing. The similar activity patterns in the bilateral FG, left IPL, and left PG further indicate that consistency effects operate equivalently across the two languages. However, distinct consistency effects in left IFG, MFG imply these regions may contribute differentially to the phonological processing of Chinese characters across the two languages. Beyond consistency, there may be other factors influenced by the inherent disparities between the writing systems could modulate the neural substrates underlying character reading.

C50 - Neural Correlates of Linguistic and Pragmatic Deficits in Right Hemisphere Stroke: A Systematic Review

Shannon M. Sheppard[1], Petrea Cornwell[2], Alexandra Zezinka Durfee[3], Melissa Johnson[4], Perrine Ferré[5], Laura Murray[6], Margaret Lehman Blake[7], Jamila Minga[8], Ronelle Hewetson[2]; [1]University of Washington, Seattle, WA, [2]Griffith University, South East Queensland, Australia, [3]Towson University, Towson, MD, [4]Nazareth University, Rochester, NY, [5]McGill University, [6]Western University, London, ON, Canada, [7]University of Houston, [8]Duke University

Introduction: Right hemisphere damage (RHD) can cause a wide variety of deficits impacting language and pragmatics, yet we know little about concomitant neural correlates. A previous systematic review focused on prosodic deficits in RHD (Zezinka Durfee et al., 2021) found that damage to right hemisphere dorsal stream structures were implicated in expressive prosodic deficits, and damage to ventral stream structures were implicated in receptive deficits. The current study is a systematic review by the Academy of Neurologic Communication Disorders and Sciences (ANCDS) Right Hemisphere Disorder (RHD) Evidence-based Writing Group to investigate neural regions implicated in additional language and pragmatic deficits frequently seen following RHD. Method: A PRISMA-guided systematic review searched research published between 1970 and 2022 and identified over 10,000 unduplicated papers. The full review included 1118 articles, and 440 remained following full article review. Methodological quality was evaluated (Kmet et al., 2004), which excluded 72 additional articles using a 55% cutoff out of the total possible quality points. Authors independently completed data extraction for the remaining 316 articles. These 316 articles were evaluated for their ability to determine brain-behavior relationships through lesion localization, and 252 were excluded. The remaining 64 articles were evaluated to determine which areas of language and pragmatics were addressed in localization analyses. Areas (e.g., neglect dyslexia, discourse production, etc.) where at least three articles evaluated localization were included in the review, which resulted in 33 articles. Lesion trends within each identified area were explored. Descriptive data on the types of lesion analyses were also extracted to determine whether articles provided specific (e.g., “superior temporal gyrus,” voxel-level) or broad (e.g., anterior/posterior) lesion information, and whether lesion relationships were explored using statistical analyses or description of relationships without statistical support. Results: The 33 articles with relevant lesion localization data addressed several linguistic and pragmatic categories: Neglect dyslexia (5 articles), emotional facial expression recognition (4 articles), theory of mind (3 articles), discourse production (6 articles), discourse comprehension (5 articles), emotion processing (experiencing emotion) (3 articles), figurative language comprehension (6 articles), word-level language comprehension (6 articles), and word-level language production (5 articles). Note that some articles addressed more than one area. Specific lesion information was provided in 42% of articles, and 64% of articles explored lesion relationships using support from statistical analyses. Similar to previous findings in expression and comprehension of emotional prosody, RH dorsal stream lesions were associated with discourse production deficits, whereas RH ventral stream lesions were linked to discourse comprehension deficits. Conclusion: Localized right antero-superior (dorsal stream) regions contributed to discourse production impairments, whereas damage to more postero-lateral (ventral stream) regions resulted in discourse comprehension deficits. This review provides support that distinct RH regions are vital for discourse comprehension and production. Impact of study design on resulting interpretations is discussed. A better understanding of brain-behavior relationships can support the identification of profiles of impairment based on neurological deficits to improve clinical assessment recommendations.

C51 - TMS Efficacy Related to Topological Properties of Right Pars Triangularis in Chronic Aphasia

Harrison Stoll[1], Apoorva Kelkar[1], Denise Harvey[2], Olu Faseyitan[2], Branch Coslett[2], John Medaglia[1,2]; [1]Drexel University, [2]Univeristy of Pennslyvania

Recovery from post-stroke aphasia requires the recruitment of new brain regions. Many of these regions are right hemisphere homotopes of left hemisphere language regions with different structural and functional properties in persons with aphasia (PWA) relative to controls (Saur et al., 2006). One region, the right pars triangularis (rPTR), has been associated with language dysfunction in PWA (Postmancheux et al., 2010) and has been a target in inhibitory transcranial magnetic stimulation (TMS) combined with language therapy (Medina et al., 2012). While a promising intervention, inhibiting the rPTR does not improve language outcomes in all PWA. One approach to identify moderating factors of TMS efficacy is to identify individual differences in the rPTR that correspond to treatment effects in language outcomes. The current study examines the structural properties of the rPTR and their relationship with naming performance after TMS. To address this, we examined single-tract connections from the rPTR to language regions in the right and left hemisphere using measures such as network centrality (e.g., degree—number of connections from one region to others) and whole brain density (e.g., fraction of observed connections between regions, relative to all potential connections). Twenty-nine PWA underwent 10 sessions of inhibitory (1 Hz) TMS to the rPTR followed by 1 hour of Constraint Induced Language Therapy. Twenty patients received active TMS and 9 received sham stimulation. Patients also completed high-resolution MRI scanning. The Philadelphia Naming Test (PNT; Roach et al., 1996) was administered at baseline. Using baseline (pre-treatment) MRI scan, we constructed structural connectomes to estimate edge weights between the rPTR and the left pars triangularis (lPTR), left middle temporal gyrus (lMTG), and right middle temporal gyrus (rMTG). For network centrality measures, we examined degree, betweenness centrality, and eigenvector centrality. We also computed measures for the entire brain, including whole-brain density. In the active and sham group, we correlated each measure with the difference between post- and pre-TMS overall accuracy on the PNT and the proportion of error types (i.e., semantic and phonological). For significant correlations, we ran post hoc regression models to if the relationship for the active group was larger than the sham group. We found a correlation between proportion of phonological errors made and single edge weight from the rPTR to the rMTG ($r = -.65$, $p < .005$). Specifically, fewer phonological errors were made after TMS when the patient had a weaker connection from the rPTR to the rMTG. The regression model comparing the active to the sham condition was also statistically significant ($b = .11$, $p < .05$), with the active group having a stronger slope than the sham group . Our findings provide evidence that the strength of anatomical connections from the rPTR to the rMTG moderate TMS efficacy

on naming in PWA. Specifically, individuals with a weaker connection at baseline derived greater benefit from TMS. The data raises the possibility that the strength of structural connection from the rPTr to the rMTG could predict response to TMS to the rPTr in chronic aphasia.

C52 - Neural Encoding for Language with Supervised Large Language Models

Jingyuan Sun[1], Marie-Francine Moens[2]; [1]KU Leuven

Neural encoding for language is a critical topic at the intersection of natural language processing and cognitive neuroscience. The recent advancements in deep learning and pre-trained language representations have opened new avenues for improving the precision and efficiency of neural encoding. Using pre-trained language representations in neural encoding allows for a deeper capture of the complex relationships between linguistic stimuli and neural responses, potentially leading to the creation of superior language processing models. Furthermore, exploring the relationship between artificial and neural representations of language can provide valuable insights into the fundamental mechanisms of language processing. Despite extensive research on unsupervised embeddings for English language neural encoding, there is a lack of studies on supervised embeddings for neural encoding in other languages, such as Chinese. Moreover, the few studies that adopt supervised embeddings for neural encoding in English often rely on fine-tuning pre-trained models for task supervision. However, fine-tuning has been shown to distort the pre-trained knowledge, which is inconsistent with the human brain's mechanism that does not require significant reformation of the language network to learn new tasks. To address these gaps, this paper proposes using both fine-tuned and prompt-tuned supervised sentence embeddings to fit a neural encoding model for Chinese. Prompt-tuning, which protects pre-trained knowledge by freezing weights and learning additional embeddings to fit a task, has not been widely explored for neural encoding, and this paper aims to address this gap. In pursuit of this goal, we employ both partial and full fine-tuning as well as prompt-tuning to adapt the pre-trained language model to eight different natural language understanding (NLU) tasks individually. The aim is to discern the influence of task tuning on a Transformer model for neural encoding and identify which tasks result in the best encoding performance. We find that: 1. Prompt-tuning on five of the eight tasks yields supervised representations that significantly exceed fully fine-tuned peers in predicting brain activities in the language network. However, on none of the eight tasks do fine-tuned embeddings significantly outperform the prompt-tuned ones in neural encoding. 2. Tuning on tasks that require a compositional understanding of entities and concepts yields supervised representations that are better at neural encoding than tuning on other tasks. 3. The proportion of tuned parameters highly influences the neural encoding performance of fine-tuned models. In summary, this paper makes three key contributions. First, we propose a novel neural encoding framework with prompt-tuned supervised representations, proving it to be a viable alternative to fine-tuning-based methods. Second, we demonstrate how different tuning methods influence a pre-trained Transformer in neural encoding through comprehensive experiments. Third, our findings indicate that balancing the protection of pre-trained knowledge and learning task-related features is crucial for optimal neural encoding performance. Overall, this work could help us better understand the relationship between task-tuned artificial and brain language representations.

C53 - The relation of articulatory and laryngeal auditory–motor control in tonal language speakers

Ding-Lan Tang[1], Win-Yin Chan[1], Siu-Hin Choi[1], Hiu-To Chu[1]; [1]University of Hong Kong

Background: Speech production is one of the most complicated motor behaviour involving multiple subsystems. Recent studies in non-tonal language speakers found no significant correlation between articulatory and laryngeal auditory-motor control subsystems. However, in non-tonal languages, articulatory parameters such as formants are used to convey phonemic identity, while laryngeal parameters such as the fundamental frequency (F0) primarily affect prosody. In contrast, in tonal languages (e.g. Mandarin and Cantonese), F0 (i.e., tones) are also used to change phonemic identity. In addition, speech production relies on both feedback and feedforward control. Previous work investigating the relationship between feedback and feedforward control of articulatory and laryngeal subsystems have yielded mixed results. Purpose: The current study aimed to examine 1) the relationship between articulatory and laryngeal auditory–motor control and 2) the relationship between feedback and feedforward systems during both articulatory and laryngeal control in tonal language speakers using altered auditory feedback paradigms. Methods: Seventeen (aiming for twenty) healthy native Cantonese speakers (all female) produced single Cantonese words (“車(cɛ1)”—car, “吃(hɛk6)”—eat, “石(sɛk3)”—stone, containing the same vowel /ɛ/), while the first formant (F1) or F0 of their auditory feedback was suddenly and unpredictably perturbed to assess reflexive responses or gradually and predictably perturbed to assess adaptive responses (F0: +100 cents; F1: + 110 mels). Results: On average, Cantonese speakers exhibited significant reflexive responses of -16.1 (± 6.2) cents and adaptive responses of -34.8 (± 52.3) cents to the unpredictable and predictable F0 perturbations, respectively. Participants also produced significant reflexive responses of -4.7 (± 7.4) mels and adaptive responses of -29.3 (± 32.3) mels to the unpredictable and predictable F1 perturbations. However, similar to previous findings in non-tonal language speakers, no statistically significant correlations were found between F0 and F1 reflexive responses or F0 and F1 adaptive responses in the current study. In addition, Cantonese speakers’ reflexive responses to unpredictable perturbations were not related to their adaptive responses to predictable perturbations during both articulatory (F1) and laryngeal (F0) control. Conclusion: These findings indicate that 1) auditory-motor control mechanisms of the articulatory and laryngeal speech production subsystems operate differently, regardless of the linguistic role of acoustic parameters in tonal or non-tonal languages; 2) there are disparate feedback and feedforward control mechanisms for both laryngeal and articulatory subsystems in tonal language speakers. The combined results provide support for differing

feedback and feedforward mechanisms for both laryngeal and articulatory control in typical speakers.

C54 - The Fundamental Role of Self-Reference in Multimodal and Dynamic Communicative Settings: An fMRI Study Using Movies

Thivina Thanabalan[1], Ina Bornkessel-Schlesewsky[1], Matthias Schlesewsky[1]; [1]Cognitive Neuroscience Laboratory, University of South Australia

Unlike any other communication medium, language allows for self-related information to be externalised and communicated to others. In turn, when others express self-related information, we can infer the intended meaning based on our own experience as language users. Strikingly, previous psycholinguistic research suggests that the first-person (self) has a special status in comparison to non-first-person (other) references even when we are comprehending another person's self-references. For example, Brilmayer et al. (2019) demonstrated that in contrast to other-references, self-references elicited electrophysiological responses that were unaffected by contextual factors in a naturalistic story. In the present study, we set out to expand on prior perspectives regarding the "self" by exploring how self and other references manifest in terms of functional neuroanatomy. To this end, we employed open-source functional magnetic resonance imaging (fMRI) data recorded while participants watched full length movies. Out of the 86 participants' data made available by the Naturalistic Neuroimaging Database (Aliko et al., 2020), we selected data from 50 participants (24 females, aged= 19-58 years, M= 27.80, SD= 10.58) who watched one of four movies belonging to various genres (horror, romance, comedy and documentary). We annotated the selected movie transcripts with relevant linguistic features including first, second and third person pronouns and their importance in the discourse (topic status). Using these linguistic features as regressors of interest, we conducted whole-brain fMRI analyses to identify group-level self vs other contrast effects as well as topic main and interaction effects. Our findings revealed that, in contrast to self-references (I), second-person references (you) activated partly unimodal visual processing areas such as the occipital and calcarine gyri. By contrast, third person references (he, she) more strongly engaged an extensive cortical network comprising regions including the precentral gyri, cerebellum and putatively supramodal posterior temporal and inferior parietal areas. This suggests that self-reference can be regarded as a default in communication, with the processing of other reference types recruiting additional brain networks. Additional support for this view stems from the finding that whole-brain BOLD responses to self-reference tended to be close to baseline levels regardless of how important these references were in the discourse (i.e. regardless of their topic status). Self-reference thus appears to serve as an anchor point in an otherwise dynamic communicative setting. Our results provide further converging evidence for the fundamental role of self-reference in human interactions. They further indicate that this is implemented in neural terms through the dynamic recruitment of various additional networks for the processing of reference to others, possibly reflecting the added requirements of non-first-person perspective taking.

C55 - Vision matters for shape representation: Evidence from sculpturing and drawing in the blind

Shuang Tian[1], Lingjuan Chen[1], Xiaoying Wang[1], Guochao Li[1], Ze Fu[1], Yufeng Ji[4,5], Jiahui Lu[1], Xiaosha Wang[1], Shiguang Shan[4,5], Yanchao Bi[1,2,3]; [1]State Key Laboratory of Cognitive Neuroscience and Learning & IDG, McGovern Institute for Brain Research, Beijing Normal University, Beijing 100875, China, [2]Beijing Key Laboratory of Brain Imaging and Connectomics, Beijing Normal University, Beijing 100875, China, [3]Chinese Institute for Brain Research, Beijing 102206, China, [4]Institute of Computing Technology, Chinese Academy of Sciences, Beijing 100190, China, [5]University of Chinese Academy of Sciences, Beijing 100049, China

Shape is a property that could be perceived by vision and touch, and is classically considered to be supramodal. While there is mounting evidence for the shared cognitive and neural representation space between visual and tactile shape, previous research tended to rely on dissimilarity structures between objects and had not examined the detailed properties of shape representation in the absence of vision. To address this gap, we conducted three explicit object shape knowledge production experiments with congenitally blind and sighted participants, who were asked to produce verbal features, 3D clay models, and 2D drawings of familiar objects with varying levels of tactile exposure, including tools, large nonmanipulable objects, and animals. We found that the absence of visual experience (i.e., in the blind group) led to stronger differences in animals than in tools and large objects, suggesting that direct tactile experience of objects is essential for shape representation when vision is unavailable. For tools with rich tactile/manipulation experiences, the blind produced overall good shapes comparable to the sighted, yet also showed intriguing differences. The blind group had more variations and a systematic bias in the geometric property of tools (making them stubbier than the sighted), indicating that visual experience contributes to aligning internal representations and calibrating overall object configurations, at least for tools. Taken together, the object shape representation reflects the intricate orchestration of vision, touch and language.

C56 - Clinical neuroimaging as a predictor of recovery from aphasia over time

Lily Walljasper[1], Deborah F. Levy[1], Marianne Casilio[1], Sarah M. Schneck[1], Jillian L. Entrup[1], Anna V. Kasdan[1], Michael de Riesthal[1], Stephen M. Wilson[1,2]; [1]Vanderbilt University Medical Center, [2]University of Queensland

Although acute MRI/CT is highly predictive of long-term outcomes in aphasia after stroke [1,2], the predictive power of clinical neuroimaging for projecting recovery (change in behavior over time) is substantially harder to demonstrate. The subacute-to-chronic period—a critical time frame where acute medical factors have resolved yet substantial recovery is still occuring—poses a particular challenge, given that behavioral change in this timeframe depends strongly on initial aphasia severity. This study aimed to test whether clinical neuroimaging is a meaningful predictor of change in aphasia severity between 1 and 12 months post-stroke onset. We recruited 354 acute

ischemic or hemorrhagic stroke patients, of whom 218 presented with aphasia acutely. Patients were evaluated with the Quick Aphasia Battery (QAB), then those with aphasia were followed up at 1 month, 3 months, and 12 months, where possible. The present analysis is based on 47 patients who were tested at the 1 month timepoint, who still presented with aphasia at that time (QAB overall <8.9 out of 10), and were subsequently evaluated at the 12 month timepoint. We used fixed effects linear models to predict aphasia severity at 12 months (QAB overall) based on (1) a baseline model of aphasia severity at 1 month (QAB overall); (2) damage to temporal, prefrontal, and fronto-parietal ROIs (defined using fMRI in a separate group of neurologically normal participants) [3], and total lesion extent, in addition to the baseline; (3) demographic factors (age, sex, handedness, years of education) and stroke type, in addition to the baseline. Prediction r2 and mean absolute error were assessed in leave-one-out cross-validation. In the baseline model, aphasia severity at 12 months was predicted quite well by aphasia severity at 1 month (model r2=62.6%; prediction r2=57.1%; mean absolute error=0.90 QAB scale points). Critically, we found that prediction was substantially and significantly improved by adding neural factors (damage to the 3 ROIs, and total lesion extent) to the model (model r2=79.8%; prediction r2=70.1%; mean absolute error=0.75 QAB points; p<.001 relative to the baseline model). Temporal damage in particular was predictive of poorer recovery: an extensive temporal lesion could reduce the predicted outcome by >3 QAB points. In contrast, prediction was not improved relative to the baseline model by adding only demographic factors (age, sex, handedness, education) or stroke type, either individually or in combination (all p≥.17). In sum, we found that neuroimaging is a significant and meaningful predictor of recovery from aphasia between 1 month and 12 months, above and beyond the predictive power of aphasia severity at 1 month. An important implication of this finding is that we need to make the relevant imaging information accessible to speech-language pathologists. This could involve (1) training neuroradiologists and neurologists to identify critical features and communicate this information in their reports; (2) training speech pathologists to interpret key aspects of certain brain images; and/or (3) developing automated tools to derive aphasia predictions from neuroimaging data.

C57 - "Cohort" and "Rhyme" in Lexical Tones in Spoken Word Recognition

Xin Wang[1], Bob McMurray[2]; [1]Macquarie University, [2]University of Iowa

One of the classic debates in Spoken Word Recognition (SWR) is whether lexical tones carry similar cue weighting as in segments in recognizing a spoken word (Malins & Joanisse, 2010). Tones and segments belong to different acoustic dimensions, and they are intertwined given a syllable. However, it is not clear how different tones, as critical phonetic cues in a tonal language, are integrated during spoken word recognition. Theories of speech perception and spoken word recognition must take into account the timing of tone integration (McMurray et al., 2008). Here, we ask a different question. Instead of comparing the relative cue weighting of tones and segments, we first establish the time course of tone integration during SWR. That is, do listeners wait till a unique point of pitch contours to kick off lexical competition or integrate tonal cues incrementally? We used the Visual World Paradigm to investigate this question (Tanenhaus, et al., 1995), specifically, for Tone 1, Tone 2 and Tone 4 in Mandarin Chinese. Mandarin Chinese has four distinct tonal categories (Wang, 2021). We showed tone timing of three tone contrasts (T1 vs. T2, T1 vs. T4, T2 vs. T4) as the Target and Competitor in VWP during word recognition (e.g., '/ba1/' competed by '/ba2/'), given the same syllable in a particular trial. Eye-movement data analysis was based on non-linear curve fitting to show the time course of eye-movements on different objects (i.e., targets, competitors and distractors), and the competition effect was measured as the difference between eye-fixations on competitors and distractors (McMurray, 2023). In a within-participant and within-item design, we observed robust competition effects across all tone contrasts (all p <.05). These results indicate that lexical tones serve as independent cues in SWR. Importantly, these competition effects arising from different tone contrasts differ from each other, measured by curve parameters. That is, different tone contrasts generated different degrees of competition effects in terms of when the curves reached the peaks and their magnitudes. Our results showed earlier and stronger competition effects of Tone 1/4 contrast relative to Tone 1/2 contrast, indicating listeners were sensitive to F0 height when integrating tonal cues. In Mandarin, Tone 1 and Tone 4 start from similar F0 height but diverge from each other given time, and the competition effect for this tone contrast resembled the Cohort effect, where acoustic cues activate multiple lexical access (Marslen-Wilson, 1987). Tone 1 and Tone 2 start from different F0 height but gradually converge given time, and the competition effect of this contrast resembled the Rhyme effect (Luce & Pisoni, 1998). Finally, Tone 2 and Tone 4 contrast shares the least similarity in F0, and thus showed the least competition effect in their curves compared to the other two contrasts. To summarize, our results demonstrate incrementality in lexical tone processing and support word recognition theories of cue integration in which tones are used for lexical access as soon as they are available.

C58 - Extra Language Control Required for Morphological Inflections in Bilingual Word Production

Qiping Wang[1], Hongfu Qu[2], Yannan Ji[2], Xin Wang[3], Junjie Wu[2]; [1]Beijing Normal University, [2]Tianjin Normal University, [3]Macquarie University

For effective language production, bilinguals must control their two conflicting languages. However, prior investigations have mainly concentrated on words without considering inflection, leaving it unknown how morphological inflection affects language control. To bridge this gap, we conducted two experiments involving Chinese-English bilinguals who speak two languages with distinct inflectional morphologies—inflectional for English and non-inflectional for Chinese. Specifically, participants engaged in language-switching tasks in either Chinese or English, generating uninflected words for singular object pictures in Experiment 1 and producing corresponding uninflected or inflected words for one or two objects in Experiment 2. The outcomes of Experiment 1

reproduced symmetric switching costs and asymmetric mixing costs observed in previous studies, which serve as indices for examining local and global language controls, respectively. Furthermore, we found the symmetric switching costs in Experiment 2, alongside heightened asymmetric mixing costs when participants encountered two objects as opposed to only one. These findings indicate that bilinguals exert greater global control over Chinese when no inflections can express the plurality. In summary, the current study offers pioneering evidence of specific processing stages of bilingual language control with morphological inflectional production. Keywords: bilingual, language control, grammatical encoding, global control, local control.

C59 - Lexical Tone in Bilingual Crosstalk

Xin Wang[1], Bob McMurray[2]; [1]Macquarie University, [2]University of Iowa

Spoken word recognition is characterized by competition, as the lexical processor needs not only to interpret the unfolding speech input, but also to inhibit the activation of non-target candidates (e.g., Luce & Pisoni, 1998). This competition has been extended to investigations in bilingualism to understand how bilingual listeners recognize spoken words in one language that sound similar to words in the other (e.g., Ju & Luce, 2004; Weber & Cutler, 2004). One linguistic dimension, lexical tones, has been shown to provide independent cues for lexical access within a tonal language (e.g., Malins & Joanisse, 2010). If tones are crucial in spoken word recognition, a key question is whether this linguistic knowledge is utilized in bilingual spoken word recognition. In other words, does lexical tone play a crucial role in cross-language lexical competition? To address this question, we used the Visual World Paradigm due to its temporally sensitive measures of lexical activation and competition (Tanenhaus, et al., 1995). These measures are collected by recording eye-movements when participants are instructed to click a target matching an auditory stimulus in an array of pictures on a computer screen. The experimental manipulation is realized through the presence of a competitor, the name of which bears a phonological relationship with the target. Here, through two experiments, we investigated whether lexical tones provided independent cues in cross-language lexical competition, compared to segments. In Experiment 1, we presented Mandarin-English participants with two types of target-competitor pairs: Segmental ("bay"--"cup") where 'cup' in Mandarin Chinese is '/bei/1' phonologically related to 'bay' (pronounced in statement intonation) only in segments, and Segment + Tone ("bay" – "quilt") where 'quilt' in Mandarin Chinese is '/bei/4' phonologically related to 'bay' (pronounced in statement intonation) in both segments and tones. The task was to click on the target (e.g., 'bay') when listening to 'bay' in English. The competition effect is measured by showing the difference between eye-fixations on competitors and unrelated distractors, indicating the lexical activation of the competitor relative to the target. In a within-participant design, we observed competition effect in the segment + tone condition, but not in the segmental condition. In addition, the competition effect was significantly larger in the segment + tone condition than the segmental condition. To replicate and consolidate these results, Experiment 2 was designed to reverse the effect of Segmental (seg) vs. Segmental + Tone (segtone) by presenting synthesized tokens whose tone matched the other competitor. In Exp 1, a target (e.g., bay) was recorded with a falling tone, resulting in a better match to /bei4/ ("quilt", segtone) than /bei1/ ("cup", seg). Here, we manipulated the pitch contours of the targets such that bay now had a high-level tone and so that /bei1/ was now the stronger competitor. This way, the seg vs. segtone condition in Exp 1 swapped with each other in Exp 2. We observed larger competition effects when both segment and tone cues were available in the stimuli. These results first demonstrate the obligatory role of lexical tones in cross-language lexical competition in VWP.

C60 - The sound of silence: Congenitally deaf individuals rely more on visual motion to derive object sound knowledge

Shuyue Wang[1], Ziyi Xiong[1], Xiaosha Wang[1], Yanchao Bi[1]; [1]Beijing Normal University

The mechanism in which the human brain derives rich knowledge about the world through multiple sensory modalities and language is a major question in cognitive neuroscience, yet remains elusive given the intricate interaction and association among various types of experiences. For instance, an object sound (e.g., the common sounds of a cat or a hammer hitting a nail) is primarily perceived through the auditory modality, and yet can also be derived to varying extents from other sensory modalities that have rich associations with or indications of sound (e.g., tactile vibration) and language (e.g., sound words). Studying sound knowledge in populations deprived of auditory experience thus provides unique opportunities to disentangle the unique contribution, redundancy, and interaction among different types of experiences. In this study, by asking congenitally deaf and hearing subjects to answer the question of whether an object has common sounds, we aimed to reveal the cognitive and neural mechanisms by which object sound knowledge is constructed from auditory, non-auditory (object size/weight, tactile, visual motion, taxonomy) and language (estimated by large language models) experiences. First, 46 deaf and 50 hearing individuals participated in the behavioral survey about whether an object (animals or artifacts) has common sounds. The deaf and hearing groups produced highly correlated patterns across objects (that is, they tend to judge similarly whether an object has common sounds), despite overall underestimation in the deaf group. Regression models were then used to predict sound knowledge response (yes/no) for a given object from the above variables in each group. Results showed that sound judgment was positively associated with auditory experience and language encoding in both groups and that the deaf relied more on visual motion than the hearing. In a picture naming fMRI experiment, we first localized the brain regions whose activities were significantly modulated by object sound properties in the two groups. Among these regions, the superior temporal regions were modulated by visual motion in deaf subjects, to a greater extent than in hearing subjects, which may explain their behavioral overreliance on visual motion in object sound judgment. In summary, auditory deprivation alters how different sensory cues are weighted to infer such

knowledge. These findings suggest that the human brain adapts different ways to construct knowledge when available sensory experience alters, with visual motion highlighted as a substitute for auditory properties.

C61 - Is grammatical gender a lexico-syntactic or a lexico-semantic feature for Chinese-German L2 learners?

Jin Wang[1], Jurriaan Witteman[1], Niels,O. Schiller[1,2]; [1]Leiden University, [2]City University of Hong Kong

In some Indo-European languages, such as German and Dutch, producing a grammatically correct sentence requires adhering to the principle of grammatical gender agreement. For instance, in the German phrase “das Glas (the glass),” the grammatical gender of the noun "Glas (glass, neuter)" determines the gender of the determiner "das (the, neuter)". Grammatical gender is considered an inherent, intrinsic lexico-syntactic feature of nouns. A number of empirical studies have demonstrated that when producing a noun phrase, the grammatical gender of the noun is always activated and enters the lexical selection stage. In contrast, Chinese does not possess a grammatical gender system. As a typical isolating language, Chinese relies more on semantic connections rather than formal inflections to link words and convey information. Various hypotheses in second language acquisition suggest that the learner’s first language often influences the process of acquiring a second language. Given the significant typological differences between Chinese and German, it is still unclear what mechanisms native Chinese speakers use to process a second language like German. Specifically, when processing grammatical gender features, do native Chinese speakers process them as syntactic or semantic information? This study investigated how native Chinese speakers process grammatical gender features when producing German noun phrases. The experiment employed a picture-word interference paradigm in a picture-naming task. Target pictures were presented simultaneously with superimposed distractor words. Participants were required to name the target pictures overtly in the form of "determiner + noun" in German while ignoring the distractor words. The grammatical gender congruency (whether the target and distractor shared the same gender) and semantic relatedness (whether they belonged to the same semantic category) were manipulated. Naming latencies and the electroencephalogram were recorded simultaneously. Regarding behavioural results, compared to previous studies on native German speakers, the overall naming speed was slow, and no effects of grammatical gender congruency or semantic relatedness were found. Regarding EEG data, time windows and regions of interest for further statistical analysis were identified using mass univariate analysis. The results indicated that, compared to the gender-congruent condition, the gender-incongruent condition elicited more negative voltage amplitudes around 400 ms after stimulus onset. Additionally, compared to the semantically-related condition, the semantically-unrelated condition elicited more negative voltage amplitudes around the 350-600 ms time window. These findings indicated that both the gender congruency and semantic interference effects were detected in second-language learners. Moreover, their manifestation in the EEG data aligns with the typical time windows and brain regions associated with the N400 effect. Therefore, we hypothesized that the grammatical gender processing by native Chinese speakers is related to the processing of semantic information.

C62 - Functional Magnetic Resonance Spectroscopy (fMRS) Study on Reading-Related Metabolite Changes

Katarzyna Wasilewska[1], Agnieszka Glica[1], Bartosz Kossowski[2], Katarzyna Jednoróg[1]; [1]Laboratory of Language Neurobiology, Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland, [2]Laboratory of Brain Imaging, Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland

Functional Magnetic Resonance Spectroscopy (fMRS) is a non-invasive technique used to measure changes in metabolite concentrations in response to various stimuli. While it is a powerful tool for gaining deeper insights into the mechanisms accompanying brain activations, it remains relatively novel, lacking clear guidelines for optimal data acquisition and analysis. Most existing studies have focused on changes in the visual cortex in response to simple visual stimuli. In our innovative approach, we examine metabolite changes induced by reading-related stimuli within individually localized language-sensitive left superior temporal cortex (STC) and a control region in the medial prefrontal cortex (MPC). Moreover, we extend the investigation by incorporating fMRS data acquisition with varying delays between stimulation and signal acquisition, aiming to study the glutamate response function (500 ms, 1000 ms, 3000 ms, 4500 ms). Fifty-six adolescents and young adults aged 15-24 years (27 females, 29 males) with varying reading levels participated in an fMRS experiment on a 7T GE scanner. Visual stimuli were Polish words and false font strings (written with BACS font). There were 13 stimulation blocks (64 seconds each) containing 12 trials (6 made of words and 6 false fonts in pseudo-random order). Each trial included 3 stimuli presented for 250 ms with 50 ms break in between (850 ms in total). The rests between stimulation blocks varied in duration (between 32 and 36 seconds). Participants were asked to press a button every time when saw a word or a false font string with descending feature. The experiment for single voxel (320 averages with suppressed water and 8 averages with unsuppressed water) took 21minutes 52 seconds. Data were acquired from two regions of interest (voxel size: 15 x 15 x 15 mm^3): the MPC and left STC. In the left STC, we observed significant changes relative to baseline in glutamate levels at 500 ms ($t = -2.073$, $p = 0.043$), 1000 ms ($t = -2.097$, $p = 0.041$), and 4500 ms ($t = -2.211$, $p = 0.032$) after stimulus presentation (average for words and false font strings). No such changes were observed in the control MPC region. In conclusion, we found significant changes in glutamate levels following visual stimulation in the left STC, a brain region involved in the reading process, but not in the control MPC region. These findings indicate that the observed changes are specific to the language-sensitive region. Further analysis will explore the temporal dynamics of glutamate changes. fMRS has great potential for investigating the neurobiological processes of reading, and it is essential to continue developing and refining this technique.

C63 - Investigating the Role of Cortical Microstructure in Language Lateralization Using Quantitative MRI

Xiaoyin wu[1], Miaomiao Zhu[2], Chu-Chung Huang[1,3], Qing Cai[1,2,3]; [1]School of Psychology and Cognitive Science, East China Normal University, China, [2]Institute of Brain Science and Education Innovation, East China Normal University, China, [3]NYU-ECNU Institute of Brain and Cognitive Science, New York University Shanghai, China

A striking observation in the human brain is the hemispheric asymmetry of many information-processing functions, particularly in language production. Previous studies suggest that functional lateralization may be linked to cortical myeloarchitecture and macromolecular content. However, the cortical microstructure underlying language lateralization remains unclear. We hypothesize that there are microstructural differences between atypical (right hemisphere language dominance) and typical lateralization groups. To reveal the microstructural properties of gray and white matter tissues, we used a novel and noninvasive technique, quantitative magnetic resonance imaging (qMRI), to acquire two maps, longitudinal relaxation rate (R1) and magnetization transfer saturation (MTsat). R1 pertains to myelin, lipid content, and synapses, while MTsat reflects macromolecular conditions. Seventeen left-handers participated in this study due to their higher prevalence of atypical lateralization patterns compared to right-handers. Based on an fMRI word-generation task (WGT), eight were classified as atypical lateralization, and nine were known to have left hemisphere dominance for language (typical lateralization). Using Freesurfer's mri_vol2surf algorithm, we analyzed the R1 and MTsat values at different intracortical depths in both groups. The R1/MTsat volume was projected into surface vertices at increasing 25% steps, starting from two locations below the gray–white boundary to the pial surface. Using general linear model, we detected the differences of R1/MTsat values between the two groups at different intracortical depths. We found that in relatively superficial white matter, the R1 values in the middle and superior temporal gyrus (MTG and STG), temporal pole, and precentral gyrus of both hemispheres were significantly higher in the atypical language lateralization group compared to those in the typical group. In deep gray matter, the right-dominant group showed higher R1 values in the right hemisphere's MTG and STG than the left-dominant group, with only the STG showing similar results in the left hemisphere. In relatively superficial gray matter, the atypical group had significantly higher R1 values only in parts of the right hemisphere's MTG and medial occipital area. Additionally, we observed a marginal negative correlation between the lateralization index (LI) of the R1 values in the orbital part of the inferior frontal gyrus and the LI of WGT in the Broca region (rdeep gray matter = -0.46, $p = 0.06$). The LIs of the R1 values in the temporal pole at different depths were significantly negatively correlated with the LI of the fMRI task ($r = -0.55$ to -0.68, $p < 0.05$). For MTsat at different depths in gray and white matter, the differences between atypical and typical language lateralization groups in the temporal region did not resemble the R1 findings, especially in deep gray matter, with more differences observed in the middle frontal gyrus. The current findings suggest that the lipid content and synapse density in brain tissue may support functional lateralization. This study supports the idea that lateralization may have a microstructural basis, providing new evidence for the underlying neural mechanisms of language lateralization.

C64 - When A Man Says He Is Pregnant: The Neural Correlates of Speaker-contextualized Language Processing

Hanlin Wu[1], Zhenguang Cai[1]; [1]The Chinese University of Hong Kong

#Introduction# One fundamental aspect of spoken language is that it carries both linguistic content such as the explicit message and extra-linguistic contexts such as the speaker's identity. Over the past two decades, researchers have used ERPs to investigate the neural correlates of speaker-contextualized language processing by exposing participants to implausible utterances where the message mismatches the speaker's identity. However, the findings were mixed, with some studies showing N400 effects (e.g., Van Berkum et al., 2008) while others showing P600 effects (e.g., Foucart et al., 2015). We hypothesize that this inconsistency of findings relates to how listeners deal with different types of implausibilities. When the utterance violates people's social stereotypes (socially implausible utterances) such as "I'm going to have a *manicure* this weekend" spoken by a man compared to a woman, listeners tend to integrate the utterance with their social stereotypes, resulting in an N400 effect reflecting an effortful integration of the message, the speaker's identity, and listeners' social stereotypes. In contrast, when the utterance violates people's biological knowledge (biologically implausible utterances) such as "The first time I got *pregnant* I had a hard time" spoken by a man compared to a woman, listeners tend to revise their perception of the utterance to reconcile this extremely low plausibility, as predicted by rational accounts of language processing (e.g., Cai et al., 2022; Gibson et al., 2013), resulting in a P600 effect reflecting an effort to revise the utterance for a possible interpretation. #Methods And Results# To test our hypothesis, we recorded 80 socially plausible/implausible Mandarin utterances and 80 biologically plausible/implausible utterances. Plausibility ratings (30 participants: 15 males, 15 females) showed that socially implausible utterances were significantly more plausible than biologically implausible utterances. ERPs (another 64 participants: 32 males, 32 females) showed that socially implausible utterances triggered an N400 effect, 300-900 ms after the critical word onset. In contrast, biologically implausible utterances triggered a P600 effect, 600-1000 ms after the critical word onset. Additionally, social implausibility effects decreased as a function of the listeners' personality traits of openness (measured by BFI-2, Zhang et al., 2022) for both ratings and ERPs (N400 magnitudes), while such observation was absent for biological implausibility effects. #Discussion And Conclusion# These findings suggest a new framework for speaker-contextualized language processing, where different types of utterances go through distinct neural-cognitive processes, depending on how an interpretation can be achieved. Specifically, listeners arrive at an interpretation (posterior) based on their world knowledge (prior) and the utterance (evidence). For socially implausible

utterances, listeners integrate the utterance with their social stereotypes to arrive at an interpretation, resulting in an N400 effect. For biologically implausible utterances, as they deviate too much from the listener's biological knowledge, an error revision process is triggered for the perception of either the message or the speaker's identity, resulting in a P600 effect. Listeners' openness traits modulate their social stereotypes but not biological knowledge. Our proposed account explains the empirical inconsistencies in speaker-contextualized language processing and sheds light on how the human brain processes language in a wider context.

C65 - Abnormal developmental trajectory in the left occipitotemporal area in individuals with reading disability

Xiaohui Yan[1], Shilin Xu[2], Fan Cao[1]; [1]The University of Hong Kong, [2]Sun Yat-Sen University

Reading development is accompanied by functional changes in the brain including the left occipitotemporal (OT) region, which is involved in visuo-orthographic processing. However, significant functional differences have been found in this region in individuals with reading disability (RD). It is of great importance to understand how the left OT region develops in individuals with RD. In a cross-sectional study, we examined age-related changes in the brain during an auditory rhyming task in 61 fifth-grade children (mean age: 11.07 years), 44 seventh-grade adolescents (mean age: 13.21 years), and 61 college students (mean age: 20.80 years) with and without RD. We found that typical readers showed age-related increase in brain activation in the anterior/lateral OT and age-related decrease in the posterior/medial OT, while RD readers did not show age-related changes in the posterior/medial OT and weaker age-related increase in the anterior/lateral OT. Representational similarity analysis (RSA) showed that the OT regions are specialized for orthographic representation, especially in the anterior/lateral OT, however, RD readers did not show this greater orthographic specialization in the anterior/lateral OT than posterior/medial OT. These findings indicate abnormal developmental trajectories in the left OT region in RD readers, providing important insights about the prognosis of RD.

C66 - Utilizing Resting- and Task-State EEG with Convolutional Neural Networks to Screen for Developmental Dyslexia in Hong Kong Chinese Children

Yaqi YANG[1], Zhaoyu Liu[2], Brian W.L. Wong[1,3], Shuting Huo[1,4], Jie Wang[5], Tan Lee[6], Fumiko Hoeft[7], Urs Maurer[1,8,9]; [1]Department of Psychology, The Chinese University of Hong Kong, Hong Kong, China, [2]Department of Biomedical Engineering, The Chinese University of Hong Kong, Hong Kong, China, [3]Basque Center on Brain, Language and Cognition (BCBL), Donostia-San Sebastián, Spain, [4]Department of Applied Social Sciences, The Hong Kong Polytechnic University, Hong Kong, China, [5]Department of Psychology, The Education University of Hong Kong, Hong Kong, China, [6]Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong, China, [7]Department of Psychological Sciences, University of Connecticut, Waterbury, Connecticut, United States of America, [8]Centre for Developmental Psychology, The Chinese University of Hong Kong, Hong Kong, China, [9]Brain and Mind Institute, The Chinese University of Hong Kong, Hong Kong, China

Developmental dyslexia (DD) is a prevalent learning disorder with presumed neurological origins. Despite numerous attempts to integrate machine learning algorithms with electroencephalogram (EEG) techniques for efficient and cost-effective screening, a reliable EEG-based classification framework for screening Chinese children with DD and identifying potential neural biomarkers has yet to be discovered. Our study addresses this gap by combining EEG data with Convolutional Neural Networks (CNNs) to screen for DD in 130 Chinese children (7-11 years old), including both DD and typically developing (TD) children. We transformed pre-processed EEG signals into functional connectivity (FC) matrices using three distinct FC measures—Pearson Correlation Coefficients (PCC), Phase Locking Value (PLV), and Rho Index (RHO)—across four frequency bands (delta, theta, alpha, and beta) under four experimental conditions (resting-state eye-open, eye-closed, one-back, and two-back working memory tasks). After pre-processing the FC matrices, we divided them into two independent samples. We trained and validated the CNNs model using one sample through 5-fold cross-validation and conducted cross-sample validation with a permutation test on the other sample. The eye-open beta-band-based RHO index achieved the highest 5-fold average classification accuracy, reaching approximately 98%. In cross-sample validation, the accuracy remained around 70%, significantly above the chance level. We also identified discriminative FCs for DD classification. The TD group showed stronger temporal-parietal, temporal-frontocentral, and central-centroparietal FCs compared to the DD group. Conversely, the DD group exhibited stronger frontocentral-frontal, prefrontal-anterior frontal, and frontal-centroparietal FCs than the TD group. Additionally, we found a negative correlation between Chinese reading abilities and discriminative FCs in the DD group. Overall, our study presents a robust deep-learning framework using EEG-based methods for DD screening in Chinese children, validated in an independent sample. The findings may help uncover potential behavior-related neural biomarkers. This innovative approach enhances the practicality of EEG-based deep learning in DD screening and expands our understanding of the neural substrates of Chinese DD.

C67 - Brain activation in children with varying reading skills during visual motion processing

Ya-Xi Yang[1], Jin-Yi Zhang[1,2], Yu-Long Zhou[1], Li-Hai Tan[1,3,4]; [1]Center for Language and Brain, Shenzhen Institute of Neuroscience, Shenzhen, China, [2]School of Management, Jinan University, Guangzhou, China, [3]Guangdong-Hongkong-Macau Institute of CNS Regeneration, Jinan University, Shenzhen, China, [4]Neuroscience and Neurorehabilitation Institute, University of Health and Rehabilitation Sciences, Qingdao, China

Introduction Reading is a complex cognitive skill requiring the coordination of multiple brain regions. It involves visual information processing, text shape recognition, speech and

semantic conversion, language generation, and grammar processing (1). Previous studies found that many poor readers had particular problems with rapid visual processing because they had a mild impairment of the visual magnocellular system (2). However, the relationship between reading skills and visual information processing in typically developing children is still not clear. Methods We recruited 23 right-handed children aged 9–12 years for this study. The participants first completed the semantic judgment task and the visual motion processing task during fMRI scanning. To classify them into higher-function (HF) and lower-function (LF) groups, we calculated the Lateralization Index (LI) to indicate reading skills based on their performance in the semantic judgment task (3). Subsequently, we compared the performance of the visual motion processing task between the two groups using region of interest (ROI) analysis, focusing on the V5/MT area (4). Results In the semantic judgment task, we observed significant brain activity in areas related to language processing and visual information processing compared with the baseline. Based on the result, we selected bilateral pars triangularis of the inferior frontal gyrus as ROIs. For the visual motion processing task, after corrected by rest condition, mixed ANOVA analysis showed stronger brain activation during dynamic conditions than static ones in the right middle temporal gyrus and the left middle occipital gyrus. The effect was confirmed by paired sample t-test without correction by rest condition. That is, significant brain activation was observed at V5/MT during dynamic conditions using static conditions as the baseline. Whereas, a similar effect was only observed in the LF group, not in the HF group. There were no significant differences in accuracy or reaction time for either task. Conclusion We used pars triangularis of the inferior frontal gyrus as ROI in the semantic judgment task to compute LI as an index of reading skills. Task performance on the visual motion processing task did not differ between the HF and the LF groups. However, different activation patterns emerged, with the LF group showing stronger activation in the V5/MT area. This suggests potential functional restructuring or compensatory activation to cope with task demands (5). It may reflect the application prospects of non-invasive brain stimulation to intervene in children with poor reading skills. References 1. Price CJ. A review and synthesis of the first 20 years of PET and fMRI studies of heard speech, spoken language and reading. NeuroImage. 2012 Aug;62(2):816–47. 2. Stein J. The current status of the magnocellular theory of developmental dyslexia. Neuropsychologia. 2019 Jul;130:66–77. 3. Bradshaw AR, Thompson PA, Wilson AC, Bishop DVM, Woodhead ZVJ. Measuring language lateralisation with different language tasks: a systematic review. PeerJ. 2017 Oct 24;5:e3929. 4. Olulade OA, Napoliello EM, Eden GF. Abnormal Visual Motion Processing Is Not a Cause of Dyslexia. Neuron. 2013 Jul;79(1):180–90. 5. Park DC, Reuter-Lorenz P. The Adaptive Brain: Aging and Neurocognitive Scaffolding. Annu Rev Psychol. 2009 Jan 1;60(Volume 60, 2009):173–96.

C68 - The left hemisphere isn't so dominant after all: Prevalence of aphasia in acute right-hemisphere stroke

Jeremy Yeaton[1], Sigfus Kristinsson[2], William Matchin[2], Roger Newman-Norlund[2], John Absher[2], Julius Fridriksson[2], Gregory Hickok[1]; [1]University of California, Irvine, [2]University of South Carolina

Background. It is the working assumption in the field that language is a left-lateralized system. Although there is some evidence for left-lateralization of some language functions, there is also evidence for bilateral organization of receptive language processing (Rogalsky et al., 2022). This left-hemispheric dominance assumption has led to a sampling bias in aphasia research: most large-scale aphasia studies focus on participants who a) have left-hemisphere lesions, and b) present with aphasia. This excludes two critical groups: 1) participants with left hemisphere lesions and no aphasia, and 2) participants with right hemisphere lesions who show aphasia. Revisiting these assumptions with a large sample could provide key insights. Methods. To provide some preliminary insights into this question, we analyzed data from a uniquely large, unselected sample of acute stroke patients (n=888). From a retrospective analysis of patient records, three coarse language measures were identified: 1) the language subscore of the NIH Stroke Scale (NIHSS), 2) a binary bedside assessment of presence of aphasia by an attending physician or Speech-Language Pathologist, and 3) proportion of correctly repeated items from WAB-R repetition subtest. Each participant's lesion was traced from their MRI and automatically converted into percent of damage to ROIs under the JHU parcellation. We performed univariate statistics testing the reliability of damage to each ROI in predicting each of our language scores across the whole group, as well as filtering out participants who did not have contralateral damage when examining LH and RH ROIs separately. We used total lesion volume as well as stroke severity (total NIHSS score) as covariates. Results. When considering all gray matter ROIs across all participants, we found that damage to bilateral inferior frontal ROIs, as well as RH temporal ROIs were significant predictors of a bedside classification of aphasia. NIHSS Language score was predicted only by damage to LH ROIs: superior & inferior frontal gyri, SMG, STG, and insula. Repetition score was predicted by damage to bilateral superior and middle frontal gyri, right STG, MTG, and postcentral gyrus, and left fusiform gyrus. When considering only LH ROIs, we found that damage to IFG, STG, insula, and fusiform gyrus were predictive of NIHSS language score, while pre- and post-central gyri, as well as middle occipital gyrus were predictive of repetition score. When considering only RH ROIs, damage to inferior frontal and insular ROIs were predictive of bedside assessment of aphasia, and damage to STG was predictive of repetition score. Conclusions. Overall, damage to both LH and RH ROIs in the canonical language network were predictive of language scores in acute stroke. Critically, most of these ROIs are not implicated in motor-speech impairments, which may be conflated with language impairments in clinical scales. Although the measures used in this work are coarse, the substantial size and unselected nature of the sample lends credence to these findings, pointing to a need for more investigation into the role of the right hemisphere in aphasia, as well as for a reconsideration of the assumption of left hemisphere dominance in the neurobiology of language.

C69 - Manipulability in Disguise: Uncovering Behavioral and Neural Differences in Processing Words Representing Small and Big Objects

Ruifeng Yu[1], Hongli Liu[1], Feng Gu[1]; [1]Sichuan University

Size is a fundamental visual-spatial characteristic of the physical world. Previous studies have shown distinctive neural responses along the ventral temporal cortex when processing pictures representing small and big objects, suggesting that object size was a key dimension that organized concrete concepts. However, it remains unclear whether this size-based categorization is limited to perceptual information or extends to symbolic input, such as words. Furthermore, some behavioral studies have indicated that words denoting big objects (big words) were recognized faster than those denoting small objects (small words), but this effect remains controversial and might be task-dependent. Therefore, the present study investigates both the behavioral and neural differences in processing small and big words, and whether these differences are task-dependent. In the behavioral study, two experiments were conducted. Experiment 1 sought to replicate the effect that big words were recognized faster, using the same lexical decision task (LDT) as the original study but with a larger sample size of 60 participants. Experiment 2 used a semantic decision task (SDT) in which another sixty participants were asked to judge whether the presented word was a concrete word. The real words in Experiment 1 and concrete words in Experiment 2 were the same 40 small and 40 big words that were matched in other variables. In the EEG study, two groups of twenty-six participants separately performed the same LDT (Experiment 3) and SDT (Experiment 4), and all participants rated the object size and five size-related properties denoted by the words after the experiments. Behavioral results revealed a significant processing advantage for big words in the LDT, evidenced by shorter reaction times and lower error rates. However, this advantage was not observed in the SDT. The multivariate pattern and time generalization analyses of EEG data showed distinguishable and stable neural patterns for processing small and big words between 190 ms and 250 ms in both tasks. Additionally, in the SDT, these neural patterns persisted from 390 ms to 520 ms, reflecting a reactivation of earlier neural representations. Further analysis using multiple RSA regression explored what object properties (size and five size-related properties) could explain the representational geometry of the neural responses, which revealed that manipulability, rather than size, was the primary factor explaining the neural responses, with the significant time windows consistent with the above-chance decoding time windows in both tasks. Therefore, we suggest that manipulability is a key semantic factor underlying the neural representations of concrete concepts. In the LDT, processing small words with higher manipulability than big words may cause early simulated motor experiences, interfering with key-pressing control and leading to the observed processing advantage for big words. In the SDT, this interference effect may be counteracted by the later strong activation of the manipulability-related features of small words, which facilitates semantic decisions. These findings also highlight a flexible and two-stage processing of semantic concepts. The first stage likely involves automatic activation of language-derived representations accompanied by sensory simulations, while the second stage likely involves activation of sensory-derived representations controlled by top-down mechanisms.

C70 - Distinguishing the role of the default mode network in perceptually coupled social and decoupled states

Meichao Zhang[1,2,3], Bronte Mckeown[4], Charlotte Murphy[3], Chang Liu[1,2], Daniel Margulies[5], Robert Leech[6], Jonathan Smallwood[4], Elizabeth Jefferies[3]; [1]Institute of Psychology, Chinese Academy of Sciences, [2]Department of Psychology, University of Chinese Academy of Sciences, [3]Department of Psychology, University of York, [4]Department of Psychology, Queen’s University, [5]Integrative Neuroscience and Cognition Centre (UMR 8002), Centre National de la Recherche Scientifique (CNRS) and Université de Paris, [6]Centre for Neuroimaging Science, Kings College London

Regions of parietal, temporal and frontal cortex within the default mode network (DMN) are linked to a range of states including perceptually-decoupled states of memory retrieval, and behaviours linked social, semantic, and spatial cognition. DMN regions are equidistant between regions linked to perception and action on the cortical mantle, suggesting its functional associations may depend on its relationship with primary systems. Our study set out to understand whether the functional relationship between DMN and visuomotor systems can help to explain its role in cognition in different situations. To this end we recorded functional magnetic resonance imaging (fMRI) while participants made category decisions (faces, objects, scenes) guided by either visual inputs or information from memory – all classes of stimuli linked to the DMN. Using this paradigm, we explored how the relationship between DMN and primary systems varied across perceptually coupled and decoupled situations. Distinct DMN regions responded selectively to memory-guided decisions, and social stimuli (faces) irrespective of whether decisions were based on memory or sensory input. The social-relevant DMN regions were linked to equivalent activity levels in visual and motor systems, and showed equal functional coupling to both systems. In contrast, stimulus-independent decision-making was associated with stronger recruitment of motor than visual regions, while DMN regions that responded in this situation showed more connectivity with visual cortex. These results are consistent with the view that the roles of DMN in distinct aspects of cognition are related to the different ways that this network interacts with regions related to perception and action.

C71 - The causal role of left inferior frontal gyri in Chinese character handwriting: A transcranial magnetic stimulation study

Yichi ZHANG[1], Xufeng DUAN[1], Joseph DEVLIN[2], Zhenguang CAI[1]; [1]The Chinese University of Hong Kong, [2]University College London

Objective: Producing written words involves central processes such as orthographic retrieval from long-term memory (LTM), phonology-orthography conversion (POC) and holding orthographic information in the working memory, together with

peripheral processes such as allographic/letter shape selection and graphic-motor planning. Previous fMRI studies suggest that the left inferior frontal gyrus (LIFG) is related to retrieving orthographic representations. However, it remains unclear whether the LIFG plays a causal role in central orthographic processing, such as retrieving orthography from long-term memory during simplified Chinese character handwriting, and whether inhibiting the LIFG would disrupt this process. Therefore, we set out to answer these questions by administering the transcranial magnetic stimulation with the inhibitory repetitive TMS (rTMS) protocol over LIFG to assess the behavioral changes of simplified Chinese orthographic processing. Methods: 20 healthy adults native to simplified Chinese underwent this within-subject offline TMS experiment, composed of a handwriting following offline rTMS to LIFG and another handwriting session following offline rTMS to the vertex (as a control site). The rTMS protocol used the stimulation frequency of 1 Hz, lasting for a duration of 20 minutes (1200 pulses in total). The order of the two stimulations was counter-balanced across participants and the two sessions were separated with an interval of about 25 min. After offline rTMS in a session, participants wrote 60 Chinese simplified characters one by one according to a dictation prompt (e.g., 灶台的灶, "the character 灶 in the word 灶台"), with a total of 120 characters over the two sessions. In a handwriting trial, participants first heard a dictation prompt, wrote down the target character. After handwriting, participants were shown the target character and reported whether they had correctly written the target character, did not know what character to write, or knew what character to write but could not (fully) write it. We collected three behavioral measures: handwriting latency (from the offset of the dictation prompt to the onset of handwriting) as a measure orthographic retrieval, handwriting duration (from the onset to the offset of handwriting) as a measure of the cascading central and peripheral processes of handwriting, and handwriting accuracy (proportion of accurate handwriting in the self-reports) as a measure of participant's success in orthographic retrieval. Results & Discussion: We observed an inhibitory effect of offline rTMS on handwriting latency (but not on handwriting duration): Participants needed longer times to initiate handwriting after hearing a dictation prompt after receiving offline rTMS on LIFG than on the vertex. The findings that disrupting LIFG led to elevated handwriting latencies but not elevated durations suggest that LIFG is casually involved in the retrieval of orthographic representations (but not in the execution of peripheral processes of handwriting). We also observed no offline rTMS effect on handwriting accuracy, which may suggest that though the offline rTMS we applied impacted orthographic retrieval, it was not strong enough to lead to failure of orthographic retrieval. In conclusion, this study demonstrated that LIFG plays a causal role as a core orthographic region supporting complex orthographic processes across languages.

C72 - Causal inference in discourse: N400 predicted by surprisal estimates from large language models

Xingyuan Zhao[1], Wenjun Ma[1], Seana Coulson[1]; [1]UC San Diego

Prior ERP research on text and discourse comprehension has suggested that participants make inferences about unstated causes for events, as evidenced by discourse priming phenomena. In prior work, we recorded EEG from 16 healthy adults as they listened to vignettes requiring a causal inference, each followed by a visually presented probe in a cross-modal priming paradigm. Participants' task was to answer yes/no comprehension questions about the vignettes and thus the probes were not task relevant. For example, the vignette "The farmers left the grapes out on a tarp. They shriveled into raisins in a few weeks," was followed by a visually presented probe word that was either Causally Related (e.g., sun), Lexically Related to the final word in the vignette (e.g., months), or Unrelated (i.e., words that were either causally or lexically related to different vignettes in the stimulus set). Multiple stimulus lists were constructed so that each participant only saw one of the probe words after each vignette. Priming was indexed by the amplitude of the N400 ERP component elicited by probe words in each condition. Standard ERP analysis revealed a much larger N400 effect for the Causally Related probes than the Lexically Related probes (Relatedness x Probe Type, $p < 0.01$), suggesting greater priming for the unstated cause of the event in the vignette than for the lexically related word. Here we ask whether these discourse priming effects on the N400 component are explicable in terms of the surprisal of the probe words used in those paradigms as estimated by a variety of large language models. Surprisal is a measure of the unexpectedness of a word derived by taking the negative base-2 logarithm of its contextual probability. A quantification of a word's information content, surprisal has previously been shown to correlate with the size of the N400 elicited by words in language contexts. Accordingly, we conducted single trial analyses to examine the relationship between N400 elicited by probe words in this study and their surprisal values as estimated by a series of autoregressive transformer language models with different model parameter sizes. N400 amplitude was operationalized as the mean amplitude voltage measured 300-500ms post-word onset at the central parietal electrode cluster. Six mixed effects models were constructed to predict N400 amplitude for each probe word as a function of its surprisal as estimated by gpt-3 Ada, Babbage, Curie, Davinci, Babbage-002, and Davinci-002. Each model included a fixed effect of surprisal and a random intercept for subject. A null (viz intercept-only) model included only a random intercept for subject and served as a baseline. Statistical model comparison involved computing a delta AIC score by subtracting each model's Akaike Information Content (AIC) score from that of the null model. N400 amplitudes were well predicted by surprisal scores from the four largest language models ('Curie'ΔAIC = -17, 'Davinci'ΔAIC = -16, 'Babbage_002'ΔAIC = -17 and 'Davinci_002' ΔAIC = -27), suggesting discourse priming effects can be explained (in principle) as a side effect of a neural architecture that optimizes next-word prediction.

C73 - Increased behavioral interference from hemispheric collateralization of language production and spatial attention in dual-task performance

Miaomiao Zhu[1], Qing Cai[1]; [1]East China Normal University, Shanghai, China

Most individuals exhibit left hemisphere dominance for language and right hemisphere dominance for spatial attention, which are considered typical lateralization patterns. Previous studies with brain lesions and animal models have suggested that disruptions during the establishment of functional lateralization can lead to cognitive deficits. However, the effects of different lateralization patterns on behavioral performance and their underlying mechanisms in healthy individuals remain unclear. This study focused on left-handed individuals (N = 98 for brain imaging, 45 of them for behavioral testing), given their higher prevalence of atypical lateralization patterns compared to right-handers. Functional lateralization of language and spatial attention was measured using functional magnetic resonance imaging during the verbal fluency and landmark tasks, respectively. Lateralization indices (LI) were calculated via a bootstrap method, with right dominance defined as LI < 0 and left dominance defined as LI > 0. Language performance was assessed by the number of words generated in the verbal fluency task. Spatial attention ability was measured by spatial bias in the continuous spatial trisection task (CSTT). These single tasks were integrated into a novel dual-task paradigm. Overall behavioral performance was calculated by summing the z-scores of the two tasks, and overall cognitive interference was quantified by summing the z-scores of performance differences between the dual and single tasks. Diffusion data were analyzed using a fixel-based approach to explore the relationship between lateralization patterns and interhemispheric connectivity across seven subdivisions of the corpus callosum. The results indicated that individuals with a collateralization pattern (both functions lateralized to the same hemisphere) exhibited marginally reduced overall performance in the dual-task compared to those with a typical lateralization pattern (T = -2.16, P = 0.055). The reduction was particularly evident in the CSTT but not in verbal fluency task. Second, individuals with a collateralization pattern showed greater overall performance interference than those with a typical lateralization pattern (T = 2.56, P = 0.022). However, no such differences in performance interference were identified between the reversed lateralization pattern (right language dominance and left attention dominance) and the collateralization pattern. Marginal interference differences were also observed between the typical and reversed lateralization patterns (T = 1.77, P = 0.063). Third, no significant differences in callosal connectivity were found among the groups. Additionally, a negative correlation was observed between the degree of lateralization and the combined fiber density and the cross-section of the corpus callosum's rostrum (r = -0.33, p_fdr = 0.056). These findings suggest that the functional crowding of language production and spatial attention within the same hemisphere increases cognitive interference, thereby reducing cognitive efficiency. The absence of behavioral advantages in the reversed pattern group suggests that while this functional segregation allows for parallel processing, atypical brain organization may diminish the potential benefits. Moreover, the relationship between callosal connection and functional lateralization appears to be related more to the extent of lateralization rather than the pattern. This study advances our understanding of how lateralization patterns influence behavior and offers new insights into the mechanisms underlying cognitive deficits resulting from brain reorganization after lesions.

C74 - Automated Lesion Segmentation Using Acute and Chronic Stroke MRI with nnU-Net

Tammar Truzman[1], Ajay Halai[1], Matt Lambon-Ralph[1]; [1]University of Cambridge

Introduction : Stroke is a leading cause of language deficits (aphasia) and cognitive-clinical neuroscience research has explored the relationship between brain, behaviour and recovery after stroke for many decades. Lesion segmentation is central for both clinical and research purposes, particularly for lesion-symptom mapping1,2 and estimating functional and structural disconnections3. Therefore, accurate and reliable lesion segmentation is essential, with manual tracing considered to be the gold standard. However, manual tracing is time-consuming, subject to inter-tracer variability and unfeasible for large/multi-site studies. Many automated algorithms have been prosed (i.e., 3–5); however, their performance is only moderate for multi-site datasets6 (max DICE=0.55 compared to manual tracing inter-rater reliability DICE=0.73). Additional significant challenges arise in longitudinal studies, where a 'lesioned' voxel/region may change over time making it difficult to know which areas should be marked as lesioned given different imaging modalities, and questioning the validity of using acute lesion tracing for chronic data. In this study, we took large multisite datasets in acute and chronic stroke and apply nnU-Net7 for lesion segmentation. We expected that: (1) nnU-Net models would outperform previous benchmark algorithms; and (2) perfusion MRI would be crucial for lesion identification in the acute phase, whereas structural T1 would be primary for lesion mapping in chronic stroke. Methods: We collated open-source datasets of acute8,9 and chronic stroke10,11 along with data from the MRC Cognition and Brain Sciences Unit and Korea University (KU), which had MRI and manual tracing. The acute dataset included N=1798 cases based on DWI b=1000, DWI apparent diffusion coefficient, FLAIR and T1, while the chronic dataset included N=1171 cases based on T1 only. Separate nnU-Net models were built for acute and chronic datasets using the default settings in nnU-Net (v2). Model performance (DICE coefficient) was tested using 5-fold cross validation with all data except the KU dataset, which was used for external out-of-sample validation. As we had multi-model MRI for acute data, we tested which scan types and combinations were most important for accurate lesion estimation. Results: The nnU-Net chronic model surpassed the accuracy of previously used algorithms with a DICE=0.68; importantly nearing manual tracing performance. The results for the acute data showed that: using T1 only leads to poor performance as expected (DICE=0.35), but FLAIR was also ineffective (DICE=0.47). In contrast, using DWI b=1000 scans led to high performance (DICE=0.74) and neared the reliability of manual tracing12 (DICE=0.76 and 0.79 for inter- and intra-rater evaluations, respectively). Conclusion: In this study, we were able to demonstrate that the nnU-Net framework for lesion estimation can outperform previous benchmarks and approaches the reliability for manual tracing for both acute and chronic stroke. This would aid large scale studies and also guide which imaging sequence(s) offer the best lesion segmentation

in the acute stage. We will make the models open source with accompanying code, which can be tested further or refined with more data or better algorithms. References: Not enough space.

Poster Session D

Saturday, October 26, 10:30 am - 12:00 pm, Great Hall 4

D1 - Network Analysis of Hemispheric Language Dominance Reveals Enhanced Fronto-Temporal Connectivity in Atypically Lateralized Individuals

Ieva Andrulyte[1], Laure Zago[2], Gael Jobard[2], Herve Lemaitre[2], Francois M Rheault[3], Simon S Keller[1], Laurent Petit[2,3]; [1]University of Liverpool, [2]University of Bordeaux, [3]Université de Sherbrooke

Introduction: The lateralisation degree of language functioning has been suggested to depend on hemispheric asymmetry in white matter (Verhelst et al, 2021; Westerhausen et al, 2006); however, the directionality of these findings remains unclear. This suggests that simple tractography techniques might not be sensitive enough to identify language dominance. Significant insights into the functional organization of the human brain may be achieved by considering networks and brain connectivity, providing more information about discrepancies in people with different hemispheric language dominance. In this study, we examined 283 healthy participants (aged 18-58 years) from the BIL&GIN database (Mazoyer et al., 2016) to compare their structural connectomes at the whole-brain level and determine the networks responsible for different laterality groups. Methods: All participants underwent functional and diffusion-weighted 3T MRI. Using a language production task, individuals were classified into three groups: 239 typical, 35 atypical, and 9 strongly atypical for left-asymmetrical language function (Mellet et al., 2014). Probabilistic tractography was employed to generate whole-brain tractograms (Theaud et al., 2020), and the Extractor_flow post-processing technique was used to extract white matter fibres according to anatomical Boolean guidelines (Petit et al., 2023). Connectivity matrices were generated using the Scilpy tool (https://github.com/scilus/scilpy), with nodes representing the homotopic regions of interest from the AICHA atlas corresponding to the 32 supramodal sentence areas from the SENSAAS language atlas (Labache et al., 2019), and edges weighted by fractional anisotropy (FA). Network-based statistics (NBS) tool was used to identify subnetworks that significantly differed between groups (Zelesky et al., 2010). We used an F-test to compare edge weights across the typical, atypical, and strongly atypical groups. This nonparametric approach is analogous to cluster-based correction and addresses the statistical challenge of massive multiple comparisons in whole-brain connectivity analysis by identifying the largest statistically significant fully connected network of suprathreshold edges. The p-value for a subnetwork was calculated as the proportion of permutations where the largest connected subnetwork was the same size or larger than the observed subnetwork, normalized by the number of permutations. Results: NBS analysis revealed one significant network comprising 29 nodes and 29 edges, showing group differences in edge weight associations among the three laterality groups. This network spanned bilateral temporal and frontal lobes, with particularly high nodal degree in the anterior insula and middle temporal gyrus bilaterally. The strongest connections were observed between bilateral temporal regions; from the left temporal lobe to the right frontal lobe; and between the right supplementary motor area and the precuneus. Post-hoc analyses indicated that atypical individuals exhibited stronger connectivity between the right anterior insula and right superior frontal gyrus, as well as bilateral temporal connections compared to left-lateralized individuals. Similarly, strongly atypical individuals had higher FA connectivity in bilateral fronto-temporal lobes; and between the right supplementary motor area and right precuneus compared to typical individuals. There was no significant difference in network connectivity between strongly atypical and atypical individuals. Conclusions: Both atypical and strongly atypical individuals showed stronger bilateral temporal connectivity compared to typically lateralized people, suggesting a potential compensatory mechanism.

D2 - Comparing novel visual words learning methods and the impact of consolidation with an original FPVS-EEG approach

Amaury Barillon[1], Christine Schiltz[1], Aliette Lochy[1,2]; [1]University of Luxembourg, [2]Université catholique de Louvain

Throughout adulthood, we continually learn novel written words that are integrated in neural circuits of our brain. But the impact of phonology, orthography, and semantics in creating the corresponding new neural representations is still unclear. Furthermore, the mandatory role of sleep consolidation is debated. Here, we investigate the emergence of novel neural representations for written words using fast periodic visual stimulation (FPVS) with EEG recordings and lexical decision tasks. We tested 30 adults (19 females; age mean=23.25; range=18-34 years old) before, immediately after and two days after learning 32 rare French words. In the first learning stage, words were learnt with phonological information only (PH), or with additional explicit semantic information (SEM). In the second stage, orthographic information was provided regardless of the method. Novel words were taught by blocs of 8, through different learning tasks (repetition, sentence making, matching, etc…), and were counterbalanced so that they were either learned with PH or SEM method. Each testing session (pre, post, and consolidation) included lexical decision tasks and frequency-tagging (FPVS) with EEG recordings. A written free recall was added in the consolidation session. The FPVS-oddball paradigm measures neural word-selective responses by displaying pseudowords at 10 Hz, with deviant words every 5 stimuli (2Hz). Responses to deviant stimuli at 2Hz indicate that words have been automatically discriminated from pseudowords and hence, lexical discrimination. We contrasted 4 sequence types displaying words (learned words with PH, learned words with SEM, unknown words, and known words) among respectively matched pseudowords. Every condition was repeated 4 times for a total of 16 sequences of 60 seconds. EEG results show a significant learning effect, with increased amplitudes at post-test for word-selective responses over the left occipital-temporal cortex with both learning methods, while

no response was observed at pre-test. Moreover, this effect persists over time, showing no difference between post and consolidation sessions, while a significant difference is observed between pre and consolidation sessions with both methods. Lexical decision tasks show better recognition (accuracy) of the novel words at post and consolidation sessions, and an increase in reaction times for novel words' orthographic neighbors, and for 1-letter close pseudo-words with both methods at post and consolidation testing, suggesting immediate competition with new lexicalizations. No differences between methods were found in neural responses assessed with FPVS-EEG, or in behavioral lexical decision results. However, the free recall task indicated a clear advantage for words learned with the semantic method (50% vs 38% recall). In conclusion, our findings provide new evidence for the emergence of immediate new lexicalization for novel words after a short learning period, that persists over time. Also, when comparing methods, our study highlights a divergence between results as a function of the task as we demonstrated a clear semantic advantage only when the task was sufficiently challenging. In other words, novel words are well encoded with both methods, but their retrieval is facilitated when novel words are learnt with a semantic method.

D3 - Relative encoding of speech intensity in the human temporal cortex

This abstract will now be presented as a slide in Slide Session B, Talk 1 instead of a poster.

D4 - A passive auditory language fMRI paradigm in children with diverse language development profiles

Tatiana Bolgina[1], Ekaterina Shcheglova[1], Elizaveta Dmitrova[2], Militina Gomozova[1], Tatyana Zhilyaeva[3,4], Ulyana Nasonova[3], Olesya Klekochko[3], Evgenij Klyuev[3], Olga Dragoy[1,5]; [1]Center for Language and Brain, HSE, Moscow, Russia, [2]Center for Language and Brain, HSE, Nizhniy Novgorod, Russia, [3]Privolzhsky Research Medical University, Nizhny Novgorod, Russia, [4]Bekhterev National Medical Research Center for Psychiatry and Neurology, St. Petersburg, Russia, [5]Institute of Linguistics, Russian Academy of Sciences, Moscow, Russia

A passive auditory language fMRI paradigm has become a necessity for a reliable presurgical functional language assessment especially in pediatric clinical populations (Lyn Ives-Deliperi & Butler, 2018; Suarez et al., 2014). The paradigm does not require any overt patient participation, has been validated to detect activations in language-related cortices showing consistent results with invasive clinical gold-standards (Manan et al., 2020; Okahara et al., 2023; 2024). While the paradigm has been validated in pediatric and adult epilepsy surgical planning (Okahara et al., 2024; Suarez et al., 2014) as well as in healthy adults (Haller et al., 2007), children with diverse language development profiles remained understudied (Vannest et al., 2009). The goal of this study was to determine language functional localization in children with different language development profiles. Twenty-eight Russian children (20 males; M age = 6.4 years, SD = 0.7, range = 5–7.5) underwent 1.5T magnetic resonance imaging and a language development assessment with the Russian Child Language Assessment Battery (RuCLAB) (Arutiunian et al., 2022). The sample included six typically developing children and children with one or several disorders such as articulation speech disorder, expressive speech disorder, receptive speech disorder and/or attention-deficit/hyperactivity disorder to form a continuum of language development profiles. Language-related functional activations were registered using a passive auditory paradigm: the participants listened to the Russian fairy tale "Teremok" in the experimental condition and tones in the baseline condition. The obtained functional T2*-images (TR/TE/FA = 3000ms/54ms/90°, matrix size 64*64, voxel 3x3x3 mm, 90 axial slices) and structural T1-images (TR/TE/FA = 2160ms/5.26ms/15°) were analyzed in SPM12. Functional lateralization indices (LIs) were calculated in the LI toolbox (Wilke & Lidzba, 2007) using the formula (left - right) / (left + right), t-weighting of voxels, and frontal, temporal, and parietal lobes masks. The group analysis showed significant BOLD signal increases in the left superior temporal gyrus extending to the left middle temporal gyrus (k = 453 voxels, peak at MNI: -62

-32 4, p=.001) and in the right superior temporal gyrus extending to the right middle temporal gyrus (k = 585 voxels, peak at MNI: 60 -14 2, p=.001). LIs in all children varied from -0.74 to 0.93 (temporal lobe); from -0.96 to 0.86 (frontal lobe) and from -0.84 to 0.98 (parietal lobe). Most children showed a bilateral activation (64.3%, n = 18), whereas a unilateral activation was found in five children. A preliminary Pearson correlation analysis did not show any significant associations between LIs and language RuCLAB scores at the corrected for multiple comparisons level. The results are in line with previous studies that found functional language activation in temporal regions during the passive listening task (Haller et al., 2007; Vannest et al., 2009; Wilke et al., 2005). The present study supports the contribution of the superior and middle temporal gyri of both hemispheres for auditory processing and language comprehension. Overall, the study confirms the validity of the passive auditory paradigm in young children with diverse language development profiles.

D5 - Earlier evoked response for lexical surprisal in L1 compared to L2 during naturalistic listening

Jonathan Brennan[1], Tzu-Yun Tung[2]; [1]University of Michigan, [2]University of Chicago

INTRODUCTION A growing body of work demonstrates alignment between next-word predictions from Large Language Models (LLMs) like GPT2 and human neural responses associated with predictive language processing in fMRI, ECoG, MEG and EEG. The present project extends this to the comparison of predictive processing in a first vs. a second language. The role of prediction in second language processing has received significant attention. While there is consensus that language proficiency modulates prediction in some way, there are differences in the nature by which predictions are changed (e.g. is the timing of prediction delayed? Are predictive cues weighted differently?), and also ongoing debate about how different kinds of bilingual language experiences (sequential, balanced, etc.) might affect predictive processing. Here we, first, replicate prior work showing effects of next-word predictability (surprisal) on evoked signals within 200 ms in L1 speakers listening to an audiobook. We then evaluate responses of the same speakers when they listen to an audiobook in a second language. METHODS N=29 L1 speakers of Mandarin Chinese (Exp. 1) and N=19 L1 Mandarin, L2 English (Exp. 2; overlapping with the first group) participated in this study. Participants in both experiments had EEG recorded from 31 active electrodes at 500 Hz (0.1-200 band-pass) while listening to chapters from an audiobook story in either L1 (Mandarin, Exp 1) or L2 (English, Exp 2). Data were epoched around word onset (-200-1000 ms), cleaned of eye-artifacts with ICA, and epochs and channels with excessive noise were marked with the autoreject algorithm. All stimuli came from translations of the same audiobook (total length: ~1 h), but participants listened to different, counterbalanced, chapters in the two languages. Surprisal estimates were derived from pre-trained English GPT2 and Chinese GPT2. Epochs corresponding to content words were sorted into equal-sized bins based on surprisal (high, med, low) and averaged to create ERPs. RESULTS Mandarin L1 datasets show a robust evoked response for surprisal such that higher surprisal leads to more negative-going waveform between 200 and 400 ms; this effect is strongest at anterior sites and replicates prior work comparing surprisal to evoked responses during naturalistic listening with EEG. L2 datasets, in English, also show more negative evoked responses for higher surprisal words at anterior sites, but this response was observed at a delay such that the waveform difference was strongest from 350-450 ms. CONCLUSION This work replicates prior research demonstrating effects of surprisal on evoked responses during naturalistic listening in L1 English and extends that work to L1 Mandarin. We also find surprisal effects with a similar topography and polarity in L2 processing (L2 English, L1 Mandarin) but with a latency delay of ~100 ms. This is consistent with the theory that predictive processing may be slower in L2 comprehension and sets the stage for future work leveraging surprisal derived from LLMs to probe the mechanisms of predictive processing across different levels of language proficiency.

D6 - Neural correlates of connected speech outcomes and recovery from aphasia in the first year after stroke

Marianne Casilio[1], Anna V Kasdan[1], Sarah M Schneck[1], Jillian Entrup[1], Lily Walljasper[1], Caitlin Onuscheck[1], Deborah Levy[1], Michael de Riesthal[1], Stephen M Wilson[1,2]; [1]Vanderbilt University Medical Center, [2]University of Queensland

Acute lesion characteristics are the most explanatory predictors of overall aphasia outcomes and recovery after stroke[1]—yet these lesion predictors remain “elusive”[2], in part because their relevance to language produced in everyday contexts (connected speech) is largely unknown. The present study characterized the neural correlates of connected speech outcomes and recovery from aphasia in the first year after stroke. Leveraging a large longitudinal study[1], we extracted connected speech samples from 195 patients diagnosed acutely with aphasia following left-hemisphere stroke; individuals were tested at four timepoints (2–5 days, 1 month, 3 months, 12 months post-onset). Samples were scored by a speech-language pathologist blinded to other data using the Auditory-Perceptual Rating of Connected Speech in Aphasia (APROCSA)[3,4], a validated assessment approach that yields scores on four dimensions: Paraphasia (misselection of words/sounds), Logopenia (paucity of words), Agrammatism (morphosyntactic omissions), and Motor speech (impaired speech motor programming/execution). Acute clinical neuroimaging was also acquired, and lesions were delineated using established methods[1]. For each individual, we computed the volume of damage in three left-hemisphere regions of interest (ROIs) within the language network (Prefrontal, Frontoparietal, Temporal)[5] and a fourth non-language region (Other). Data were analyzed using growth curve modeling. To evaluate the effect of acute lesion characteristics on outcomes, repeated measures of the four APROCSA dimension scores were expressed as a function of a random effect for participants, a fixed effect for time post-onset, and a fixed effect for all four ROIs. To evaluate the effect of acute lesion characteristics on recovery (rate of change on dimension scores), time-by-ROI interactions were added. The neural correlates of outcomes in the first year after stroke were nearly identical to those observed

acutely[4]. Paraphasia was associated exclusively with damage to the Temporal ROI (p<.001) while Logopenia was associated exclusively with damage to the Frontoparietal ROI (p=.003). Agrammatism was associated with damage to both the Frontoparietal (p=.004) and Other (p=.03) ROIs. Motor speech was associated with damage to the Frontoparietal ROI (p<.001). The neural correlates of recovery diverged from those observed acutely[4] and over the long-term. Rate of change on most dimension scores depended on a diminishing effect of the Prefrontal (Logopenia: p=.047) or Frontoparietal (Agrammatism: p=.005; Motor speech: p=.037) ROIs; damage to these regions mattered less as time post-stroke increased. Remarkably, there was no effect of the Temporal ROI; damage to this region had persistent effects across time. Additionally, there was an increasing effect of the Other ROI on Agrammatism (p=.003), along with marginal effects on the other three dimensions; damage to this region mattered more as time post-stroke increased. Collectively, these findings confirm the importance of acute lesion characteristics, reveal the differential capacity of frontal versus temporal language regions to reorganize[6], and suggest a potential role for brain regions outside the canonical language network in the recovery of language produced in context. [1]Wilson et al. Brain. 2023;146(3):1021-39. [2]Ali et al. Aphasiology. 2022;36(4):555-574. [3]Casilio et al. Am J Speech Lang Pathol. 2019;28(2):550-568. [4]Casilio et al. Brain. 2024; in press. [5]Yen et al. NeuroImage. 2019;189:368-379. [6]Stockert et al. Brain. 2020;143(3):844-861.

D7 - Clarifying the roles of spatial configuration and orthographic depth in shaping brain laterality in visual word processing

Alice HD Chan[1], Fun Lau[2]; [1]Nanyang Technological University

Introduction: Neuropsychological evidence has consistently shown that logographic and alphabetic scripts are represented differently in the occipitotemporal (OT) regions (bilateral for logographic scripts, left-lateralized for alphabetic scripts). Such distinction has been attributed to differences in spatial configuration and orthographic depth. However , how these factors independently influence neural representation of visual words has not been comprehensively investigated. Adopting an artificial orthography training paradigm, this study aims to clarify the effects of spatial configuration and orthographic depth on the laterality of the N170 ERP component, which is source-localized to the occipitotemporal region. Methods: Sixty-two subjects took part in a five-day artificial language training study, with pre- and post-training EEG sessions. Subjects were randomly assigned to learn 1 of 4 artificial orthographies. The artificial orthographies were composed using the same set of artificial letters, and differed only in spatial configuration and orthographic depth such that there were Linear Shallow (n = 15), Linear Deep (n = 16), Square Shallow (n = 17) and Square Deep (n = 14) conditions. All subjects learnt a total of 18 artificial words over the five days, and their word learning performance was assessed at the end of every session. In the EEG sessions, subjects performed a visual one-back task of the artificial words they were assigned to learn. A series of mixed-design ANOVAs were performed on the N170 amplitudes at the left OT and right OT to examine N170 laterality differences among the 4 artificial orthography conditions at pre-training, post-training, as well as the changes in N170 laterality from pre-training to post-training. Results: Subjects attained high levels of learning accuracy at the end of the training (M = 85.8%), indicating that subjects have successfully acquired the word-to-sound correspondences in their assigned artificial orthography. At pre-training, there was a sole significant interaction effect of hemisphere x spatial configuration [F(1, 58) = 6.203, p = .016], driven by left-lateralized N170 for the linear orthographies and bilateralized N170 for the square orthographies. Importantly, this effect of spatial configuration on N170 laterality is sustained at post-training [F(1, 49) = 4.139, p = .047], and remains to be the sole significant effect observed. Effects of orthographic depth, while not salient when pre- and post-training N170 amplitudes are analyzed in isolation, could potentially be captured by the change in N170 laterality from pre- to post-training, as indicated by a near-significant interaction effect of session x hemisphere x orthographic depth. Conclusion: Findings from this study indicate that the laterality of the N170 ERP component in visual word processing is primarily driven by spatial configuration, in that the processing of linear orthographies is left-lateralized and the processing of square orthographies is bilteralized. This difference in lateralization patterns was observed regardless of whether the subjects were naïve to (pre-training) or familiar with (post-training) the orthographies. While orthographic graph could possibly contribute to change in laterality patterns from pre-training to post-training, ultimately its effects on N170 laterality appear to be overshadowed by the effects of spatial configuration.

D8 - Semantic cognition and executive control functions differentially predict propositional language production in younger and older healthy adults: a preliminary investigation

Melody M.Y. Chan[1], Jessica Chow[2], Gail A. Robinson[1,2]; [1]Queensland Brain Institute, University of Queensland, [2]School of Psychology, University of Queensland

Propositional language production is an important cognitive capacity supporting social communication. It declines when people undergo normal ageing, but some older adults maintain this capacity in later life. Previous studies suggest that propositional language production is supported by both domain-specific (i.e., core language skills) and domain-general (i.e., semantic cognition and executive control functions) cognitive components. Yet, how these components interact and modulate this capacity in younger and older healthy individuals remains elusive. We sampled 30 younger adults (mean age = 19.53 years, s.d. = 2.93 years, male-to-female ratio = 8:22) and 27 older adults (mean age = 67.85 years, s.d. = 6.78 years, male-to-female ratio = 9:18). The groups were matched by sex ratio (p = .58) and fluid intelligence (Raven's Progressive Matrices; p = .10). All participants performed cognitive tasks tapping propositional language production (i.e., describe a beach scene in 1 minute), reading [National Adult Reading Test (NART)], semantic representation [Graded Naming Test (GNT)], and executive/semantic control functions [i.e., semantic verbal fluency (1-minute, category: animal) – energization and semantic control; colour-word Stroop – inhibitory control].

Although the younger and older groups had comparable propositional language production performance (speech rate: younger = 128.79 words/min, s.d. = 23.41 words/min; older = 124.89 words/min, s.d. = 28.71 words/min; p = .58), they had different cognitive task performance profiles. The older group performed better in the picture naming task (GNT accuracy rate: younger = 57.56%, s.d. = 12.47%; older = 75.77%, s.d. = 13.42%; p < .001) and word reading task (NART IQ: younger = 112.50, s.d. = 3.69; older = 116.13, s.d. = 3.20; p<.001). However, they performed worse in the inhibitory control task (Stroop task completion time: younger = 17.62s, s.d. = 6.27s; older = 30.19s, s.d. = 17.63s; p < .001) and semantic verbal fluency task (total unique responses generated: younger = 27.47 words/min, s.d. = 5.37 words/min; older = 24.26 words/min, s.d. = 6.07 words/min; p = .039). Subgroup correlation and multiple linear regression analyses revealed that, semantic representation and executive control functions (but not reading) played differential roles in modulating propositional language production in younger and older adults. Better picture naming performance was only weakly associated with (r(29) = .37, p =.042), and significantly predicted [b = .70, BCa 95%CI (-.106, 1.22); p = .042], propositional language production in younger, but not older adults. Meanwhile, better fluency (r(26) = .60, p <.001) and inhibitory control (r(26) = .54, p =.001) performance was strongly associated with, and significant predicted [fluency: b = 2.19, BCa 95%CI (.66, 3.73); Stroop: b = .61, BCa 95%CI (.084, 1.14); p < .001], propositional language production in older, but not younger adults. To maintain propositional language production performance in older age, a greater knowledge reserve compensating for the decline in executive control functions is needed. Better energization and inhibitory control abilities underlie better propositional language production in older adults, which explains why some of the older adults are able to maintain this capacity in later life.

D9 - Subgroup-level functional connectivity of the M1 inter-effector areas differentiating stuttering and non-stuttering children

Soo-Eun Chang[1], Yanni Liu[1], Fiona Hobler[1], Hannah Becker[1], Mike Angstadt[1], Adriene Beltz[1]; [1]University of Michigan

Motor cortical circuit function and anatomy have been a focus in studying the neural bases of stuttering. Recently, strong evidence supported the discovery of three “inter-effector” areas (IEAs) along the M1, interleaved between effector-specific regions (e.g., tongue, hand, feet). These IEAs are more active during action planning than movement execution and display distinct morphology and greater connectivity to brain regions involved in cognitive control, sensory processing, and movement intention. These IEAs likely support integrative functions for complex actions, with particular relevance for speech production and speech “motor” pathology like stuttering. In this study, we examined functional connectivity patterns of the three IEA areas using Group Iterative Multiple Model Estimation (GIMME), which derives group- and individual-level connectivity measures. We hypothesized that GIMME-detected connectivity would show distinct subgroup-level differences between stuttering and control groups in the (i) mid-IEA and (ii) inferior-IEA. These areas overlap with dorsal and ventral laryngeal motor cortices, respectively, which previous studies have shown to differentiate stuttering speakers from controls at baseline and change in response to intervention in terms of functional connectivity. We used CS-GIMME (Confirmatory Subgrouping GIMME), to estimate subgroup-level connections for priori known groups (stuttering, control). Connectivity results are derived at both the group and individual level, allowing us to examine subject-specific heterogeneity. CS-GIMME can detect paths between nodes (“edges”) that are consistently present for individuals within stuttering and control groups, thus facilitating our interpretation of heterogeneous connectivity maps and allowing for subgroup-specific inferences. Resting-state fMRI data were acquired from 73 children who stutter (CWS) and 76 age- and gender-matched children who do not stutter (CNS) (mean age=72 ± 22 months, age range from 38-129 months, 34 CWS girls, 40 CNS girls). Stuttering severity (SSI) range was 2-37 (17.8±6.3) (very mild ~ very severe). Data were processed using standard methods in SPM12. Subjects were included if they had at least 4 minutes of useable data (after motion censoring at FD>0.5mm) and a usable T1 image. Participant-specific time series from 8 regions of interest (ROIs) were extracted. The ROIs and their locations were selected according to average IEA coordinates reported in Gordon et al. (2023). CS-GIMME was run using a 75% threshold for group-level and 50% for sub-group-level edges. Group-level analysis revealed IEA connections with the supplementary motor cortex (SMA) and putamen (present in both groups). Subgroup-specific connections were also detected: CNS showed connections between the mid-IEA and the dorsal cerebellum, while CWS showed connections between the inferior IEA and SMA. Additionally, node centrality (number of the modeled connections involving the node) differed significantly for the mid and inferior IEAs between the groups, with CWS presenting lower centrality in the mid-IEA but higher in the inferior IEA. These results suggest that the middle and inferior IEAs develop differently in CWS, with implications for speech motor planning affected in stuttering. In future research, we will further apply GIMME to derive data-driven subgroups within the group of children who stutter to examine whether this method can help predict specific subtypes, or eventual persistence and recovery in developmental stuttering.

D10 - Transcranial Photobiomodulation on the Left Inferior Frontal Gyrus Enhances Mandarin Chinese L1 and L2 Complex Sentence Processing Performances

Luyao Chen[1], Mingchuan Yang[1], Xiujie Yang[1], Dongwei Li[1]; [1]Beijing Normal University

Objective: Owing to the feasibility of shaping the brain, noninvasive brain stimulation (NIBS), which causes electrophysiological or metabolic effects through physical or chemical approaches to alter brain activities, has become a promising method of modulation towards language ability. However, to what extent NIBS could be administered to improve first language (L1) speakers’ and second language (L2) learners’ sentence processing performances is largely unclear yet. Therefore, this study set out to evaluate the causal enhancing effect of a relatively novel NIBS technique, transcranial photobiomodulation (tPBM), recently introduced to

modulate various cognitive functions, over the left inferior frontal gyrus (LIFG), a key region for language/syntactic processing, on syntactically complex Mandarin Chinese L1 and L2 sentence processing performances. Methods: Two (L1 and L2) groups of participants (thirty per group) were recruited to receive the double-blind, sham-controlled tPBM intervention via LIFG, followed by the sentence processing, the verbal working memory (WM), and the visual WM tasks (pseudo-randomized across participants). The sentence processing task asked participants to process complex sentences with relative clauses embedded, while the verbal WM task required participants to recall and to judge whether the word and its given position were matched. The contrast between these two tasks may reveal whether sentence processing performance could be improved independently from verbal WM. Moreover, a controlled task, visual WM task, whose performance was reported to be improved after applying tPBM over the right inferior frontal gyrus (RIFG), was adopted to testify whether tPBM effects on LIFG are domain-specific (esp., to language-related processing). Results: Behavioral results revealed a consistent pattern for both groups: (a) tPBM enhanced sentence processing performance but not verbal WM; (b) Participants with lower sentence processing performances under sham tPBM benefited more from active tPBM. (c) As expected, the visual WM performances of both groups were not interfered. Taken together, the current study, for the first time, substantiated that tPBM on LIFG could enhance L1 and L2 sentence processing performances independently without contributing to WM performances, and tPBM-on-LIFG effects might be domain-specific to language abilities. Thus, we propose that tPBM would serve as a promising and cost-effective noninvasive brain stimulation (NIBS) tool for future applications on upregulating the human language faculty.

D11 - Effect of working memory load in natural sentence reading in adolescents with ADHD and ADD- Evidence from the simultaneous recording of Eye Movements and Fixation-Related Potentials

Jou An Chung[2,3], Pei-Chun Chao[1], Jie-Li Tsai[4], Chia-Ying Lee[1,2,3,5]; [1]Institute of Linguistics, Academia Sinica, Taipei, Taiwan, [2]Institute of Cognitive Neuroscience, National Central University, Taoyuan, Taiwan, [3]Interdisciplinary Neuroscience, Taiwan International Graduate Program, Academia Sinica, Taipei, Taiwan, [4]Department of Psychology, National Chengchi University, Taipei, Taiwan, [5]Research Center for Mind, Brain, and Learning, National Chengchi University, Taipei, Taiwan

Prior studies reported that executive dysfunctions such as deficits in working memory (WM) may explicate reading difficulty in individuals with Attention Deficit／Hyperactivity Disorder (ADHD or ADD). Nevertheless, the extant evidence remained equivocal since most findings relied on the correlation between WM capacity and performance on the offline standardized reading assessments. Hence, this study aimed to examine the effect of WM load on natural reading among ADHD, ADD, and normal controls by simultaneously recoding Eye-Movement (EM) and Fixation-Related ERPs (FRPs). Three levels of WM-load were determined by the varying filler-gap distance. Low WM-load (LWM) condition comprises the sentences with the simplest Chinese Subjective Relative Clause (SRC) ([FILLER] RC verb (協助/help) + RC noun (居民/resident) + 的(DE) + Head noun [GAP] (志工/volunteer)). As for the medium and high WM-load conditions, one constituent- adverbial modifier (ex: 熱心/enthusiastically) and two constituents- a locative preposition and an adverbial modifier (ex: (在社區/in the community)+(熱心/enthusiastically)) were added prior to the RC verb, respectively. Fifty-three college students with normal reading, eight ADHD, and eight ADD read 81 sentences at their own pace while EMFRPs were simultaneously recorded. The overall EM patterns revealed that ADHD showed the longest total reading time, the greatest number of total fixations, and most regressions per sentence in each WM-load condition, followed by the ADD and the normal control group. Specifically, in ADHD, the number of regressions accounted for over 70 percent of the total fixations. Compared to normal controls, ADHD and ADD initiated longer and unstable forward and backward saccades. EM patterns on the head noun (HN) where the ambiguity is supposed to be resolved were also compared. ADHD showed longer go-past-time, rereading time, higher rereading rate, regression-in, and regression-out rate, followed by ADD and the normal control. Meanwhile, the EM data from normal control revealed the significant main effect of WM load on first-pass (first fixation duration) and second-pass measures (rereading rate and regression-in rate), indicating the effect of WM load on word recognition and sentence integration. However, the WM load effect was absent in ADHD and ADD. For the FRPs, the Linear Mixed Model analysis result revealed a significant WM effect on the P200, N400, and the late frontal negativity in the normal control group. The HN in the LWM condition yielded greater positivity of the P200 than that in MWM and HWM. Subsequently, the HN in the HWM condition yielded greater negativity of the N400 in the right-parietal region and the late frontal negativity. A higher WM load can lead to effortful word recognition, difficulty in sentence integration, and ultimately results in difficulty in the referential binding process. However, this WM effect on the FRPs has not been found in ADHD and ADD, suggesting that all levels of the WM-load were challenging for them. In sum, current findings demonstrated that the modulations of WM load on sentence comprehension can differentiate three groups.

D12 - Multivariate multichannel morphometry reveals mesoscale white matter structures supporting language processing in post-stroke aphasia

Andrew DeMarco[1], Peter Turkeltaub[1,2]; [1]Georgetown University, [2]MedStar National Rehabilitation Hospital

The language network is now understood to include more gray matter regions than classical models suggested, but the anatomy of white matter connections between these regions remains underspecified. Modern macroscale investigations focus on discrete, long-distance paths abstracted via tractography, with microstructure approaches like TBSS typically restricted to strictly-thresholded voxels. These studies generally ignore white matter mesoscale architecture, including gyral blades, local U-shaped fibers, and columnar cortical structures. Here, we examine the contributions of mesoscale

white matter structures to language comprehension and production in a cohort of chronic left-hemisphere stroke survivors. We employ a multivariate, multichannel morphometry approach that fuses multiple DTI scalar maps to enhance interpretability of results. Behavioral scores and neuroimaging data, including diffusion imaging, from chronic stroke survivors (N=134) enrolled in prior studies in the Cognitive Recovery Lab were analyzed. Voxelwise tensors were fitted using FSL and warped to a shared template using ANTs. Three analyses employed a multivariate lesion-symptom mapping approach, with predictor features consisting of left-hemisphere voxels concatenated across the three orthogonal scalar FA maps. For proof-of-concept, we first localized visual field laterality index scores (N=96). We then localized the Auditory Verbal Comprehension (AVComp) and the Spontaneous Speech (SpontSpeech) subscores from the Western Aphasia Battery. Statistical significance was established via 5000 permutations, with multiple comparisons corrected by controlling for continuous family-wise error rate (v=1000, FWER = .05). Lesion volume was included as a covariate. Model solutions were backprojected and visualized as a fused 3D RGB-encoded interactive isosurface. Results were first interpreted via overlap with the XTRACT atlas. Critically, detailed spatial geometries were further interpreted. Patients scored an average visual field LI of -.08 (SD=.19), 84% (SD=17%) for AVComp, and 74% (SD=25%) for SpontSpeech. Significant field cut LI results (2149 voxels) showed strong convergence with the left optic radiation parcel, with a clear Meyer's loop, spanning from calcarine sulcus around the lateral ventricle and sweeping medially toward LGN, plus vertical occipital fasciculus. SpontSpeech results (3577 voxels) mostly overlapped with superior/anterior thalamic radiations, acoustic radiations, uncinate, corticospinal tract, and medio-dorsal longitudinal fasciculus, but excluded the superior longitudinal and arcuate fasciculi. Additionally, discrete structured tendrils reached from long tracts towards middle/inferior temporal and inferior frontal gyrus cortex, with a U-shaped structure reaching into premotor cortex. AVComp results (2515 voxels) overlapped with medio-dorsal and inferior fronto-occipital fasciculi, acoustic radiations, inferior longitudinal fasciculus and superior thalamic radiation, with some uncinate and arcuate overlap. The result dipped into the anterior temporal pole, and notable geometric structures include a clear impression of the transverse temporal gyrus and approximately five discrete lateral (red) projections into the lateral temporal cortex. Here, we show proof-of-concept for mapping mesoscale white matter structures associated with language processing. This investigation found mostly expected results with regard to long-range pathways, although some surprises such as lack of dorsal pathway with spontaneous speech. The results also contain rich mesoscale white matter geometries stereotyped across individuals, which can be studied to elaborate on general dual-stream conceptualizations of white matter contributions to language processing.

D13 - The neural basis of phonological neighborhood density and lexical frequency across adulthood

Michele Diaz[1], Abigail Cosgrove[1], Kathryn Walters[1], Jie Yan[1], Haoyun Zhang[2]; [1]Penn State University, [2]University of Macao

Although many aspects of language remain stable with age, aging is often associated with declines in language production. For example, compared to younger adults, older adults experience more tip-of-the-tongue states, show decreased speed and accuracy in naming objects, increased errors in spoken and written production, and more pauses and fillers in speech, all of which suggest age-related increases in retrieval difficulty. Although these behavioral effects are commonly observed, the mechanisms underlying age-related speech disfluencies is less understood. Prior work has demonstrated that words with small phonological neighborhoods and words that have a lower lexical frequency are produced more slowly by adults of all ages. Moreover, although older adults' neural sensitivity to phonological and semantic features is stable across adulthood (Diaz et al., 2021; 2022), older adults may be particularly vulnerable to retrieval deficits with words that have particular characteristics such as sparse phonological neighborhoods or low lexical frequency (Gertel et al., 2020). Here we examined the combined effects of these lexical factors with functional Magnetic Resonance Imaging (fMRI). We used overt picture naming and manipulated the phonological neighborhood density (PND) and lexical frequency of the pictures to be named (N = 91, ages 20 - 89). Behaviorally, we found that adults of all ages were sensitive to lexical frequency and PND. In addition, increases in age were associated with naming pictures more slowly and less accurately. There were also Age x Frequency and Age x PND interactions such that increases in age were associated with slower and less accurate naming primarily when naming pictures with low frequency and PND. In terms of fMRI results we observed age-related increases in activation to picture naming in general, largely outside of typical language regions. We also observed an Age x PND x Frequency interaction, where older adults elicited less activation to the PND x Frequency interaction compared with younger adults in bilateral Inferior Frontal Gyrus and Insula, as well as right Superior Temporal Gyrus. The neuroimaging findings suggest that picture naming is associated with both neural dedifferentiation, as well as under recruitment of language specific regions.

D14 - The cognitive neural mechanisms and age-related development of taxonomic and thematic relations processing: A resting-state fMRI study

Jinfeng Ding[1,2], Panpan Liang[1,2], Xiaohong Yang[3]; [1]CAS Key Laboratory of Behavioral Science, Institute of Psychology, Beijing, China, [2]Department of Psychology, University of Chinese Academy of Sciences, Beijing, China, [3]Department of Psychology, Renmin University of China, Beijing, China

Concepts interconnect via various semantic relations within the conceptual semantic system, among which taxonomic and thematic relations are crucial. Taxonomic relations are established based on the similar features between concepts, and thematic relations are constructed on the basis of the co-occurrence of concepts in the same events or scenarios. Research shows that as age increases, the semantic system dynamically changes, which is reflected by different developmental trends of various semantic relations. However, the neurocognitive mechanisms of the taxonomic and thematic

relations processing in children and adolescents remain underexplored. The current study aimed to explore this issue by performing a seed-based connectivity analysis of resting-state fMRI. We collected behavioral and resting-state brain imaging data from 215 subjects aged 6-18 years. Participants performed a lexical decision task with the target words being primed by taxonomically related, taxonomically unrelated, thematically related and thematically unrelated words. Three brain regions, inferior frontal gyrus (IFG), anterior temporal lobe (ATL), and angular gyrus (AG), closely related to language processing, were selected as seed sites for the study. The behavioral results revealed taxonomic and thematic priming effects, as indicated by the shorter reaction time and higher accuracy for the target words preceded by taxonomically and thematically related words relative to the unrelated words. Combining the behavioral data with the resting-state fMRI data, we found a significant interaction between taxonomic relation and age, which was manifested in the functional connectivity between the ATL and the lateral occipital lobes bilaterally, and the functional connectivity between the IFG and the right posterior middle temporal gyrus (pMTG) and posterior inferior temporal gyrus (pITG). Further analysis revealed that in the age group of 6-9 years the better the taxonomic priming effect the stronger the functional connectivity, whereas in the age group of 10-18 years the better the taxonomic priming effect, the weaker the functional connectivity. An overlapping analysis of the obtained brain areas over seven major brain networks found that they mainly belong to the frontoparietal control network. In summary, we found that the cognitive neural mechanisms of taxonomic relation and thematic relation processing will change with individual development, mainly manifested in the change of the functional connectivity strength between cognitive control brain regions and language processing brain regions. Semantic processing is more dependent on the interaction between the control network and language network in childhood, and this dependence gradually diminishes as the semantic system matures with age.

D15 - Ultra-high-field (7T) fMRI reveals graded semantic structure in the ventral anterior temporal cortex

Saskia L. Frisby[1], Ajay D. Halai[1], Christopher R. Cox[2], Matthew A. Lambon Ralph[1], Timothy T. Rogers[3]; [1]University of Cambridge, [2]Louisiana State University, [3]University of Wisconsin-Madison

Semantic cognition supports language production and comprehension, object recognition and classification, and understanding of everyday events. The cortical semantic system includes a bilateral “hub” centred on the ventral anterior temporal lobes (vATL) that recasts modality-specific semantic information experienced over time into transmodal and transtemporal representations that express conceptual structure (Lambon Ralph et al., 2017; Jackson et al., 2021). Recent evidence from human intracranial grid electrocorticography (ECoG) showed that voltages recorded from the vATL express graded multi-dimensional semantic structure (Cox et al., 2024) in a code that is distributed across space and changes rapidly over time, especially in very anterior subregions (Rogers et al., 2021). Thus it is not clear whether fMRI can detect the vATL’s semantic code given its limited temporal resolution and the signal dropout and distortion issues that plague vATL imaging (Halai et al., 2014, 2015). To answer this question we collected 7T-fMRI data from 32 participants while they named the same 100 black-and-white line drawings employed in the ECoG study. We used a novel multi-echo, multiband acquisition protocol designed to counteract signal dropout and distortions in the vATL while maintaining enhanced signal-to-noise across the rest of the cortex (Frisby et al., in prep). To test whether the distributed animacy code observed by Rogers et al. (2021) was apparent in fMRI, we constructed a ventral temporal ROI based on the locations of the ECoG grid electrodes and trained L1-regularized logistic regression models to distinguish animate from inanimate stimuli. To test whether the vATL represents graded semantic structure, we used feature-verification norms (Dilkina & Lambon Ralph, 2013) to construct a matrix representing the similarity of each pair of stimuli, decomposed the matrix into three orthogonal semantic dimensions, and trained L1-regularized linear regression models to predict the coordinates of each stimulus on each dimension. Despite the compromised temporal resolution and signal homogeneity challenges, we reliably decoded animacy from same regions covered by the ECoG electrodes in the prior study (cross-validated accuracy > 0.8), including in the ventral ATL centre-point of the semantic “hub” (Lambon Ralph et al., 2017). Classifiers reliably decoded animacy even in very anterior regions where univariate contrast yielded null results. fMRI signals also reliably predicted stimulus coordinates along the first principal semantic dimension (cross-validated correlation > 0.6), but not on the other two, consistent with the prior ECoG results when models used L1 regularization. These results indicate that 7T-fMRI data, like ECoG, can be used in conjunction with multivariate methods to reveal semantic information across the vATL semantic “hub,” including both binary animacy distinctions and continuous, graded representation, and in regions where univariate contrast suggests no such signal exists. This opens the door to studying semantic representation noninvasively in large samples of healthy participants and with full cortical coverage. While we were unable to decode the second and third principal semantic dimensions in this data, discovery of such structure in ECoG data required use of more sophisticated regularizers. To determine whether fMRI can reveal this more subtle semantic structure, future work should adopt a comparable approach.

D16 - The Neurobiological Basis for Embodied Word Learning in Chinese and English

Connie Qun Guan[1]; [1]Beijing Language and Culture University, Beijing, China, [2]Queensland University of Technology, Brisbane, QLD, Australia, [3]Carnegie Mellon University, Pittsburgh, P.A. U.S.A.

[Introduction] Embodied hand movement facilitates the word processing, but little is known as to how language proficiency affects this process in a second language (L2). Especially when the learners operated two different languages, such as Chinese vs. English. Here, we examined word learning in L2 Chinese learners and L2 English learners using the embodied hand movement paradigm (Guan et al., 2015. 2021, 2022). [Aims] We

aimed to explore the neurobiological basis of word learning among leaners who were adopting the embodiment learning tasks. The embodiment learning tasks/conditions were designed in the way hand movements differed in the way word form-meaning- and sound are associated. [Method] We designed specifically three embodied learning conditions (i.e., the pure handwriting, shape-drawing, and delayed copying as compared to the passive visual viewing condition (i.e., baseline). We recruited 40 per group/condition of high vs. low proficient L2 learners in both Chinese and English. We collected both behavioral measures of accuracy and response times, and neurological data including several neural indicators of event-related-potentials (ERPs) (i.e., early visual of N170, attention of P300, and semantic unexpectedness of N400). We also conducted MRI (magnetic resonance imaging techniques) at neurobiological levels. [Results] Behavioral results showed that reduced response times and higher accuracy rates in conditions with specific sensorimotor experiences (i.e., pure handwriting and shape-drawing) as compared to passive visual viewing condition (i.e., baseline) for high proficient L2 learners. We claim this first finding as the facilitative effects of embodied word learning. But there was no evidence of such facilitative effect in low proficient L2 learners. Behavioral results were also associated with the neural indicators. Event-related potentials (ERPs) showed that embodied learning modulations in N170 and N400 for low and proficient L2 learners, suggesting a critical role of proficiency in language embodiment: behaviorally, sensorimotor experiences facilitate L2 word recognition in high but not low proficient L2 learners; at the neural level, sensorimotor experiences promote processing early visual form information for low proficient L2 learners and late semantic information for high L2 learners respectively. The MRI evidence also suggested highly activated connectivity between the visual and semantic hub areas of the brain. [Conclusion] We concluded that both Chinese and English L2 users are adopting the similarly embodied neurological mechanism in processing the new word, especially at the early visual/orthographic wordform areas and the semantic-integration regions of the human brain. Furthermore the Chinese L2 word learning seems to challenge more for the form-meaning association, whereas the English L2 word learning seems to challenge more for the form-sound attentional regions of the brain. The language-general and language specific mechanisms of the embodiment word learning were discussed using the linguistic relativity theories and its applications in L2 learning practices.

D17 - Receptive language proficiency relates to cortical tracking of continuous speech in noise in children

Amanda Hampton Wray[1], Ashley Parker[1], Jacie R. McHaney[2], Brittany Coleman[1], Abby Block[1], Bharath Chandrasekaran[2]; [1]University of Pittsburgh, [2]Northwestern University

Receptive language refers to an individual's ability to process and comprehend language. It is one of the earliest skills a child learns, typically emerging in the first year of life, and continuing to develop into adulthood. It is traditionally measured using behavioral ("tabletop") tasks, where a child may be tested on their ability to understand words and sentences, relationships between words, grammatical rules, and comprehending and following directions. These tests require coordination between receptive language and other cognitive skills, including working memory. Thus, when a child struggles with receptive language, it is not always clear at which processing stage(s) breakdown may occur. Neurophysiology, specifically neural tracking of temporal speech envelopes, is a technique for examining the neural encoding of continuous speech; it can be considered a way of assessing receptive language while limiting some other cognitive demands. Previous work has shown a relationship between neural tracking of continuous speech in quiet and receptive language in preschool-aged children. However, suboptimal, complex listening environments are known to be particularly challenging for children. The degree to which receptive language skills support speech/language perception in complex listening environments in children with intact, though still developing, language skills is not yet clear. In the current study, we used electroencephalography (EEG) to track temporal speech envelopes and administered a battery of speech and language measures to examine the relationships between receptive language proficiency and neural tracking of continuous speech both in quiet and in complex listening environments. Children (n=30, 6-12 years old) with normal audiometric thresholds and no developmental or communication disorders completed subtests of the Clinical Evaluation of Language Fundamentals (CELF-5), Sentence Comprehension, Word Classes, and Following Directions, to derive the Receptive Language Index. Neural tracking of continuous speech was measured using EEG. Participants listened to a target audiobook across two conditions: (1) in quiet, and (2) in the presence of another talker (a different audiobook narrated by a distinct speaker). We used a multivariate temporal response function (mTRF) method where models were used to evaluate the extent to which acoustics of both the target and the masker story contributed to the predictive power of the recorded EEG ("prediction accuracy"). Receptive Language Index standard scores ranged from 89 to 135 on the CELF-5 (mean=112.25). Prediction accuracy (a z-transformed Pearson's correlation between the predicted and measured EEG responses) was stronger in quiet than in noise, with a high degree of individual variability in each condition. We also found a significant effect of language proficiency on neural tracking in noise ($r=0.482$, $p=0.015$). This relationship was not found in neural tracking during the quiet condition. Children with stronger receptive language skills had higher levels of prediction accuracy as measured by neural tracking of continuous speech, specifically in noise. These early results may suggest that receptive language skills in school-aged children may not have a direct relationship with neural tracking in simpler, quiet conditions, but that stronger language skills become critical when the listening environments are complex, with competing speech signals.

D18 - Sublexical linguistic features drive the speaker-listener neural synchronization

Chen Hong[1], Xiangbing Teng[1], Yu Li[2], Shen-Mou Hsu[3], Feng-Ming Tsao[3], Patrick C. M. Wong[1], Gangyi Feng[1]; [1]The Chinese University of Hong Kong, [2]BNU-HKBU United International College, [3]National Taiwan University

Language allows us to communicate our thoughts and feelings to others. Verbal communication conveys different levels of linguistic information through sounds. The speaker translates thoughts into sounds, while the listener hears the sounds and interprets them into meaningful content. These communication processes are proposed to be supported by synchronized neural activities between speakers and listeners across our speech production and perception systems. However, we are still far from understanding what speech content drives the speaker-listener neural synchronization and when and how the informational content transforms from the speaker's production system to the listener's perception system. To address these questions, we conducted a pseudo-hyperscanning magnetoencephalography (MEG) experiment with a story-telling paradigm and applied an encoding modeling approach to estimate the contribution of acoustic and sublexical linguistic contents (segmental and supra-segmental units) to the speaker-listener neural synchronizations. Our MEG experiment involved recording the neural signals of a speaker while the speaker naturally re-told eight stories (7 minutes per story) after reading scripts. We then collected the MEG responses of 22 listeners as they listened to the recorded stories. We estimated the cortical source activities across regions related to speech production and perception for both the speaker and listeners using dynamic statistical parametric mapping (dSPM). We used the temporal response function (TRF) approach to estimate to what extent the neural signals of the speaker predict the neural signals of the listeners to uncover shared neural variances (i.e., neural couplings) and the associated time lags between the speaker and listeners' neural responses. We further estimated the extent to which the acoustic and sublexical linguistic features of the speech can account for these shared neural variances. We found significant speaker-listener neural couplings in a wide spread of regions, including auditory temporal (STG/HG), middle temporal (MTG/ITG), parietal (SMG/IPL), frontal (IFG), and central gyri (Pre/PostCG). The listeners' auditory regions are best coupled with the speaker's overall neural responses, with a degrading pattern from auditory to higher-level fronto-temporo-parietal regions (STG/HG, r = 0.016; MTG/ITG, r = 0.015, SMG/IPL, r = 0.012; IFG, r = 0.011; Pre/PostCG, r = 0.009); whereas the peak time differences in coupling show an opposite pattern (IFG = ~340ms; MTG/ITG = ~ 260ms; Pre/PostCG = ~260ms; STG/HG = ~260ms; SMG/IPL = ~210ms). Importantly, we found that both acoustic and linguistic features contributed to the neural couplings. Specifically, all features showed significant unique contributions, where the tone category and pitch height significantly outperformed other features in explaining neural couplings. We also identified weak but significant common contributions between acoustic and linguistic features as well as common contributions among segmental and supra-segmental features, but they differed in temporal latency. These findings not only reveal synchronized neural responses between speaker and listener but also demonstrate how linguistic features in assemble drive neural synchronizations. These findings shed light on revealing the common linguistic space created by interlocutors and the shared mechanisms of production-perception systems in representing linguistic information, highlighting the interconnected nature of language processing between individuals engaged in communication.

D19 - Brain Mechanisms Underlying the Reading of Mandarin Derivational Morpheme

Chun-Hsien Hsu[1], Ting-Hsin Yen[1]; [1]National Central University

The present study aims to explore the neural mechanisms underlying the processing of different morpheme types—suffixes and quasi-suffixes—during the reading of Chinese disyllabic words. Specifically, true suffixes are highly grammaticalized morphemes that typically attach to the end of a word to modify its grammatical category or function. For example, the suffix 頭 /tóu/ can denote something that is at the head or top. 頭 /tóu/ can be used to create nouns, as in 石頭 /shítou/ (stone). Quasi-suffixes, on the other hand, are partially grammaticalized morphemes that still retain more of their original lexical meaning compared to true suffixes. For example, 場 /chǎng/ can function as a suffix indicating "place" or "field," and it retains its original meanings in compounds, as in 市場 /shìchǎng/ (market). A lexical decision experiment was conducted to address whether quasi-suffixes, which are less grammatically conventionalized than true suffixes, elicit different patterns of neural activity, particularly in brain regions associated with semantic ambiguity and syntactic structure formation. Twelve native Chinese speakers participated in the experiment, in which they were required to determine whether visually presented disyllabic words were real Chinese words or pseudowords. The target stimuli were thirty disyllabic words with a suffix as the second morpheme and thirty disyllabic words with a quasi-suffix as the second morpheme. Target words were selected by matching lexical parameters between the two types of words, including word frequency, frequency of the first character, frequency of the second character, number of meanings of the first character, number of meanings of the second character, number of senses of the first character, number of senses of the second character, semantic transparency between the first character and the word, and the semantic transparency between the second character and the word. During this task, magnetoencephalography (MEG) were recorded with a 156 channel axial-gradiometer system. The source analysis of MEG data revealed distinct neural activity patterns associated with the reading of suffixed and quasi-suffixed words. Specifically, the reading of quasi-suffixed words generated greater brain activity compared to suffixed words in the left pars orbitalis and the left temporal cortex. These regions have been previously implicated in semantic ambiguity and syntactic structure formation, respectively. The observed larger brain activity for quasi-suffixes suggests that quasi-suffix constructions are more complex in both syntax and semantics due to their less conventionalized grammatical status. The findings of this study support the hypothesis of the grammaticalization of affixes, suggesting that suffix morphemes undergo semantic bleaching, resulting in reduced neural activity in regions associated with semantic and syntactic processing. Additionally, these results demonstrate the neural basis of morphological complexity. Specifically, the results indicate that the left inferior frontal and left temporal cortices are sensitive to

morphological complexity in the reading of Chinese words, highlighting the role of these brain regions in managing different types of orthographic systems during visual word recognition.

D20 - Exploring the Impact of Emotion on Sentence Reading in Older Adults

Yi-Wen Huang[1], Chia-Lin Lee[1]; [1]National Taiwan University

Language is a critical vessel for emotions, and in turn, emotional information in language can heighten attention allocation and enhance further evaluation during comprehension. This raises an open question about how emotion modulates language processing in advanced age. While advanced age is associated with less efficiency in constructing or maintaining a message-level representation from context, older adults typically exhibit more adaptive and stable emotion processing, focusing more on positive aspects and being less affected by negative stimuli compared to younger adults. Given the influence of emotional information on various aspects of language processing, this study examines how emotional context affects meaning access and context integration in young and older adults. Past literature has indicated a well-replicated Word Position Effect (WPE) in young adults, with incrementally less negative N400s to open-class words as sentences unfold. Older adults show a similar trend but with a reduced effect, indicating less effective use of contextual constraints for semantic access. To explore the role of emotion in this process, we recorded Event-Related Potentials (ERPs) from 30 healthy young (mean age = 22 years, range = 20-27) and 30 healthy older (mean age = 71 years, range = 58–82) native speakers of Taiwan Mandarin as they read sentences presented in a word-by-word fashion. Sentence contexts were neutral, positive, or negative, with mean valences of 6.37 for positive contexts, 5.45 for neutral contexts, and 3.00 for negative contexts on a scale of 1-9. Trial-level N400 responses measured for all word positions in all trials except sentence-final words were analyzed using the Linear Mixed Effects Model. To avoid complications arising from any P2 differences, the N400 effect (350-450 ms) is baseline-corrected using the mean amplitude during the P2 time window (150-250 ms). We hypothesized an interaction between Age, Word Position, and Context Valence, expecting emotional contexts to moderate age differences in WPE. The results demonstrated a reliable effect of Word Position that is modulated by age, with older adults showing a milder N400 reduction over word position compared to younger adults. This Age by Word Position interaction is further modulated by Context Valence, with age effects observed in positive and neutral contexts but not in negative contexts. Further comparisons among contexts within each group showed a reduced WPE in negative contexts for young adults and a reduced WPE in positive contexts for older adults. These results successfully replicated the Age by Word Position interaction reported in prior studies and demonstrated that age-related differences in the WPE can be modulated by emotional context. Moreover, these results suggest that contextual integration may be more difficult when it comes to the emotion that is prioritized in different age groups. Together, these findings shed light on the influence of emotional contexts on the reading process and how these effects interact with cognitive changes associated with healthy aging. Descriptors: Aging, Emotion, N400 reduction, Event-Related Potentials (ERPs)

D21 - Mapping the task-general and task-specific neural correlates of speech production: meta-analysis and fMRI direct comparisons of category fluency and picture naming

Gina Humphreys[1], Matt Lambon Ralph[1]; [1]University of Cambridge

Improving our understanding of the neural network engaged by different forms of speech production is a crucial step for both cognitive and clinical neuroscience. Semantically driven speech production involves a network of regions, yet the function of each of the sub-regions of the network remains unclear. Here, we directly investigate this issue using two of the most commonly utilised speech production paradigms in research and the clinic: picture naming and category fluency. Harnessing the similarities and differences between the two tasks offers a powerful methodology to delineate the core systems recruited for speech production, as well as revealing task-specific processes. These tasks were formally compared in 1) a meta-analysis of existing neuroimaging studies; and 2) a tightly controlled fMRI study that directly compared the activation from an overt picture naming task , a paced category fluency task, and a non-semantic speech production control task. Together the results showed that both picture naming and category fluency tasks engaged a shared fronto-temporal speech production network, including executive and motor frontal areas, as well as semantic representational regions in the anterior temporal lobe (ATL). This network presumably reflects the core speech production systems. Task-specific differences in the degree of language-laterality, however, were also revealed. Specifically, category fluency was associated with boosted left lateral frontal activation, whereas naming showed an overall weaker but more bilateral pattern with no significant hemispheric differences. In terms of semantic representation, the ATL showed bilateral engagement for fluency and naming tasks, in contrast no evidence was found for the involvement of the angular gyrus (AG) in either task (in fact, both tasks showed AG deactivation relative to rest and the control tasks) thereby questioning the contribution of the AG to speech production. The results have implications for neurocomputational speech production models, and the choice of task best used for clinical assessment of production abilities in patients.

D22 - Cross-species representation of semantic information in prefrontal cortex at single-cell resolution

Mohsen Jamali[1], Irene Caprara[1], Benjamin Mash[1], Raymundo Báez-Mendoza[2], Ziv Williams[1]; [1]MGH, Harvard Medical School, [2]German Primate Center, Göttingen

The capacity to anticipate events in their environment through the categorization of objects and experiences based on semantic information is a shared trait among both humans and many animals. It is believed that conserved neural mechanisms exist across species for processing semantic information, serving as a common foundation to navigate their environments. While previous research has revealed neuroanatomical similarities between species, understanding whether and to

what extent neurons similarly represent semantic information has posed a major challenge. To address this, single-unit recordings were conducted in the homologous prefrontal cortex areas involved in semantic processing and categorization in macaque monkeys (n = 2) and human participants (n = 2) undergoing awake neurosurgery. Various images spanning different semantic categories were presented as stimuli while recording neuronal activities. To enable cross-species comparison, similar sets of images with diverse semantic content, valence, and themes were used, and normative ratings were obtained. For further comparisons, human participants were also presented with audio stimuli consisting of sentences covering similar themes and semantic categories. Vectorial representations of the stimuli were obtained and used for clustering the images and modeling and decoding neuronal responses. Our preliminary results showed that neurons in both monkeys and humans responded selectively to specific semantic domains, and their collective activities decoded categorical information about the presented images – with striking similarities in the relationships between certain semantic domains and their hierarchical organization. However, we also find that there was variability in how semantic information was represented within neuronal ensembles across species and how stimuli mapped across population response patterns. These findings demonstrate a striking cross-species representation of semantic information at the neuronal level, suggesting conserved mechanisms for processing semantic knowledge. They also highlight species-specific differences in the organization and mapping of semantic information, offering together new insights into the evolutionary divergence and convergence of semantic representations at a cellular level.

D23 - Seeking Visual Word Form Area in EEG: A study in three languages and four orthographies

Hareem Khokhar[1,2], Jill McLendon[1], Donald Dunagan[1], Zahin Hoque[1], Dustin Chacón[1,2]; [1]University of Georgia, [2]University of California Santa Cruz

[INTRODUCTION] Across writing systems, the left fusiform gyrus ('visual word form area', VWFA) is a key brain area in reading (Dehaene & Cohen 2011). VWFA-localizer tasks are used in studies on word recognition and morphological processing (Tarkiainen et al. 1999; Gwilliams et al. 2016). Can we develop a VWFA-localizer using a typical EEG lab? We examine four language-orthography pairs: English (Roman), Mandarin Chinese (MC) (Hanzi), Urdu (Naskh Arabic script), and Urdu (Nasta`liq Arabic script). Two variants of Urdu were included because they differ in degree of letter overlap and letter segmentation cues (Naz et al. 2013), which affect word-form recognition. In English, Urdu (Naskh), Urdu (Nasta`liq), we identified a cluster on the left ventral surface for the 'Type II Word Effect', although we do not identify a VWFA functional ROI in MC. [METHODS] Participants (N = 34 English; N = 34 MC; N = 28 Urdu) passively viewed words and symbols for 60ms followed by 240ms of blank screen. Brain activity was continuously recorded with a 64-channel EEG. Stimuli were 50 short frequent words (4 letters in English and Urdu; 2 in MC) and length-matched symbols; stimuli were embedded in two levels of noise (Low, High). Within each comparison, we controlled psychophysical factors luminance, height, visual angle subtended, and perimetric complexity (Pelli et al. 2006) (ps > 0.1) [RESULTS] [EEG Sensor Data]. Raw EEG data was band-pass filtered from 0.1–40Hz, then epoched from –100 to 300ms, with baseline correction to –100-0ms. Artifacts were excluded using ICA, and epochs exceeding 100μV peak-to-peak threshold were excluded. Spatio-temporal cluster-based permutation tests (Maris & Oostenveld 2007) were conducted using Noise (Low, High) × Stimulus (Word, Symbol) ANOVAs. Urdu data were analyzed separately for Naskh and Nasta`liq. In all four comparisons, Low vs. High Noise ERPs differed ~100–150ms, and one cluster was identified between ~200–300ms that distinguished Words vs. Symbols (ps < 0.05). [Source Estimates]. EEG data were coregistered with fsaverage template brain. We used sLORETA to estimate source activity (Pascual-Marquis 2002). We used sensor-space clusters as temporal localizers for one-way ANOVAs comparing Word vs. Symbols and High vs. Low Noise. Clustering was constrained to bilateral occipito-temporal regions. In all four comparisons, bilateral occipital activity was greater for Low vs. High Noise stimuli ~100–150ms. In English, a posterior left fusiform cluster showed greater activity for Symbols vs. Words; in Urdu (Nasta`liq), an anterior left fusiform cluster showed greater activation for Words vs. Symbols, both ~200–300ms (ps < 0.05). In Urdu (Naskh), a similar, insignificant cluster was identified as in Nasta`liq (p=0.16). No clusters were identified in occipito-temporal regions in MC.[CONCLUSION] We presented a VWFA localizer task using a typical EEG set-up that can identify portions of left fusiform gyrus involved in early stages of reading in English and Urdu. Unlike previous MEG findings, English VWFA activity was greater for symbols than words; whereas the typical increased activity for words was demonstrated for Urdu. No functional VWFA was identified for MC, which may echo previous findings (e.g. Bolger et al. 2005).

D24 - Neural Correlates of Motor Speech Sequence Learning in Adults Who Stutter and Neurotypical Speakers

Jackie S. Kim[1], Haochen Wan[2], Jason A. Tourville[1], Barbara Holland[1], Alfonso Nieto-Castañón[1,3], Frank H. Guenther[1,2,4]; [1]Boston University, [2]Department of Biomedical Engineering, Boston University, Boston, MA, [3]McGovern Institute for Brain Research, Massachusetts Institute of Technology, Cambridge, MA, [4]Picower Institute for Learning and Memory, Massachusetts Institute of Technology, Cambridge, MA

Stuttering is a multifactorial neurodevelopmental motor speech disorder that affects a speaker's ability to produce fluent speech. Previous literature suggests that stuttering interrupts the execution, rather than the learning, of new phonemic sequences at the single-syllable level. The Gradient Order Directions into Velocities of Articulators model posits that stuttering involves structural/functional anomalies in the motor loop, specifically in the left ventral premotor cortex and/or to impaired processing within the cortico-basal ganglia loop. Despite extensive neuroimaging studies on people who stutter, the underlying neural mechanisms involved in speech sequencing remain unclear. Therefore, the current fMRI study investigated speech motor sequence learning through a non-word repetition task in 15 adults who stutter (AWS) and 15 age-matched neurotypical

controls (NT). Participants performed a nonword repetition task across two consecutive days, where they practiced three-syllable subsets of six-syllable nonwords with phonotactically legal consonant clusters in English. All stimuli and condition lists (novel vs. learned) were balanced across and within groups. Behavioral results analyzing error rates before and after training demonstrated that although AWS were less accurate than NT overall, both groups showed similar learning trajectories over time. Neuroimaging results based on the BOLD response during production of novel and learned words revealed no significant group differences – both groups demonstrated increased brain activation in regions linked to phonological working memory (bilateral pre-supplementary motor area and posterior inferior frontal gyrus), speech motor planning (left ventral premotor cortex), auditory processing (posterior superior temporal gyrus), and speech articulation (left anterior insula and frontal operculum). These findings are consistent with prior motor speech sequence learning studies in AWS with non-native consonant clusters at the single syllable level. Interestingly, posterior inferior sulcus did not show significant activation in this present study contrary to previous work, suggesting that this area may be less involved when learning new multisyllabic sequences containing previously established phonemic motor programs (i.e., familiar consonant clusters). Overall, the findings corroborate evidence that AWS present with deficits in execution, rather than motor learning, of new motor speech sequences before and after acquisition and consolidation. The planning loop, which is part of the phonological working memory system, may be relatively preserved in AWS. The results of the study contribute to our understanding of the neural correlates of speech sequencing and motor learning in people who stutter.

D25 - Humans vs. NLMs in Processing Wh-Filler-Gap Dependency and Backward Sluicing

Keonwoo Koo[1], Wonil Chung[1], Myung-Kwan Park[1], Hyosik Kim[1]; [1]Dongguk University

Seeing the remarkable performance of recent artificial neural language models (NLMs) in understanding and generating human language, this study shows that there are differences in language processing between humans and NLMs, thus limitations with the latter. Specifically, our experiment results indicate that human language processing is sensitive to the syntactic complexity of Wh-Filler-Gap Dependency (WhFGD) constructions in English, whereas NLMs are not. Previous research has shown that human processing of WhFGDs is influenced by the syntactic complexity within the dependency: configurations where a wh-filler is followed by a noun phrase (NP) and then a gap, i.e., wh-filler … NP … gap, are more difficult to process than configurations where a wh-filler is followed by a complementizer phrase (CP) and then a gap, i.e., wh-filler … CP … gap (Gibson and Warren 2004; Keine 2015; Kim 2023). We adopted these configurations to investigate whether pre-trained NLMs, such as GPT2-XL, GPT-NEO, and OPT, exhibit similar sensitivity to syntactic complexity during WhFGD processing. In Experiment 1, we used 24 WhFGD constructions, manipulating structural complexity (CP vs. NP) and construction type (WhFGD vs. sluicing) in a 2×2 factorial design. Sluicing, which also forms a WhFGD, was included to test the generality of WhFGD processing. We measured surprisal, the negative log-probability given the preceding context, which correlates with reading time measurements (Hale, 2001; Smith and Levy, 2013; Wilcox et al., 2020; Shain et al., 2022). A sum-contrast coded linear mixed-effects model with maximal convergence revealed that the NP construction was more difficult for humans to process (β=0.12, SE=0.03, t=3.37, p<0.001), while GPT2-XL found the CP condition more difficult than the NP condition (β = -0.89, SE = 0.46, t = -1.93, p = 0.05). Experiment 2 replicated the design of Experiment 1, except for the construction type levels: WhFGD vs. no-WhFGD. The no-WhFGD condition tested whether the results from Experiment 1 were specific to WhFGD processing. Linear mixed-effects models showed that humans found the NP condition harder to process than the CP condition (β=0.06, SE=0.02, t=2.35, p<0.05), particularly in the WhFGD context, resulting in a significant interaction effect (β=-0.11, SE=0.05, t=-2.19, p<0.05). However, all three NLMs consistently found the CP condition more difficult to process than the NP condition across both construction types ($p < 0.05$). The main difference between humans and NLMs in processing CP vs. NP structures in WhFGD constructions is their sensitivity to syntactic complexity. Humans find the NP structure more difficult due to the lack of an intermediate position (Spec-CP), which increases the cognitive load required to process the material between the wh-filler and the gap. This results in slower reading times and greater processing difficulty. Conversely, NLMs have greater difficulty with the CP condition because they cannot utilize the intermediate position provided by the CP structure and rely more on statistical patterns. This suggests that NLMs fail to effectively leverage the grammatical structure of CP, employing different strategies from humans when processing syntactically complex sentences.

D26 - The spatio-temporal dynamics of phonetic encoding in aging and aphasia

Jill Kries[1], Pieter De Clercq[2], Maaike Vandermosten[2], Laura Gwilliams[1]; [1]Stanford University, [2]KU Leuven

Comprehending natural speech entails rapidly converting continuous acoustic input into discrete units, such as phonemes and words. In younger adults, this process entails neural encoding of phonetic features, whereby different neural ensembles are recruited across time – termed “Hierarchical Dynamic Coding”. The duration of phonetic encoding has been linked to resolving lexical uncertainty, and the speed of encoding dynamics with the speed of incoming inputs. Given that disorders like post-stroke aphasia can affect phoneme identification and decrease neural encoding of acoustic features and phoneme onsets, it is important to establish whether difficulty in speech comprehension arises from distorted dynamics of phonetic encoding. Here, we tested (1) whether dynamic encoding of phonetics can be reproduced with EEG, using a relatively short recording duration (~25 mins), in healthy older adults, and (2) whether the dynamics of phonetic encoding in aphasia differs from healthy older adults. 39 individuals with aphasia in the chronic phase after stroke (> 6 months after onset; with left-hemispheric or bilateral lesions) and 24 age-matched healthy control participants listened to a narrative for

25 minutes while EEG data was recorded. The narrative was annotated for phonetic features, allowing time-resolved decoding of these features from the EEG signals. The decoding was performed using one-versus-all logistic regression and 5-fold cross-validation for 18 phonetic features, including manner, place, voicing, roundness, and front-back-ness of consonants and vowels. Temporal generalization was implemented by testing how a classifier trained on time t performs on data from subsequent and preceding timepoints. Phonetic features were decodable above chance in healthy older adults from -0.04 to 0.49 seconds relative to phoneme onset ($p<.001$). Comparing healthy older adults to individuals with aphasia, we observed significantly lower decoding accuracy from 0.09 to 0.26 seconds after phoneme onset ($p<.001$), indicating a shorter duration of phonetic encoding. No significant group difference was found in the temporal generalization, with an average generalization time of 139ms in the aphasia group and 132ms in the control group. Spatially, we identified a cluster of 22 EEG sensors ($p<.001$) over which individuals with aphasia had lower decoding accuracy of phonetic information than healthy controls, particularly over the left auditory cortex and posterior sensors bilaterally. A potential explanation is that this is related to structural and functional changes following stroke. In conclusion, we replicate robust phonetic encoding in older healthy adults using 25 minutes of EEG data. This suggests that the analytical approach is robust, and can be applied to relatively short recording durations to study different populations. In comparing healthy controls and individuals with aphasia, we find that the primary marker of the language disorder lies in the shorter duration of phonetic encoding, which spatially localized to left-hemispheric auditory sensors. The neural pattern of phonetic encoding evolved at the same rate for both groups, as evidenced by the generalization analysis, not providing evidence for distinct dynamics of information evolution in aphasia. Overall, our study suggests that speech comprehension challenges in aphasia may be related to difficulties in maintaining lower-order phonetic information long enough to facilitate lexical recognition.

D27 - Causal role of vTPJ and lATL in social-semantic working memory: Insights from TMS

Nan Lin[1], Weiting Shi[1], Baishen Liang[1], Wanying Zhao[1]; [1]The Institute of Psychology of the Chinese Academy of Sciences

Introduction Recently, it has been proposed that the left ventral temporoparietal junction (vTPJ) and lateral anterior temporal lobe (lATL) underlie social-semantic working memory, demonstrated by their heightened activation to sentences with social meaning compared to word lists, as well as their persistent social-semantic-selective activity after the stimuli disappeared (Zhang et al., 2023). However, there is still a lack of consensus on this hypothesis. This study aimed to examine the hypothesis using transcranial magnetic stimulation (TMS), which induces a transient 'virtual lesion' by disrupting normal firing patterns, thus providing causal links between targeted brain regions and behavior that imaging techniques cannot offer. Methods In Experiment 1, continuous theta-burst stimulation (cTBS) was administered to four sites, including the vTPJ, lATL, posterior superior temporal sulcus (pSTS), and vertex. The pSTS, implicated in general sentence processing, and the vertex, presumed to be non-contributory to cognitive tasks, served as control sites. Immediate recall performance was examined across four categories of stimuli: social sentences, non-social sentences, social word lists, and non-social word lists. In Experiment 2, online TMS was used to selectively suppress activity in the vTPJ and vertex during stimulus maintenance, to assess the impact on subsequent recall of the same types of stimuli. Results In Experiment 1, inhibition of the vTPJ or lATL (but not pSTS) significantly impaired the recall of social sentences compared to non-social sentences, a distinction not observed with word lists. These results support the social semantic working memory hypothesis proposed by Zhang et al. (2023). Additionally, inhibition of the vTPJ or lATL (and the pSTS) resulted in a greater impairment in sentence recall compared to word-list recall, even when only non-social stimuli were considered. This indicates that these regions contribute to sentence processing beyond the social semantic domain. Furthermore, Experiment 2, which specifically interrupted the stimulus maintenance stage, revealed similar suppression effects in the vTPJ, providing clearer evidence for its role in working memory function. Conclusion Our findings provide causal evidence for the involvement of the vTPJ and lATL in social semantic working memory, with a particular emphasis on the vTPJ. Furthermore, TMS-induced suppression in these regions also affected non-social sentence recall, suggesting a broader spectrum of cognitive functions than previously indicated by the activation patterns in Zhang et al. (2023). This highlights the importance of employing diverse methodological approaches to comprehensively evaluate the functional roles of specific brain regions.

D28 - When words denoting entities and/or events become subjects: an EEG study

Yingyi Luo[1], Xiaoqian Zhang[1]; [1]Institute of Linguistics, Chinese Academy of Social Sciences

To reveal the neurocognitive mechanism of the use of word category information (such as the division of nouns and verbs), researchers have attended to the representations when words of different categories are presented in isolation, and also the online processing when words are understood in a sentence context that constrains the word category. However, little neural evidence exists regarding how word category information modulates the build-up of syntactic structure when words serve identical syntactic functions in sentences with limited contextual cues. This study addressed this gap with Chinese, where nouns and verbs hardly dissociate from a morphological perspective. Specifically, words denoting events ("ju4jue2", refuse/refusal) can function as either predicates ("ju4jue2 chi1fan4", refuse to eat) or as arguments ("ju4jue2 hen3shang1ren2", rejection hurts) without morphological change. Moreover, there is a significant group of Chinese words that are ambiguous between entities and events (AM), e.g., "bao4gao4" ("yi1fen4 bao4gao4", a report; "bao4gao4 lao3shi1", report to teachers). Based on the Lexical Semantic Component Classification Framework, we selected 47 AM, 42 words exclusively denoting events (EV), and 42 words exclusively denoting entities (EN) from the high-frequency bisyllabic Chinese words, all denoting non-natural

things and related to human cognition. Thus, this study particularly focused on how these three types of words influence the Subject Effect, which compares the neural activities induced by words when presented as standalone units and as sentence-initial subjects (maintaining identical word form). The aim was to investigate the role that word category plays in lexical access during the early stage of sentence construction. EEG data (128 channels) were collected from 21 native speakers. The experiment adopted a 3 (word type) x 2 (task) design. In the lexical decision task, target words visually appeared randomly in the word list (400ms + 400ms blank screen), and participants responded to pseudowords (filler) by pressing a button. In the sentence comprehension task, target words were embedded in a sentence framework "If + Target + BE/BE-NOT..., ...". Each sentence was visually presented word by word (400ms + 300ms blank screen). Participants judged the logical coherence of each sentence. Half of the participants completed the lexical decision task first. Data processing and 2-way ANOVA statistics (word type * task) were conducted using the EEGlab. ERP analysis showed that the divergence in Subject Effect between AM and EN was primarily observed in the early 0-100ms, with AM exhibiting a more negative effect in posterior regions under the sentence comprehension task. The difference between AM and EV in Subject Effect emerged after 300ms. Compared to the lexical decision task, the sentence comprehension task elicited more positive responses in posterior regions, particularly for EV. The results suggest a similar processing time course for AM and EN when functioning as subjects. The early increased negativity for AM may be due to interference from ambiguity. EV, compared to AM, require greater cognitive demand when serving as the sentence-initial subjects, likely due to the relatively low frequency of starting a sentence with (unspecified) events.

D29 - A computational investigation of the transformation from talker-specific detail to talker-invariant lexical representations

Sahil Luthra[1], Kevin Brown[2], Jay G. Rueckl[3], James S. Magnuson[3,4,5]; [1]Carnegie Mellon University, [2]Oregon State University, [3]University of Connecticut, [4]BCBL: Basque Center on Cognition, Brain and Language, [5]Ikerbasque: Basque Foundation for Science

A long-standing theoretical question in the field of speech perception is the extent to which representations of speech sounds include talker-specific detail or might be conditioned on talker (e.g., Goldinger, 1998; Kleinschmidt, 2019; Magnuson & Nusbaum, 2007). Neurobiological data have provided some insight into this question, with evidence that phonetic processing and talker processing are supported by separate but overlapping neural systems (for review, see Luthra, 2021). The goal of the current work is to test whether computational constraints may create pressure for a neurobiological system to adopt such a dual-stream architecture (Avcu et al., 2023). Although most computational models of spoken word recognition operate on abstract phonetic features (and thereby sidestep the issue of talker-related acoustic-phonetic variability), a notable exception is the EARSHOT model (Magnuson et al., 2020). Because it operates on spectrogram-based inputs, EARSHOT offers a tool for investigating how talker-to-talker acoustic variability might be processed. Here, we use Representational Similarity Analysis (RSAs; Kriegeskorte et al., 2008) to assay how talker-specific and talker-invariant information are represented over time in the model-internal hidden states of three EARSHOT model variants. First, we trained a standard “lexical-objective” model to map acoustic inputs to lexical-semantic outputs. Second, we trained a talker-objective variant, the only goal of which was to identify talkers. Third, we trained a dual-objective variant to map speech to lexical and talker outputs simultaneously. RSA indicated that talker-specific details quickly dissipate from hidden unit activity for the standard model, but talker-specific details more strongly drive hidden unit activity for the talker-objective model. Our results provide insight into how talker-specific surface details are mapped to abstract, talker-invariant lexical representations depending on training targets. They may generate novel hypotheses about similar transformations in the brain, a possibility we will test by comparing models to cortical responses to speech (cf. Brodbeck et al., 2024; Mesgarani et al., 2020).

D30 - Developmental neural incongruency patterns between sentence reading and arithmetic: An ERP study

Jie MA[1], Wai Leung WONG[2], Kelvin F.H. LUI[3], Shuting HUO[4], Catherine MCBRIDE[5], Urs MAURER[1]; [1]The Chinese University of Hong Kong, [2]BCBL, Basque Center on Brain, Language and Cognition, Donostia-San Sebastian, Spain, [3]Lingnan University, Hong Kong, [4]The Hong Kong Polytechnic University, [5]Purdue University

Language comprehension and arithmetic are often treated as distinct cognitive skills, but they share fundamental similarities. Both can be viewed as structured computational systems, governed by specific rules (e.g. syntax, arithmetic) and composed of coherent semantic units (e.g. words, numbers). When processing these semantic units, individuals form anticipations based on the contextual cues, and exhibit additional processing when their predictions are incongruent with the actual input. Previous research has found that semantic incongruency, where the encountered information conflicts with one's anticipations, elicits a larger N400 effect in both sentence processing and arithmetic tasks. This suggests possible overlap in the neural mechanisms underlying semantic processing across these two domains. However, a direct comparison and the developmental trajectories of these incongruency effects in language and arithmetic is currently lacking. Therefore, the present study aimed to investigate the developmental patterns of neural incongruency effects during semantic processing in sentence reading and simple addition, using ERP. Sixty children from grades 1, 2 and 3 (MAge=7.48 years) and 43 adults (MAge=19.57 years) judged whether Chinese sentences made sense or not and whether additions were correct or not. ERP maps including all electrodes were analyzed using timepoint-to-timepoint TANOVA with factors incongruency, task and group. Behavioral responses were slower but more accurate in the incongruent condition than in the congruent condition. This incongruency effect was stronger for the arithmetic processing than for sentence reading. Furthermore, a developmental effect

was observed, but only for response times - as compared to in the arithmetic task, adults performed stronger incongruency effect than children in the sentence reading task. TANOVA revealed similar incongruency main effects in the N400 (226-442ms) and LPC (490-774ms, 926-1218ms) time ranges for both sentence reading and arithmetic tasks. Moreover, an interaction between group and incongruency showed a N400 effect in adults from 236-346ms, not in children. Topographic analyses further indicated the N400 incongruency effect had similar distributions between adults and children, but with a 100ms latency shift - adults exhibited the effect from 200-400ms, children from 300-500ms. An interaction of group and task was also observed, indicating how brain activity topographies change over time during arithmetic and sentence reading tasks between adults and children. Specifically, compared to sentence reading, arithmetic tasks elicited a more pronounced rightward shift in central-frontal brain activity in children across the 200-800ms time window, while adults showed an even greater rightward shift in central positivity during the narrower 300-400ms time period. In summary, this study sheds light on common processes in solving semantic conflicts, as well as similar developmental speed across language and arithmetic processing. Specifically, adults exhibit earlier and potentially more efficient semantic conflicts processing abilities compared to children. However, the distinct neural activations for adults versus children suggest domain-specific developmental changes in the underlying cognitive and neural systems for language versus arithmetic processing.

D31 - Gray matters: Impacts of electrode placement on responses recorded during natural speech listening

Anna Mai[1], Andrea Martin[1,2]; [1]MPI Psycholinguistics, [2]Donders Centre for Cognitive Neuroimaging

Intracranial electroencephalography (iEEG) is increasingly recorded using intracerebral depth electrodes (i.e., stereo EEG) (Engel 2018, Abou-Al-Shaar et al. 2018, Miller et al. 2021) that record from a combination of gray matter (GM) and white matter (WM) sites. Previously, WM sites were assumed to be electrically neutral and used as reference channels (Mercier et al. 2022). However, activity recorded in WM contains signal from both nearby and distant GM (Mercier et al. 2017, Rizzi et al. 2021), increasing its relevance to models of cognition and language. This project enriches knowledge of WM's role during language processing by showing how signal correlation varies not only as a function of distance between electrodes but also as a function of electrode placement in GM vs. WM, band frequency, and language familiarity. Intracranial EEG was recorded while nine English speakers with no Catalan familiarity listened to excerpts of conversational American English from the Buckeye Corpus (Pitt et al. 2007) and excerpts of conversational Catalan from the Corpus del Catalá Contemporani (Alturo et al. 2002). Stimulus-timelocked band-limited activity was subsequently extracted from the recordings. The similarity between activity recorded at pairs of electrodes was quantified using the Pearson correlation coefficient and was calculated for both phase and analytic amplitude of activity. Separate linear mixed-effects models were fit for phase and analytic amplitude. The correlation between sites (phase or amplitude) was modeled with participant identity as a random effect and combinations of electrode placement (GM vs. WM), language condition (English, Catalan, or silence), band (delta, theta, alpha, beta, gamma, or high gamma), and distance between electrodes as fixed effects. Models were compared within response variable type (phase or amplitude) using the Akaike Information Criterion (AIC). Best-fit models carried 100% of the cumulative model weight and had AIC scores >30 lower than other models. For both phase and amplitude, best fit models included all fixed effects, all two-way interactions, and the three-way interactions band*matter*distance and condition*matter*distance. Beta weights for GM>WM were negative and significant ($p<0.0001$), indicating that both phase and amplitude are less correlated across sites in GM than in WM. Similarly, weights for Catalan>Silence and English>Silence were negative ($p<0.0015$), indicating that responses during speech listening are less correlated than during silence. The interaction between GM>WM and English>Silence was positive (phase: $p=0.031$, amplitude: $p=0.047$), indicating that both phase and amplitude are more correlated across sites in GM when participants are listening to English. Results for other model features will be discussed further at the poster. Although correlations in WM and during silence are generally higher across sites, correlations in GM are higher when participants listen to a familiar language. These results most likely reflect a higher SNR in GM combined with better cortical tracking of a familiar language. Combined with effects of band and distance on phase and amplitude correlation across sites, these results paint a complex picture of the characteristics of language-related data recorded in WM and reiterate the impact of language familiarity on recorded response.

D32 - Dorsolateral prefrontal cortex supports lexical selection during spoken word recognition

Mel Mallard[1], Chad S. Rogers[2], Michael S. Jones[1], Sarah McConkey[1], Brent Spehar[1], Kristin J. Van Engen[1], Mitchell S. Sommers[1], Jonathan E. Peelle[3]; [1]Washington University in St. Louis, [2]Union College, [3]Northeastern University

Listening to speech often feels simple and automatic, but there are many factors that can make understanding speech more difficult, including both the content of the speech (for example, psycholinguistic properties) and the acoustic clarity with which it is presented. Although most studies of single word processing have implicated bilateral superior temporal gyri, it has been suggested that regions of the frontal lobe—particularly dorsolateral prefrontal cortex (DLPFC)—are engaged to deal with various types of acoustic or linguistic challenge during listening. Here we tested a hypothesis that left DLPFC is more active in conditions of higher lexical competition in the context of spoken word recognition. We conducted an fMRI study in which we presented words in background noise to both young and older adults. Words varied in lexical competition, being selected to have either few neighbors (i.e., from a sparse phonological neighborhood) or many neighbors (i.e., from a dense phonological neighborhood). Participants were both younger (n = 47; aged 19-30 years) and older (n = 31; aged 65-81 years) adults. Participants performed a speech-repetition

task. To measure repetition accuracy, each trial was graded as either a correct or incorrect repetition. Accuracy was generally good, and we restricted further analyses to correct responses only. As expected, at the whole brain level, spoken word recognition in noise was associated with activity in the left and right superior temporal gyrus. To test our hypothesis about DLPFC involvement in spoken word recognition we extracted parameter estimates from each participant, showing a significant density effect [$t(77) = 3.36$, $p < .001$, $d = 0.38$], with Dense words eliciting more activity than Sparse words. Notably, this density effect did not significantly differ by age [$t(73.98) = 1.18$, $p = .241$, $d = 0.26$) and was not significantly correlated with hearing ability (better-ear pure-tone-average) in either the young [$r(45) = -.056$] or older [$r(29) = -.080$] group. We conclude that DLPFC, anatomically situated outside classic language regions, participates in lexical selection, being sensitive to the number of competitors a target word has. We found in this region a significant density effect that is robust against age and hearing, revealing a degree of stability in the neural systems underlying spoken word recognition outside the temporal lobe.

D33 - Resting-State Connectivity and Language Impairments in Primary Progressive Aphasia: A Comparative Study of lvPPA and nfvPPA

Michèle Masson-Trottier[1], Jessie Gallegos[1], Alexandros Afthinos[1], Sophia Norvillas[1], Cesia Diaz[1], Kyrana Tsapkini[1]; [1]Department of Neurology, Johns Hopkins School of Medicine, Baltimore, (MD), USA

Primary progressive aphasia (PPA) is a neurodegenerative disorder characterized by language deficits [1]. There are three main variants: semantic (svPPA), logopenic (lvPPA), and nonfluent (nfvPPA). These variants have distinct clinical profiles, atrophy patterns, and underlying pathology. Diagnosing lvPPA and nfvPPA can be challenging, especially in early stages of disease due to overlapping symptoms. According to the consensus diagnosis criteria, sentence repetition impairment is a key differentiator between these two variants, which is more pronounced in lvPPA [1]. Resting-state functional connectivity (rsFC) is a neuroimaging method that measures the temporal correlation of spontaneous brain activity while a person is at rest. This method has been increasingly used to understand the neural underpinnings of various behavioral impairments in neurological conditions [2, 3]. This study aims to identify the rsFC underpinnings of repetition impairments in nfvPPA and lvPPA, which could further be used as differential diagnostic criteria. We examined 37 participants with PPA (24 lvPPA, 13 nfvPPA). Participants were matched for age, time post-onset, overall severity, and language severity, and they underwent neurocognitive assessments and imaging including a rsfMRI scan. MRI preprocessing and rsFC analysis were conducted using the CONN toolbox [4]. We examined ROI-to-ROI connectivity between 91 cortical regions based on the Harvard-Oxford and AAL atlases and the NACC sentence repetition scores. Both groups performed equally on the sentence repetition task ($p=0.986$). In the lvPPA group, higher inter-cluster rsFC between a phonological processing cluster (bilateral insular cortex, central operculum, Heschl's gyrus, and planum temporale) and a semantic processing cluster (bilateral temporal pole, temporo-occipital middle temporal gyrus (MTG), frontal orbital cortex, and the right anterior and posterior MTG) was associated with better repetition. In the nfvPPA individuals, higher inter-cluster rsFC between a speech motor planning cluster (bilateral central opercular cortex and bilateral parietal operculum) and a phonological working memory cluster (bilateral anterior supramarginal gyrus (SMG) and the right frontal operculum) was associated with better performance in repetition. Different neural correlates for repetition were identified in lvPPA and nfvPPA, reflecting their distinct impairment profiles. In individuals with lvPPA, the increased parieto-temporal connectivity between the phonological processing and the semantic processing clusters associated with better repetition may support more efficient transfer and integration of auditory, phonological, and higher-level semantic information. In nfvPPA, increased fronto-parietal connectivity between the speech motor planning and the phonological working memory clusters may support better motor planning and phonological processing integration. In lvPPA, enhanced parieto-temporal connectivity could represent either a specific compensatory mechanism for repetition abilities, despite underlying neurodegeneration, or a lvPPA disease mechanism. Similarly, in nfvPPA, enhanced fronto-parietal connectivity might represent a different compensatory mechanism, specific for nfvPPA, for repetition abilities despite the neurodegenerative speech production impairments, or a nfvPPA disease mechanism. Leveraging rsFC analysis, this study elucidates distinct connectivity patterns associated with repetition deficits in these two PPA variants. These findings provide insights that could aid differential diagnosis and inform the development of therapeutic strategies targeting functional connectivity, such as neuromodulation. References 1. Gorno-Tempini 2011 https://doi.org/10.1212/WNL.0b013e31821103e6 2. Chaudhary, 2022 https://doi.org/10.1177/15333175221082834 3. Tao 2023 https://doi.org/10.3389/fnagi.2021.681043 4. Nieto-Castanon 2022 https://doi.org/10.56441/hilbertpress.2246.5840

D34 - Lesion-symptom mapping of phonological working memory load using rhyme judgments in people with chronic post-stroke aphasia

William Matchin[1], Dirk den Ouden[1], Zeinab Khoshhal Mollasaraei[1], Julius Fridriksson[1]; [1]University of South Carolina

Working memory (WM) is a critical supporting mechanism for sentence processing. Phonological WM deficits are pervasive in aphasia, which makes it difficult to determine the extent to which a patient struggles with syntactic and semantic aspects of sentence processing, potentially limiting effective interventions. Brain research has converged on several regions, including inferior frontal lobe, inferior parietal lobe, and posterior superior temporal gyrus as critical regions for phonological WM, potentially distinct from the hypothesized brain bases of syntactic processing in the temporal lobe. This suggests that, in principle, syntactic deficits can be distinguished from phonological WM deficits in aphasia. However, it is difficult to distinguish regions implicated in difficulties with WM load as opposed to general aspects of task performance and sensory-motor abilities. Here we performed lesion mapping analyses people with chronic post-stroke aphasia of two different

measures of phonological WM using rhyme judgments, using covariates to isolate the effects of WM load independent of the sensory, motor, and executive function aspects of the task by using covariates to control for these confounding variables. 103 patients with chronic post-stroke aphasia were recruited for a clinical trial conducted at the University of South Carolina and the Medical University of South Carolina. All patients were administered with the Western Aphasia Battery-Revised as well as several subtests of the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA) and the Temple Assessment of Language and Short-term Memory in Aphasia (TALSA). Here analyzed performance on the TALSA triplets word rhyming task with heavy WM load using the PALPA auditory word rhyming task to control for auditory processing and executive task demands and the WAB-R auditory word recognition task to control for visual image recognition based on auditory stimulus. In addition, a subset of 78 patients completed the NAVS sentence comprehension test; we therefore related performance on our composite measure of phonological WM load to noncanonical sentence comprehension. We performed lesion mapping analyses using a mass univariate approach with regions of interest from the Johns Hopkins University atlas, analyzing proportion damage to each ROI for each participant and a permutation correction for multiple comparisons across regions (4,000 permutations). We also calculated uncorrected voxel-wise maps in order to spatially visualize the lesion maps associated with each of our primary analyses. The TALSA triplets task (with PALPA auditory word rhyme and WAB-R auditory word recognition as covariates) revealed significant lesion correlates in the supramarginal gyrus, inferior longitudinal fasciculus, and posterior insula. Voxel-based analyses revealed primary lesion correlates extending into the inferior parietal lobe. When including our composite measure of phonological WM as a covariate, lesion-symptom mapping analyses of noncanonical sentence comprehension were highly robust, implicating temporal lobe damage that did not extent into parietal lobe. The results suggest that the lesion bases of phonological WM load and those for syntactic comprehension deficits established in the literature at least partially diverge. In addition, measures of phonological WM load using rhyme judgment can be a useful tool for assessing WM abilities in people with post-stroke aphasia.

D35 - Neural Facilitation in Visual Word Processing Following Parafoveal Preview and Stimulus Repetition

Urs Maurer[1]; [1]The Chinese University of Hong Kong

The visual N1/N170 component of the ERP has been shown to be sensitive to print early during literacy acquisition showing an increase for words compared to control stimuli that emerges with learning to read. However, this N1 print sensitivity decreased with further reading practice suggesting that decreased N1 activation might reflect more efficient processing in proficient reading. Similarly, N1 amplitude was found to be decreased for high frequency compared to low frequency words. In our recent work, we found more evidence that the N1 (particularly the N1 offset) is reduced, when word processing is facilitated. I will report results from several EEG studies that used (masked) repetition priming and boundary paradigm experiments with concurrent eye-tracking. The results showed similar effects of a reduction in the late N1/N250 component, if a word was repeated or previously viewed in the parafovea. Parafoveal preview facilitation also depended on the experience with the direction of a writing system, as tested with horizontal and vertical Chinese in readers from Mainland China and from Taiwan. The results suggest that early visual-orthographic processing as measured by the late N1 and N250 components of the ERP is not just sensitive to the development of visual expertise for print at the beginning of learning to read, but also reflects facilitation through previously available stimulus information in skilled reading.

D36 - Infants Neural Speech Encoding Forecasts Language Outcomes in Preschool Years: Convergence of Prediction and Validation

Shaoqi PAN[1,2], Ching Man Lai[1], Peggy H.Y. Chan[1,3], Gangyi Feng[1,2], Hugh Simon Lam[3], Tak Yeung Leung[4], Nikolay Novitskiy[1,2], Ting Fan Leung[3], Patrick C.M. Wong[1,2]; [1]Brain and Mind Institute, The Chinese University of Hong Kong, Hong Kong SAR, China, [2]Department of Linguistics and Modern Languages, The Chinese University of Hong Kong, Hong Kong SAR, China, [3]Department of Paediatrics, The Chinese University of Hong Kong, Hong Kong SAR, China, [4]Department of Obstetrics and Gynaecology, The Chinese University of Hong Kong, Hong Kong SAR, China

Introduction: Understanding the neurobiological basis of language development is crucial for early diagnosis and intervention of childhood neurodevelopment. Early neural speech encoding (NSE), as reflected by early-latency EEG responses such as frequency following responses (FFR), provides a snapshot of auditory processing in the hearing brain (Kraus et al., 2017). These responses have shown to be neural markers of language functions in early childhood (Wong et al., 2021), as measured by the Chinese Communicative Development Inventory-Cantonese version (CCDI-C). Objectives: Building on the initial predictive results, the current study examined whether NSE can predict additional language developmental measures as well as whether the performance of the original model remains high when validated by unseen data. Methods: A cohort of 534 Cantonese-speaking children (240 females) received language assessments using the CCDI-C and/or the language subscale of the Bayley Scales of Infant and Toddler Development, third edition (Bayley-III). All children underwent EEG testing, with 486 evaluated by the CCDI-C (mean age, months: 5.3155±3.7756, 0-24) and 419 by the Bayley-III (mean age, months: 5.5482±3.623, 0-24). EEG measured neural encoding of three speech stimuli: native Cantonese Tones 2 and 4, and non-native Mandarin Tone 3, within the /ga/ syllable, extracting both early-latency responses (FFRs) and long-latency responses (LLRs). A predictive model was constructed to validate the generalizability of the NSE-based prediction model by forecasting language outcomes from 118 Propensity Score Matching (PSM)-matched unseen data. In addition, predictive models were developed to analyze the association between early NSE data and later language outcomes (CCDI-C: mean age, months: 20.2783±5.6006, 11-32; Bayley-III: mean age, months: 20.0764±7.4084, 7-36). All

models were constructed by Random Forest with out-of-bag validation, in which children were classified as below or above 16th percentile (1 SD below mean) of the language outcomes. Results: Validation using unseen data showed area under curve (AUC) and sensitivity over 0.88, demonstrating the original models' robustness in predicting language outcomes. The NSE-based models accurately forecasted language outcomes assessed by CCDI-C and Bayley-III up to 36 months. The EEG->CCDI-C model achieved an AUC of 0.888±0.0078 and a sensitivity of 0.811±0.0155, while the EEG->Bayley-III model attained an AUC of 0.947±0.0047 and a sensitivity of 0.898±0.01298. Conclusion: High AUC and sensitivity values were found in predictive models constructed with NSE data, regardless of whether CCDI-C or Bayley-III were the outcome measures. When tested with unseen data, the performance of the predictive models remained high. As a language diagnosis can usually be made after 3 or 4 years of age, these findings underscore the high potential of NSE and AI analytics in predicting future language development at least 3 years earlier, which could enable prescription of preemptive intervention. Future research should focus on refining these predictive models and exploring their applications in broader neurodevelopmental and language contexts to further understand the neurobiology of language development.

D37 - Somatosensory-based tongue response to tongue stretch perturbation during steady state vowel production: EMG data and biomechanical modeling.

Pascal Perrier[1], Morgane Bourhis[1], Maxime Calka[1,2], Mohammad Ali Nazari[3], Yohan Payan[2], Takayuki Ito[1]; [1]Univ. Grenoble Alpes, CNRS, Grenoble INP, Gipsa-lab, Grenoble, France, [2]Univ. Grenoble Alpes, CNRS, Grenoble INP, TIMC, Grenoble, France, [3]School of Mechanical Engineering, Biomechanics, University of Tehran, Iran

While speech production primarily conveys linguistic information via acoustics, it has been shown that speech motor control uses all available sensory inputs - auditory, somatosensory, tactile and even visual - to plan and control the evolution of the state of the orofacial system over time. It has also been suggested that somatosensory feedback could be major during on-line speech production, because of its latency, which is shorter (13 to 55ms in EEG and MEG studies) than the one of the auditory feedback (above 100ms in EEG studies). This study investigates the mechanisms underlying somatosensory based tongue motor control in speech production by combining EMG recordings in response to a tongue-stretch perturbation during vowel production and simulations of tongue movements with a 3D biomechanical model. An experimental study was designed to apply tongue-stretch perturbations with a robotic device during the steady-state production of French vowel /i/. EMG was recorded from the anterior part of the mouth floor using a uni-polar surface electrode. EMG signal from this site reflects in large part the activation of the anterior genioglossus muscle, which plays a major role in the control of tongue blade in front/high vowels. EMG data recorded in this task were compared to those recorded in a voluntary reaction task during the same steady-state vowel production and with a resting task. We found in all the three tasks an increase of muscle activation in response to tongue-stretch perturbation with a latency close to 50ms. The magnitude of this response was smaller in the resting task than in both speech production tasks, but it was not reliably influenced by the voluntary reaction. This suggests that the observed EMG response is driven by a reflex mechanism which magnitude is task-dependent. In a previous study, using Electromagnetic Articulography, we recorded tongue kinematics under the same conditions, which enabled us to associate a posteriori EMG activations and tongue movements. Finally, a follow-up study using the same perturbation paradigm during the production of French vowel /e/ with and without auditory masking strongly suggested that these EMG responses were primarily induced by somatosensory feedback. Our group has developed a 3D biomechanical model of the tongue of an adult male subject (called “Reference subject”). It includes an accurate account of the 3D anatomical implementation of the muscles, and of the mechanical properties of tongue tissue based on fresh cadaver’s tongue data. It also incorporates a 3D muscle model that generates stress and modulates muscle tissue’s elasticity in response to EMG-like activation. The model was evaluated and validated based on its capacity to faithfully reproduce 3D tongue postures measured during the production of French phonemes by the Reference subject. We propose here to use this biomechanical model to simulate, from various tongue postures, a step-like increase in the activation of the anterior-genioglossus, in order to study tissue time response. These two combined studies enabled us to disentangle in the timing of tongue responses to stretch perturbation the respective influences of neural feedback delays and time response of tongue tissue.

D38 - Infant directed speech facilitates vowel category discrimination in pre-verbal infants

Varghese Peter[1], Caitlin Hooper[2], Denis Burnham[2], Marina Kalashnikova[3]; [1]University of the Sunshine Coast, [2]Western Sydney University, [3]Basque Center on Cognition, Brain and Language

Compared to adult-directed speech (ADS), infant-directed speech (IDS) is acoustically exaggerated. It has been proposed that such exaggerations facilitate speech sound discrimination and phonetic learning in young infants. This proposal was tested here using an abstract mismatch negativity (MMN) paradigm to assess 4- and 9-month-old infants’ and adults’ neural responses to a vowel contrast produced in IDS and ADS. In 4-month-olds, IDS stimuli elicited a negative MMN, but ADS stimuli elicited a positive mismatch response (MMR), associated with acoustic change detection, typical for infants of this age who are still acquiring their native language’s phonemic inventory. In 9-month-olds and adults, both IDS and ADS stimuli elicited MMN, associated with native phonemic processing. These results suggest that for 4-month-olds, for whom speech processing is predominantly acoustic/phonetic, the heightened acoustic variability and phonetic saliency in IDS, compared to ADS, augments vowel discrimination, whereas for 9-month-olds, their additional phonemic processing affords vowel discrimination in both augmented (IDS) and non-augmented (ADS) speech contexts. This neural level evidence is consistent with the perceptual attunement argument that early language-general

acoustic/phonetic speech processing gives way to a more abstract form of phonemic speech processing as a function of experience in a specific language environment, and also demonstrate that the properties of IDS may facilitate this developmental transition during infants' first year of life.

D39 - Prior knowledge benefits nap-mediated consolidation of Cantonese tones through talker generalization

Zhen Qin[1], Ruofan Wu[2], Caicai Zhang[2]; [1]The Hong Kong University of Science and Technology, [2]The Hong Kong Polytechnic University

Post-training sleep is beneficial for consolidating new sounds in second language (L2) learners. However, it is not yet clear how prior phonological knowledge affects the consolidation of new lexical tones. This study investigates whether nap-meditated memory consolidation of L2 tones depends on prior tonal knowledge, by manipulating the similarity of L2 Cantonese tonal contrasts (level-level or contour-level tonal contrasts) to L1 Mandarin tonal contrasts. While contour-level tonal contrasts are familiar to Mandarin listeners, level-level tonal contrasts are novel and perceptually challenging. Importantly, lexical tones are characterized by high variability across talkers, and previous studies have shown that sleep-dependent consolidation promotes talker generalization. Therefore, the present study adopted a nap design to investigate whether nap helps Mandarin speakers consolidate Cantonese tones through talker generalization and whether the consolidation effect depends on prior knowledge of tonal contrasts. Ninety Mandarin speakers from North China were recruited for the experiments. They were trained with two Cantonese contour-level (T5-T6) tonal contrasts and two level-level (T3-T6) tonal contrasts, respectively (240 trials each tonal pair, order counterbalanced), followed immediately with the 1st tone identification (ID 1) task using the stimuli produced by the trained (male) talker (80 trials for each tonal pair). Participants, matched in nap habits and sleep chronotypes, were then pseudo-randomly assigned to either the nap group (50 participants), who napped for 1.5 hours with brain EEG activities recorded, or the non-nap group, who rested and stayed awake by watching silent documentaries for 1.5 hours. After the nap manipulation, the participants were tested again with the trained talker in the 2nd ID task and a novel (female) talker in the 3rd ID task. Mixed-effects models were conducted on the ID accuracy across sessions. The ID 1-2 model, comparing the accuracy before and after the nap, showed the main effects of Tone ($z = -18.88$, $p < .001$) and Session ($z = 2.27$, $p = .02$) but no significant interaction effects involving Group. The ID 2-3 model, comparing the accuracy of trained and novel talkers, revealed a 3-way interaction between Group, Session, and Tone ($z = 2.37$, $p = .02$). Follow-up models showed that only the nap group had an interaction between Tone and Session ($z = -2.41$, $p = .02$), but not the non-nap group. The nap group showed a smaller ID difference between the trained and novel talkers for contour-level than for level-level tonal contrasts, whereas the non-nap group did not show the effect. The results of sleep-related EEG activities showed that sleep spindle density ($z = 2.28$, $p = .02$) and slow-wave sleep percentage ($z = 2.75$, $p < .01$) positively predicted the talker generalization effect in the contour-level tonal contrasts. The findings support the beneficial role of naps, which enhanced the nap participants' tone consolidation by promoting talker generalization. Importantly, nap appears to prioritize the generalization of contour-level tonal contrast to a new talker, an effect attributable to the participants' prior knowledge of contour-level tonal contrasts. The beneficial effect might reflect brain activities indexing the hippocampal-neocortical cycle underlying memory consolidation processes.

D40 - Uncovering language deficits in focal epilepsy: Beyond the limits of noun naming and verbal fluency

Aoife Reardon[1-3], Lisa Gillinder[1,4], David Copand[1-3], Katie McMahon[5], Sonia Brownsett[1-3]; [1]University of Queensland, [2]Surgical Treatment and Rehabilitation Service (STARS), [3]La Trobe University, [4]Princess Alexandra Hospital, [5]Queensland University of Technology

Background: A range of language impairments have been reported in people with epilepsy both pre- and post-surgically, however language is not routinely comprehensively assessed in epilepsy clinics. When language is assessed, this is typically as part of a broader neuropsychological battery of assessment, often limited to tests of noun naming and/or verbal fluency, despite evidence to suggest these tests are not sufficiently sensitive to detect the often-subtle deficits present in chronic focal epilepsy. Many areas of language function, including the production of connected speech, have also not been adequately explored in this population, and research relating to subjective report of language and communication difficulties is limited. A more comprehensive assessment of language, which includes patient report, is required to determine the presence and extent of language impairment in people with focal epilepsy. Aim: The aim of the present study was to systematically investigate the prevalence and pattern of language impairment in a group of people with chronic focal epilepsy using a comprehensive aphasia battery and a patient reported outcome measure. Method: Language skills were assessed in 26 right-handed people with chronic focal epilepsy using the Comprehensive Aphasia test (CAT; Swinburn et al., 2004), in addition to standard clinical assessments of noun naming and verbal fluency. Participants' self-report of their language and communication skills was also collected, using the La Trobe Communication Questionnaire (LCQ; Douglas et al., 2000). Outcomes and Results: 85% of participants with focal epilepsy were impaired on one or more language subtests of the CAT. In contrast, only 15% of participants were impaired on tests of confrontation noun naming, and none were impaired on a test of verbal fluency. The CAT findings were supported by subjective data, with 82% of participants self-reporting a communication difficulty. Conclusions: Our results show that current approaches to language assessment are inadequate for identifying language impairments in people with focal epilepsy, and likely underestimate the prevalence of language impairment in this population. In particular, verb naming and picture description subtests revealed deficits across the majority of the sample, highlighting the need for more comprehensive assessment of language to be routinely conducted in this population.

D41 - White matter differences in individuals with developmental dysgraphia

Romi Sagi[1], Brenda Rapp[2], Michal Ben-Shachar[1]; [1]Bar-Ilan University, [2]Johns Hopkins University

Producing written language is a fundamental aspect of daily communication, yet the neural pathways that support it are still not well understood, and far less studied compared to reading. Functional MRI studies have revealed that spelling requires information transfer within a distributed, left-dominant cortical network (Planton et al., 2013; Purcell et al., 2011). Diffusion MRI (dMRI) studies have shown that left ventral and bilateral dorsal white matter pathways are associated with spelling performance (Banfi et al., 2019; Cheema et al., 2022; Gebauer et al., 2012; Neophytou et al., 2023; Sagi et al., 2024). Recent data suggest that lexical aspects of spelling map to left ventral pathways, while sublexical aspects map to dorsal pathways (Cheema et al., 2022; Sagi et al., 2024). Here, we evaluated the white matter integrity of dorsal and ventral language-related pathways in two right-handed individuals with severe developmental dysgraphia: father (RBT, 56y) and son (TBT, 19y). Developmental dysgraphia in these participants was accompanied by developmental surface dyslexia. In particular, they experienced difficulties in spelling and reading orthographically irregular words compared to regular words and pseudowords, indicating a specific developmental difficulty in acquiring or retrieving lexical-orthographic representations. Other cognitive skills, including spoken language, memory and executive functions, were typical or superior to age norms. Microstructural properties of white matter pathways in each participant were compared with matched control groups (N=12 for RBT, N=22 for TBT). dMRI scans were acquired on a 3T Philips scanner using a single-shot EPI sequence along 64 directions. Data were preprocessed with tensor modeling at the voxel level, coupled with whole-brain deterministic tractography. Tracts of interest were identified bilaterally using automated segmentation tools; dorsally: the arcuate fasciculus (AF) and superior longitudinal fasciculus-III (SLF-III); ventrally: the inferior longitudinal fasciculus (ILF) and inferior fronto-occipital fasciculus (IFOF). For each participant and tract, fractional anisotropy (FA) values were averaged and lateralization indices were calculated. FA values and lateralization indices were compared between each participant and their matched control group using a two-tailed Crawford-Howell t-test. Both father and son showed an overall pattern of reduced FA in certain dorsal and ventral left-hemisphere tracts, coupled with right-biased lateralization in both streams. Specifically, both participants showed reduced FA in the left ILF compared with matched controls. Significant right-biased lateralization indices (vs. controls, $p<0.05$) were observed in the father in a dorsal tract (SLF-III) and in the son in both dorsal and ventral tracts (AF and ILF). These results are consistent with previous dMRI findings showing spelling associations with both dorsal and ventral streams in typical adults. Reduced anisotropy in the left ILF and right-biased lateralization overall may reflect poor lexical-orthographic spelling processes mediated by the left ventral stream and greater reliance on the right-hemisphere dorsal pathways for sublexical spelling. Our findings shed light on the neural system that supports spelling and broaden the understanding of developmental spelling deficits. Given the close relationships between spelling and reading, further work will be required to distinguish the contribution of the underlying white matter pathways to spelling and reading difficulties, respectively.

D42 - Changes in pupil size track the syllabic rhythm of natural speech

Sebastian Sauppe[1], Giorgia Sironi[1], Chantal Oderbolz[1], Catalina Torres[1], Martin Meyer[1]; [1]University of Zurich

Neural tracking — the systematic cortical response to the low-frequency, quasi-rhythmic structure of spoken language — is a ubiquitous phenomenon that supports the segmentation and comprehension of speech and is traditionally measured through electrophysiological methods. Since the 1960s, changes in pupil diameter have been used as a psychophysiological tool to study cognition and attention. Recently, it has been shown that pupil dilation is sensitive to the rhythm of syllable streams in statistical learning tasks and that the correlation between pupil size and neural activity increases during listening to narratives. We present the first systematic demonstration of the sensitivity of pupil dilation to the low-frequency characteristics of natural speech by testing whether there is a consistent phase relationship between the speech envelope and the size of listeners' pupils. Additionally, we tested whether pupillary speech tracking is sensitive to variations in prosody by manipulating the acoustic profile of auditory stimuli. Prosodic information, especially syllable rate, accounts for the most prominent modulations in the speech temporal modulation spectrum and drives neural tracking. Participants (N = 28) listened to naturalistic stimuli, while pupil size was recorded with an eye tracker and cortical EEG activity was recorded (64 electrodes, both sampled at 1000 Hz). This co-registration allowed to assess the "trackability" of the stimuli by measuring an expected neural speech tracking response. Participants listened to excerpts from audio books (in total approx. 30 minutes) and answered comprehension questions, to encourage paying close attention. Half of the excerpts were acoustically manipulated by resynthesizing vowel and pause durations and fundamental frequency to reduce the acoustic strength of boundaries and prominences. Since previous studies have found sizable individual differences in tracking abilities, participants were additionally classified as high or low synchronizers, based on the Speech-to-Speech Synchronization task. To determine the degree of speech tracking, the phase-locking value between pupil size and EEG activity and the gammatone-bank filtered speech envelope was calculated in a frequency band of 3-4.5 Hz (representing the range of syllabic rates in the audio book excerpts) and in time bins of 5 seconds. Statistical significance was assessed through mixed-effects beta regression and regression trees (recursively partitioning the data to find subgroups, thus allowing to model the spatial structure of EEG). Phase-locking between neural activity and the speech envelope showed a wide-spread topography and was decreased by both the prosodic manipulation and in low synchronizers (all ps < 0.001). Pupil size was also phase-locked with the speech envelope ($p < 0.001$), but no effects of the prosodic manipulation or participants' synchronizer status were observed. This decreased sensitivity

could be explained by the lower dimensionality of the pupil data (1 vs. 64 channels). Our study shows that pupil size changes track at least the syllabic structure of speech. As pupil size changes reflect sensory tuning and attentional states, driven by activity in the locus coeruleus, these results open a window into the role of the brainstem in language processing and provide a prospective psychophysiological tool for studying speech tracking (e.g., in populations not easily examined with EEG).

D43 - Investigating word production errors in aphasia with large language models and intracortical microelectrode recordings

Laura Schiffl[1], Lisa M. Held[1], Arthur Wagner[2], Bernhard Meyer[2], Jens Gempt[3], Simon N. Jacob[1,2]; [1]Translational Neurotechnology Laboratory, Department of Neurosurgery, Klinikum rechts der Isar, Technical University of Munich, Munich, Germany, [2]Department of Neurosurgery, Klinikum rechts der Isar, Technical University of Munich, Munich, Germany, [3]Department of Neurosurgery, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany

Damage to cortical brain regions associated with the left-lateralized language network typically results in language disorders (aphasia). One of the most frequently observed chronic symptoms in patients with non-fluent aphasia is an impairment in word finding. Behavioral, electrophysiological, and neuroimaging evidence suggests that these difficulties can be attributed to failures in conceptualization, lexical retrieval, and phonological encoding rather than to sensory-motor deficits. However, current studies of the neural processes underlying word production errors in individuals with non-fluent aphasia lack the temporal and spatial resolution to disentangle the mechanisms at the single-neuron level. In particular, the role of the unimpaired right hemisphere of patients with left-hemispheric lesions in the rehabilitation of language functions remains a matter of debate. The extent to which right hemispheric regions support residual language functions, such as successful word production, in this group of patients requires further investigation. In this unique case study, we investigated the contribution of right-hemispheric brain regions homotopic to the left language system using large-scale single-unit recordings (N=256 intracortical microelectrodes covering the inferior frontal gyrus, middle frontal gyrus, angular gyrus, supramarginal gyrus) in a patient with non-fluent aphasia performing three language tasks (naming, repetition, comprehension). Over several months, the patient showed typical patterns of impairment, with reliably high performance in comprehension and repetition, but low performance in naming. Although stable over time, naming accuracy varied for individual words. This variation was predictable using logistic regression classifiers trained on speech and language embeddings from large language models (LLMs). The LLM embeddings effectively predicted the correctness of a trial. They also captured the relationships between target words and their output in speech, specifically the error type (e.g., semantic paraphasia, circumscription, onomatopoeia, phonological paraphasia, mixed paraphasia) and semantic distance. We found that individual neurons in all recorded brain areas exhibited firing rate changes that were task-, performance-, and region-specific, arguing for their involvement in the respective tasks. For example, contrasting neuronal responses in correct naming trials with responses in incorrect naming trials showed that single neurons, especially in MFG and IFG, exhibited variations in spiking activity that were correlated with the patient's performance. Furthermore, neuronal activity in the SMG varied as a function of individual target words prior to speech onset in the naming task, but less so in the repetition and comprehension task. As repetition and naming involve similar articulatory processes but differ in word-finding demands, this result supports a role for the right SMG in lexical access and phonological encoding. In IFG, we also found an effect of the target word on neuronal activity before speech onset in naming trials. This is in line with the involvement of IFG in speech planning. By combining the strength of speech and language embeddings from LLMs with the superior spatial and temporal resolution of intracortical microelectrode recordings, this study will promote our understanding of the role of the right hemisphere in aphasia in general and the temporal and spatial signatures of the cognitive processes required to move from intention to articulation in particular.

D44 - Do deaf readers pre-activate phonology during sentence comprehension?

Zed Sehyr[1], Manuel Perea[2], Mairéad MacSweeney[3], Marta Vergara-Martínez[2], Eva Gutierrez-Sigut[4]; [1]Chapman University, [2]University of València, [3]University College London, [4]University of Essex

The ability of readers to use linguistic and contextual cues to predict upcoming words in a sentence is well-documented. This predictive processing allows for more efficient recognition of words, particularly when the context of a sentence is highly predictable (Federmeier & Kutas, 1999; Metusalem et al., 2012). Evidence suggests that phonological pre-activation could also facilitate word recognition (Ito et al., 2016). However, it remains unclear whether prelingually deaf readers, who rely primarily on visual rather than auditory input, engage in similar predictive processes. This study aims to investigate to what extent deaf readers pre-activate semantic and phonological information during sentence comprehension. We hypothesize that, like hearing readers, deaf readers will show semantic pre-activation but may differ in phonological pre-activation due to their unique linguistic experiences. We recorded electroencephalograms (EEGs) from deaf and hearing participants as they read 224 high-cloze probability sentences (e.g., "Pete broke his arm and had to wear a …") presented one word at a time centered on a computer screen. Participants answered comprehension questions following each sentence. The critical sentence-final words were manipulated across four conditions: 1) Congruent (cast), 2) Semantically incongruent (wall), 3) Pseudohomophone (kast), and 4) Orthographic control pseudoword (yast). Low-cloze (<30%) probability sentences were included as fillers. Of all items, 30% contained a pseudoword. Only correctly answered sentences were analyzed. Preliminary data from 5 deaf and 8 hearing participants (data collection is ongoing and full analysis will be presented the conference) showed a typical N400 response for semantically incongruent words (wall) compared to congruent

words (cast) in both groups, indicating semantic pre-activation. Interestingly, differences emerged in the Late Positive Complex (LPC) responses: hearing readers exhibited a positive-going LPC for incongruent endings, while deaf readers showed a negative-going deflection for predicted endings, suggesting a continued semantic processing post-lexical access in deaf readers. For hearing readers, the orthographic control (yast) differed from the congruent condition (cast) early on, while the pseudohomophone condition (kast), only differed after 400ms, indicating phonological pre-activation and a possible re-analysis of pseudohomophone as a misspelling. For deaf readers, both orthographic control (yast) and pseudohomophone (kast) differed from the congruent condition (cast) only at the LPC stage. These preliminary findings suggest that while both deaf and hearing readers use semantic pre-activation, their phonological processing strategies diverge. Hearing readers appear to first use of the phonological information available in the pseudohomophone and later engage in reanalysis for phonologically similar pseudowords. Deaf readers seem to engage in different and later processing of both types of pseudowords. Overall, our study provides initial evidence that both deaf and hearing readers pre-activate semantic information during sentence comprehension. However, phonological pre-activation and subsequent reanalysis appear to differ. Our findings will further our understanding of the mechanisms used by deaf readers during reading comprehension.

D45 - Transcranial direct-current stimulation of core language areas facilitates contextual acquisition of spoken and written words: multi-study evidence

Yury Shtyrov[1]; [1]Aarhus University

We describe a series of experiments aimed at comprehensively assessing effects of transcranial direct current stimulation (tDCS) on word acquisition. tDCS is a non-invasive neurostimulation technique putatively able to shift transmembrane potentials, thereby changing excitation/inhibition thresholds and modulating cortical networks' capacity for plastic changes. Previous tDCS studies on language have shown disparate results, particularly with respect to language learning and word acquisition. To address this, we systematically investigated effects of tDCS of core left-hemispheric language cortices on neural processes underpinning contextual word learning under different conditions. To this end, prior to a word-learning session, healthy adult participants (N=232) were given 15 minutes of either anodal or cathodal 1.5mA tDCS of Wernicke's or Broca's areas, or a control sham/placebo stimulation, in a between-group design. Two sets of experiments were conducted. The first set investigated acquisition of spoken words in implicit inference-based fast mapping (FM) and instruction-based explicit encoding (EE) conditions, balanced for a range of variables. In a word-picture association session, each participant learned 16 novel words either perceptually (via auditory exposure combined with a novel object's image) or in an articulatory mode (where participants additionally articulated the words overtly). Immediately after this session, learning outcomes were tested using recognition and semantic decision tasks. In both tasks, articulatory learning yielded better results (higher accuracies, shorter latencies) than non-articulatory exposure. EE and FM regimes, in turn, produced generally similar outcomes, indicating their comparable efficiency. Most importantly, real tDCS of both polarities led to global learning improvements, demonstrated by faster (as opposed to sham) reactions and higher accuracies. We also found more specific tDCS effects: better word-recognition accuracy for EE vs. FM after cathodal stimulation, and more expressed improvements in recognition speed and accuracy for anodal Broca and cathodal Wernicke stimulation (particularly for unarticulated FM items). These learning mode-specific effects support the notion of partially distinct neurobiological mechanisms underpinning EE and FM learning strategies. The second set of experiments targeted acquisition of written words of different semantic types. These were presented visually within short 5-sentence stories, whose context rendered novel words as either concrete or abstract (N=10 each). Their retention was tested both immediately and 24 hours later. The results suggested that both anodal and cathodal tDCS of Broca's area improve immediate acquisition of novel vocabulary, predominantly affecting abstract semantics. Wernicke tDCS showed a similar pattern: an overall better performance over sham condition, particularly expressed for abstract semantics and cathodal stimulation. Furthermore, cathodal Wernicke (but not Broca) stimulation showed enhanced retention of abstract semantics 24 hours later. These results indicate a prominent role of core language areas in encoding abstract words and support the notion of distinct networks for concrete and abstract semantics. To conclude, tDCS of core language cortices exerts a general facilitatory effect on word acquisition with some specificity to learning regimes and word types. Overall, the results of these studies speak to existence of distinct neural networks underlying different learning strategies and different types of semantics. Furthermore, they may inform future applied research into ameliorating learning deficits and language disorders.

D46 - Multiplexed representations for attempted speech, listening, and reading on the motor cortex and their effect on speech neuroprostheses

Alexander Silva[1,2], Jessie Liu[1,2], Vanessa Anderson[2], Cady Kurtz-Miott[2], Irina Hallinan[2], Kaylo Littlejohn[2,3], Samantha Brosler[2], David Moses[2], Edward Chang[2]; [1]equal contribution, [2]University of California at San Francisco, [3]University of California at Berkeley

The motor cortex is most well known for encoding low-level motor representations, such as those of the tongue or the lips, which are the basis for complex motor behaviors, such as speech. The motor cortex has also been shown to contain representations of both multi-effector movements, where neural populations are not tuned to any one particular muscle group, as well as representations relating to perceiving visual or auditory stimuli during reading and listening, respectively. Some studies have shown a direct overlap between these functions in the motor cortex, most commonly comparing reading to listening or listening to speech, but fewer have investigated the overlap between the three. Additionally, the nature of these multiplexed representations and whether they reflect identical or shared processing remains unclear. These questions are also

particularly relevant for the development of speech neuroprostheses. Speech neuroprostheses have the potential to restore naturalistic communication to people with paralysis by decoding intended speech from persistent representations of low-level vocal-tract movements in the motor cortex. The existence of multiplexed representations in the motor cortex for attempted speech, reading, and listening then raises the concern of whether reading and listening, essential daily functions, may unintentionally engage or interfere with speech decoding. Indeed, one of the most commonly cited desires of potential users of speech neuroprostheses is that they remain specific to decoding only attempted speech and not other functions. To address these questions, we first developed a speech-decoding system in two participants with vocal-tract paralysis that maintained online performance and specificity to volitional speech attempts, regardless of whether they were also participating in listening, reading, and non-speech mental imagery tasks. Offline, we observed multiplexed neural populations that responded to attempted speech, listening, and reading, but we found that they leveraged different neural representations, partially facilitated by their unique spectrotemporal response patterns across tasks. Strikingly, these neural populations localized to the middle precentral gyrus (midPrCG). Though multiplexed representations were found in the midPrCG, it was also an important area for discriminating between attempted speech, reading, and listening and for decoding attempted speech just prior to execution. Together, these results suggest that the midPrCG may have a distinct role in speech-motor planning, which is supported by multiplexed neural activity. These results further our understanding of multiplexed speech activity in the motor cortex and demonstrate a maximally-reliable decoding framework for speech neuroprostheses.

D47 - Language-critical areas serve as connectors across language subnetworks

Marc Slutzky[1], Jason Hsieh[1,2], Prashanth Prakash[1], Robert Flint[1], Emily Mugler[1], Yujing Wang[3], Nathan Crone[3], Jessica Templer[1], Joshua Rosenow[1], Todd Parrish[1], Matthew Tate[1], Richard Betzel[4], Jeremy Greenlee[5]; [1]Northwestern University, [2]Cleveland Clinic Foundation, [3]Johns Hopkins University, [4]Indiana University, [5]University of Iowa

Historically, important abilities such as speech and language were viewed as localized to focal areas of human cerebral cortex. Moreover, direct electrocortical stimulation (ECS) has long been used clinically to identify focal sites thought to be “critical” to speech and language function. This procedure is often performed prior to epilepsy or tumor surgery to avoid damaging these functions from the resection. Yet, more recent studies have shown that large cortical networks are activated during language and speech tasks, leading many to hypothesize that eloquent functions may instead be emergent properties of distributed brain networks. Here, we sought to reconcile these different viewpoints and elucidate the network properties that predict whether cortical sites are labeled by ECS as critical for speech and language. We recorded electrocorticography (ECoG) from sixteen participants who performed a word-reading task while they underwent either awake craniotomy for brain tumor resection, or extraoperative monitoring for epileptogenic focus localization. We extracted high-gamma activity from ECoG recordings and computed the pairwise connectivity. We used modularity maximization to find the community membership of nodes in the task-activated network and calculated several well-described network connectivity metrics. We then used these metrics to examine the network properties of cortical sites defined by ECS to be critical for speech and language (those producing speech arrests and language errors, respectively) and compared to other (non-critical) cortical sites. We discovered different network signatures for cortical sites where ECS caused speech arrest and language errors. Both types of ECS-critical sites were characterized by a lower amount of local (clustering coefficient, local efficiency) and global (eigenvector centrality) connectivity than non-critical network sites. Cortical sites where ECS caused language errors, in particular, exhibited higher participation coefficients — that is, higher inter-community connectivity. Taken together, these metrics constitute a network signature that indicates that language-critical nodes serve as connectors between communities in the language network. Further, we used this set of network features alone to train support vector machine and k-nearest neighbor classifiers to predict which nodes would be critical to speech and language with ECS. These classifiers predicted critical nodes with relatively high accuracy, including across participants. These findings suggest that a site’s pattern of connections within the language network helps determine its importance to language function. For higher-order cognitive functions such as language, which depend on coordinated actions of multiple subnetworks (communities), nodes that connect these subnetworks appear to be critical to function. In contrast, for lower-order functions, such as speech articulation, connectors between communities may be less critical.

D48 - When the order is relevant: Investigating the processing of temporal order violations in conjunctive sentences

Maria Spychalska[1]; [1]Max Planck Institute for Psycholinguistics

Conjunctive sentences reporting two past events, e.g., “She wrote a letter and read a book”, suggest that the events happened in the order of mentioning, even if there is no direct link between the events. In Gricean pragmatics, this phenomenon is described as “temporal implicature”, and is explained in relation to the conversational Maxim of Manner (“be orderly”). Other authors have proposed that the phenomenon may result from a more general property of discourse or narration structure. Yet, it is still an open question to what extend the temporal representation of events as observed in real life modulates the linguistic processing, in particular, whether the temporal order of events modulates predictive processing in language. I present results of a series of ERP experiments investigating these questions, focusing especially on the role of contextual relevance of the temporal order for the processing of reversed order sentences. The experimental paradigm resembles a memory game, in which participants assign points to a virtual player and read sentences describing the game events. In each trial, five cards were dealt and the player opened two of them. Afterwards, the participants assigned points

depending on whether the cards belonged to the same category (animals vs. objects) or not (Experiment 2), or depending on the order of the cards' categories (Experiment 1). Subsequently, a sentence was presented describing the game trial, e.g., "Julia has flipped a cat and a flower". In the Correct-Order condition, sentences described the events in the order in which they happened; in the Reversed-Order condition, the events were described in the reversed order. In Experiment 3, the sentences used either "and" or connectives such as "before" and "after", while the game task did not highlight the order. In experiments where only sentences with "and" were used, the violation of temporal order primarily triggered a P600 effect, although a modulation of the N400 was observed as well if the order was indirectly highlighted in the task. However, in the experiment in which sentences used mixed forms, order violations (on the first noun, so independent of the used connective) triggered a robust N400 effect as well as the P600. As the P600 is sensitive to the integration of both structural and semantic aspects of the linguistic input, the observed P600 effect for order violation supports the hypothesis that reversed-order sentences engage more effortful combinatorial processing that may be due to the violation of the expected discourse organization. However, the additional N400 modulation by order shows that, under the right contextual support, temporal implicatures can be processed incrementally and modulate meaning-related predictive processes. In addition, sentences with "before" and "after" that were semantically false with respect to the scenario's order, showed an N400 effect on the second-mentioned event, so after the meaning of the connective could be integrated, relative to "and" sentences, where the order is derived pragmatically. (Comment: This is an update on the last year's abstract, which I could not present due to family situation)

D49 - Individualized computational models recapitulate directly-measured neural correlates of sematic and phonological impairments

Ryan Staples[1], Andrew T. DeMarco[1], Peter E. Turkeltaub[1,2]; [1]Georgetown University Medical Center, [2]MedStar National Rehabilitation Hospital

Left-hemisphere strokes frequently result in alexia. Artificial neural networks (ANNs) provide a mechanistic model for the impaired cognitive processes in alexia. Whether ANNs are adequate models of the brain, however, is unclear. Here, we assess single-word reading in a sample of left-hemisphere stroke survivors. We impair models of reading by damaging semantics, phonology, or mixed semantics/phonology. Model damage parameters are matched to stroke survivors, and we assess how well the models reproduce patterns of word reading accuracy. We use the stroke survivor-matched model damage parameters as dependent variables in multivariate voxel-based lesion symptom mapping (VLSM) analyses. We hypothesized that the models could reproduce reading accuracies across high and low frequency and consistency words in stroke survivors, and that the model damage parameters would co-localize with directly measured semantic and phonological impairments. Fifty-two left-hemisphere stroke survivors read aloud single words (varying in frequency and consistency) and pseudowords. Participants also performed semantic (Pyramids and Palm Trees, TALSA category judgement) and phonological (pseudoword repetition, rhyme judgement) tasks. We trained five independent instantiations of a triangle model of reading. Model instantiations differed only in their randomized starting weights. Models were then lesioned by removing percentages of the connections into and out of the phonological and semantic layers 10% intervals (10-90%) to model all combinations of severity of phonological and semantic damage. Each of the 99 possible lesions were modeled 15 times and the average accuracies were recorded for each lesion on: pseudowords, all words, and words in each bin of high vs. low frequency and consistency (four word types). Stroke survivors were matched to lesioned models using Euclidean distance between two-dimensional vectors of word reading and pseudoword reading accuracy. Model accuracy on the four word types was compared to real participant performance. Support vector regression-VLSM was used to determine if specific lesion locations corresponded to the modeled ANN lesions of (1) phonological damage and (2) semantic damage. Model lesion parameters were inversely correlated with phonological ($r(50)=-0.68$, $p<0.001$) and semantic ($r(50)=-0.29$, $p=0.047$) task accuracy. Stroke survivors' reading of the high/low frequency/consistency words was well-matched by the models (correlation between model and stroke survivors' reading: high-frequency consistent words, $r(50)=0.96$, $p<0.001$; high-frequency inconsistent words, $r(50)=0.941$, $p<0.001$; low-frequency consistent words, $r(50)=0.968$), $p<0.001$, low-frequency inconsistent words, $r(50)=0.85$, $p<0.001$). VLSM showed that the phonological lesion parameter is related to supramarginal (SMG) and superior temporal gyrus (STG) lesions. Semantic model lesions localized to left angular and middle occipital gyrus (both voxelwise $p<0.005$, clusterwise $p<0.05$). Model parameter VLSM results overlapped with directly measured phonology and semantic VLSM results. Our results critically show that ANNs implementing the triangle model are models of not only cognitive processes, but also of the brain. Though matched only to reading accuracy, we show that the ANNs also capture non-reading phonological and semantic processes. Our findings show that ANNs provide a framework to parse individual variability in post-stroke alexia outcomes, potentially leading to improved therapeutic approaches. Future work will adjudicate between models implementing competing hypotheses of the neurocognitive processes in reading by comparing their fits to the brain.

D50 - Parameter-Efficient Tuning Outperforms Fine-Tuning in Aligning Language Models with Brain Activity

Jingyuan Sun[1], Xinpei Zhao[2], Marie-Francine Moens[3]; [1]KU Leuven, [2]Insititute of Automation, Chinese Academy of Sciences

Tuning pretrained large language models (LLMs) has emerged as a highly effective strategy for solving diverse natural language understanding (NLU) tasks, often achieving empirical performance levels that closely approximate human performance. Traditionally, fine-tuning (FT) has been the primary method for adapting LLMs to specific tasks by adjusting their pretrained weights. While this approach can lead to superior task performance, it is resource-intensive, requiring

substantial computational power and storage capacity. To address these challenges, various parameter-efficient tuning (PET) methods have been developed. These methods preserve the pretrained parameters while integrating additional ones to tailor the model to specific tasks. Advanced PET methods significantly reduce the computational demands of tuning while delivering performance levels comparable to traditional FT. Currently, FT and PET are the principal strategies for adapting LLMs to downstream tasks. Despite the successes of tuning LLMs in numerous NLU tasks, there is ongoing debate about whether these models truly understand the nuances of language or rely on surface-level heuristics. Prior research has used human brain recordings to compare the representations derived from untuned LLMs with those generated by the human brain during language processing. This approach involves comparing model-generated representations with those captured from the brain using advanced imaging techniques, such as functional magnetic resonance imaging (fMRI). A significant correlation between these sets of representations, referred to as brain alignment, suggests a meaningful overlap in how language is represented by both the LLM and specific brain regions during comprehension. Studies have shown that untuned pretrained language models can predict activity across broad areas of the brain involved in language understanding. However, the alignment of tuned LLMs, including those adjusted via FT or PET, with human brain activity remains largely unexplored. Our study addresses this gap by exploring the connections between PET and FT of LLMs in relation to brain mechanisms through neural encoding, aiming to predict neural responses to linguistic stimuli. We selected four LLM architectures, each in two parameter sizes, resulting in a total of eight models. Unlike prior work, our models were tuned for causal language modeling on texts that human subjects were exposed to during neural response recordings, ensuring both LLMs and humans engaged with identical material. The tuning involved full FT and three PET methods: LoRA, AdaLoRA, and IA3. After tuning, we used these models to create embeddings for the stimuli, which were then used in regression models to predict neural responses recorded by fMRI from two publicly accessible datasets. Our findings reveal that embeddings from PET-tuned models consistently outperform those from FT-tuned models in accurately predicting the brain's language network, a pattern that remains stable across changes in learning rate and model size. Interestingly, PET methods can sometimes achieve better brain alignment than even the original, untuned models. We also observe that overly specific stimuli can lead to embeddings that do not accurately predict brain activation patterns, even if these are the focal points for subjects during neuroimaging studies.

D51 - A smaller 'word' in a word? Morphological processing in the bilingual 4-5-year-olds' brain

Xin sun[1], Janet Werker[2]; [1]University of British Columbia

Morphological awareness, or the ability to understand and use units of words (morphemes), is an essential language skill for reading development. Languages differ in morphological rules. For example, Chinese makes up words mainly through compounding (i.e., snow-man), while English is more characterized by affixes (i.e., read-er, fly-ing). It was found that Chinese-English bilingual young readers show different brain mechanisms than English monolingual readers when processing morphological units. Yet, what remains unknown is if these differences come from their experience with the written languages, or if they can be rooted from before reading. Indeed, behavioral evidence showed that children begin to show morphological awareness from as early as 4 years. Using fNIRS, the current study aimed to measure functional brain activities during morphological word processing among preliterate children. Bilingual Chinese-English and English monolingual children (N=140) completed a lexical morphology task in which they heard three words and picked out the one that “goes with” the target word (e.g., runner, water, dancer). Both groups activated the left frontal and middle temporal regions during the task. Moreover, while both groups showed similar activations when processing compounding words, Chinese-English bilinguals activated more left frontal regions compared to monolinguals only when processing affix structures (e.g., runn-er). These findings reflect potential differences in the strategies for breaking words into parts and accessing meanings for each part. This research will further our understanding of how the brain adapts to different types of language input to support language acquisition and emerging literacy in children from linguistically diverse backgrounds.

D52 - Evidence for Language-Shaped Conceptual Representations: Bilinguals Converge on Representations Interposed Between Monolinguals’

Maya Taliaferro[1], Esti Blanco-Elorrieta[1]; [1]New York University

Language plays a pivotal role in shaping how we construct and refine concept representations. Through language, we not only label and categorize objects, but we also establish the relationships and hierarchies among them. Importantly, however, different languages have distinct vocabularies that may emphasize certain features of reality while downplaying others. For this reason, direct translations of words across languages may not correspond to isomorphic representations of these concepts. For example, a dish considered a “bowl” in English may not always be mapped to the translational equivalent “w**ǎ**n” in Mandarin. Thus, language does not merely label pre-existing concepts, but it also shapes and molds our conceptual space. This has the potential to impact how we perceive, understand, and interact with the world. Bilingual individuals navigate a unique cognitive landscape, as they possess two languages that not only use different labels for the same concepts, but often have distinct sets of conceptual representations. If the relation between language and thought is deterministic, such that the words we use determine how we form and define concepts, then bilinguals would need to develop two independent conceptual spaces that align with the distinctions each language makes (i.e., separate system hypothesis). Alternatively, if words simply highlight certain features but neither determine nor delimit conceptual representations, bilinguals will not have two monolingual systems in a single brain, but rather conceptual representations that are a blend between the two (i.e., shared system hypothesis). To parse between these two possibilities, we use magnetoencephalography (MEG) and a novel representation

learning approach to investigate the content of language-independent concepts and how they evolve over time at the millisecond level. 48 monolingual English, 46 monolingual Mandarin and 24 bilingual Mandarin-English speakers performed a two alternative forced choice task (2AFC) to select the correct label for a visual stimulus that belonged to either experimental or control continua. Each continuum consisted of a pair of unambiguous pictures/categories on each end (e.g., a plate and a bowl) and we varied the features that distinguish them in seven steps. Critically, experimental continua contained items that were roughly equivalent across English and Mandarin but change category at a different step. Control continua were categories that overlap perfectly across languages. We analyzed the difference in category crossover steps and the nature of the language (in)dependent conceptual representations as indexed by neural representational similarity analysis of semantic features (e.g., can hold water, has a spout), low-level sensory-level features, and lexical features (frequency, lexical semantics). We found that conceptual representations overlapped for English and Mandarin monolinguals in the control continua, while they significantly diverged in the experimental continua. Critically, for concepts that diverged across languages, bilingual individuals showed representations that were the perfect blend between the two. These results support a theory of concepts where the nature of conceptual representations is heavily influenced by language and confirms that the effect of one language system upon the other in bilingual individuals goes far beyond the lexical system to permeate the semantic level and create conceptual representations interposed between both monolingual groups.

D53 - The role of basal ganglia in Chinese syntactic ambiguity resolution

Yingying Tan[1], Ran Zhang[1], Xiaolin Zhou[1], Zheng Ye[2]; [1]Shanghai International Studies University, Shanghai, China, [2]Institute of Neuroscience, Center for Excellence in Brain Science and Intelligence Technology, Chinese Academy of Sciences, Shanghai, China

Incremental language comprehension requires readers to confront temporary ambiguity and quickly extract correct meaning from the input. Previous studies have shown that ambiguity resolution activates various brain regions within the classic language network, including the left IFG, left MTG, and bilateral MFG [1, 2]. However, the role of subcortical structures, such as basal ganglia (BG), in ambiguity resolution is less understood. This study aims to investigate the role of the BG in processing Chinese ambiguous sentences and whether this role is modulated by individuals' cognitive functions like working memory (WM) and response inhibition. Sixty-four healthy participants were tested in a garden-path experiment with functional MRI (fMRI). Participants' neural activity was recorded while they read Chinese sentences containing ambiguous structures in the form of verb phrase (VP) + noun phrase1 (NP1) + "de" + NP2. For example, the phrase "bite hunter de dog" can be interpreted as either a VP that means " (someone) bit the hunter's dog", or a NP that means "the dog who bit the hunter". Seventy-two ambiguous structures were selected, with half favoring a VP interpretation and the other half favoring an NP interpretation. For each ambiguous sentence, a matched unambiguous sentence was constructed by replacing the NP1 with an adjective (e.g., bite smart de dog). Thus, ambiguity (ambiguous vs. unambiguous) and structure type (NP-preferred vs. VP-preferred) were crossed, resulting in four experimental conditions. Additionally, the same participants completed a series of behavioral tests to measure their WM and inhibition ability. Our results replicated previous findings on garden-path sentences, showing that ambiguity resolution primarily activates the classic frontal-temporal language network. Moreover, participants were less accurate in answering comprehension questions following an NP-preferred structure than a VP-preferred structure, accompanied by significant activation in the bilateral supramarginal gyrus and left precuneus. Since NP interpretation is the dominant one with higher occurrence for the ambiguous structure used [3], we suggest that these regions may be involved in processing canonical word order. Furthermore, there was a significant interaction between ambiguity and structure type. For the NP-preferred structure, the ambiguous sentences elicited statistically higher activation than unambiguous sentences in the bilateral MFG, right superior frontal gyrus, and left precentral gyrus, whereas these regions did not show significant activation for ambiguity processing of sentences with a VP-preferred structure. We suggest that these regions might be involved in syntactic reanalysis when canonical word order is violated. Most importantly, results from the ROI analysis showed that the left caudate, especially its anterior part, was sensitive to ambiguity resolution, as it showed greater activation for ambiguous sentences than unambiguous ones. However, our preliminary results did not find any correlation between individual differences in cognitive measures and BG activation levels. Our results demonstrate that both the cerebral cortex and BG are involved in ambiguity resolution during sentence processing. [1] Mestres-Missé et al., 2012. Neuroimage. [2] Rodd et al., 2010. Neuropsychologia. [3] Zhang, et al., 2000. Acta Psychologica Sinica. *The first two authors contribute equally to the work.

D54 - No causal role for premotor cortex in the perception or misperception of degraded speech: Evidence from TMS

Valeriya Tolkacheva[1], Sonia Brownsett[2,3], Katie McMahon[4,5], Greig de Zubicaray[1]; [1]Queensland University of Technology, School of Psychology and Counselling, Queensland, Australia, [2]Queensland Aphasia Research Centre, School of Health and Rehabilitation Sciences, University of Queensland, Queensland, Australia, [3]Centre of Research Excellence in Aphasia Recovery and Rehabilitation, La Trobe University, Melbourne, Victoria, Australia, [4]Herston Imaging Research Facility, Royal Brisbane & Women’s Hospital, Queensland, Australia, [5]Queensland University of Technology, School of Clinical Sciences and Centre for Biomedical Technologies, Queensland, Australia

A number of studies have shown that listeners can use prior knowledge to predict the content of noisy speech signals, enhancing perception. However, this process can also elicit misperceptions. The neural mechanisms responsible for both effects remain underspecified, although there is relatively consistent evidence for involvement of the bilateral posterior

superior temporal gyri (pSTG) in speech perception in noise using a range of syllable, word and sentence stimuli (Kennedy-Higgins et al., 2020; Tolkacheva et al., 2024). The roles of the motor and premotor cortices in speech perception are debated. While there is evidence for primary (M1) and premotor cortex (PMC) involvement in sublexical, syllable perception in noise (Brisson & Tremblay, 2021; Nuttall et al., 2016), there is little evidence using natural speech. In this study we explored the role of the PMC in perception and misperception of degraded speech. We used repetitive transcranial magnetic stimulation (rTMS) and a prime-probe paradigm to investigate causal roles for the PMC and left pSTG in speech perception and misperception using identical materials to Tolkacheva et al. (2024). Eighteen listeners were presented with spectrotemporally degraded probe sentences preceded by a clear prime. To produce misperceptions, we created partially mismatched pseudo-sentence probes via homophonic nonword transformations (e.g., The little girl was excited to lose her first tooth - Tha fittle girmn wam expited du roos har derst cooth). We expected to replicate our previous finding that inhibitory rTMS to the left pSTG impairs priming of real, but not pseudo-sentences compared to the stimulation of a control region (Vertex). We also hypothesised that TMS applied to the PMC would impair priming of both real and pseudo-sentences if this region plays a role in processing of lexical and/or sublexical information during speech perception. Compared to a control site (Vertex), inhibitory stimulation of the left pSTG selectively disrupted priming of real but not pseudo-sentences. However, inhibitory stimulation of the PMC did not significantly influence perception of real sentences or misperceptions of pseudo-sentences. These results confirm a role for the left pSTG in the perception of degraded speech. However, they do not support a role for the PMC in either lexical or sublexical processing during perception of degraded speech using sentence stimuli. These findings have significant implications for neurobiological models of speech perception. [1] Kennedy-Higgins, D., Devlin, J., Nuttall, H., & Adank, P. (2020). The Causal Role of Left and Right Superior Temporal Gyri in Speech Perception in Noise: A Transcranial Magnetic Stimulation Study. Journal of Cognitive Neuroscience, 32(6), 1092-1103. [2] Tolkacheva, V., Brownsett, S., McMahon, K., & de Zubicaray, G. (2024). Perceiving and misperceiving speech: lexical and sublexical processing in the superior temporal lobes. Cerebral cortex (New York, N.Y. : 1991), 34(3), bhae087. [3] Brisson, V., & Tremblay, P. (2021). Improving speech perception in noise in young and older adults using transcranial magnetic stimulation. Brain and Language, 222, 105009. [4] Nuttall, H., Kennedy-Higgins, D., Hogan, J., Devlin, J., & Adank, P. (2016). The effect of speech distortion on the excitability of articulatory motor cortex. NeuroImage, 128, 218-226.

D55 - Decoding anticipated semantic and visual word features in Spanish-English heritage speakers

Timothy Trammel[1], Elaina Jahanfard[1], Matthew J. Traxler[1], Tamara Y. Swaab[1]; [1]University of California, Davis

Predictive coding models (Rao & Ballard, 1999) have recently gained popularity as potential architectures for the role of prediction during language comprehension (Kuperberg & Jaeger, 2016). These models suggest that predictions are continuously generated from higher cortical levels about upcoming input from lower-levels of processing. As bottom-up input is encountered by each level of processing, prediction error is computed by comparing the input with the top-down prediction. To date, most research on prediction during language processing has focused on native speakers of one language. However, as more than 50% of the world speaks at least two languages (Grosjean, 2019) there is a need to better understand how bilinguals predict within both their native language and their second language (L2). Currently, little is known about which linguistic features are anticipated when bilinguals process L2 and whether this is done in a top-down fashion as hypothesized by predictive coding. The present study aimed to examine prediction and anticipation of information during visual word recognition in L2 of Spanish-English bilinguals. We predicted that bilinguals would be able to select the context appropriate language and tested the two crucial assumptions of the predictive coding theory 1) bilinguals anticipate semantic features (concreteness) before sub-lexical features (word length) during visual word processing in a priming, and 2) failed prediction would be evident from increased prediction error. During a visual word priming task, Spanish-English bilingual participants' (n=29) electroencephalogram (EEG) was recorded while they read a prime and target words in English. For every prime-target trial, they were instructed to try to predict the upcoming target word based on the meaning of the prime word before target onset. They were asked to indicate via button press to respond with yes if the visual target word was identical to the word they had predicted, and no when it was not. Two-thirds of the word pairs were related, and those remaining were unrelated. The combination of prediction accuracy and relatedness of the target stimuli resulted in three conditions: predicted – participants predicted the actual related target word, unpredicted – participants did not predict the actual related target word, and unrelated – participants could not predict the target word because it was unrelated. We analyzed the entire prime-locked trial epoch (3600ms; with target onset at 2000ms) using support vector machine (SVM) EEG decoding – to classify either concreteness or word length of the target word – and mass-univariate ERP analysis. Statistical testing for both analyses were performed using cluster-based permutation testing. The SVM EEG decoding results showed that target word features – both concreteness and word length – were reliably decodable at greater than chance-level (50%) prior to target word onset when the target word was predicted. The mass-univariate analyses showed reduced N400 to predicted target words relative to unpredicted but related or unrelated target words, suggesting an increase in prediction error during unsuccessful predictions. These results suggest that bilinguals predict in L2 in a manner consistent with predictive coding accounts of language processing.

D56 - Right hemisphere functional connectivity increases in large left-hemisphere strokes but does not relate to aphasia severity

Natalya Vladyko[1], Andrew T. DeMarco[1], Peter E. Turkeltaub[1,2]; [1]Center for Brain Plasticity and Recovery, Georgetown

University Medical Center, Washington DC, [2]MedStar National Rehabilitation Hospital, Washington DC

Left hemisphere (LH) strokes can lead to widespread disruption of the LH language network (LN), which relates to aphasia severity. Recruitment of homotopic right hemisphere (RH) regions may partially support aphasia recovery, at least in some individuals. Most of the evidence for RH involvement in recovery comes from task-based fMRI, but there is emerging evidence for changes in RH functional connectivity (FC) after LH stroke as well. The nature of RH functional network reorganization and whether it contributes to aphasia outcomes remains unclear. Previously, we observed that RH FC is greater in LH stroke survivors than controls, with larger increases in individuals with large lesions than those with small lesions. In this study, we further examine RH FC following LH stroke, focusing on LN homotopes. Additionally, we examine how these changes in RH FC relate to behavioral outcomes, specifically to aphasia severity as measured by the Western Aphasia Battery (WAB). This study included 79 chronic LH stroke survivors (35F, mean age=61, mean time post-stroke=53 months, median lesion size=80cc) and 72 matched controls (36F, mean age=61). Participants underwent a 14.5-minute movie-watching fMRI scan. Following standard preprocessing, we computed FC between all 246 regions defined by the Brainnetome atlas. The LH stroke survivors were median-split into small lesion (n=37, median size=25cc) and large lesion (n=38, median size=148cc) groups. We compared the edgewise RH FC of each stroke group to that of controls. We then defined a LH LN as Brainnetome parcels that activated significantly during a semantic decision fMRI task in the control group. RH homotopic parcels defined the RH LN. Parcels outside the LH and RH LNs were classified as the non-language network (NLN). We calculated the proportion of significant FC changes of edges as compared to controls, both within and between the LN and NLN in both hemispheres. Additionally, we correlated the mean FC within and between the LN and NLN and the WAB scores, controlling for lesion size. In the small lesion group, 14% of LH LN edges and 5% of LH NLN edges had significantly lower FC than controls. Only 1% of RH edges had greater connectivity than controls. In the large lesion group, 28% of LH LN edges were decreased. The RH mainly showed increases in FC. The highest proportion of these increases was within the RH NLN (29% vs. 17% in the RH LN) and between the RH LN and NLN (28%). RH FC within and between networks did not correlate with WAB scores for either group. For the small lesion group, within LH LN ($r=0.4$, $p<0.05$), within LH NLN ($r=0.37$, $p<0.05$), and interhemispheric homotopic LN FC ($r=0.43$, $p<0.05$) correlated with WAB scores. There are widespread increases in RH FC following a large LH stroke. These changes are not specific to the RH LN or NLN and occur both within and between these defined networks. Additionally, these changes, at least as measured here, do not relate to aphasia severity, thus it remains unclear whether RH network reorganization plays a meaningful role in aphasia recovery.

D57 - Neuroplasticity in language recovery-a longitudinal study with a post stroke aphasic patient

Qingchun WANG[1], Fang WANG[2], Yang LIU[2], Lu YU[2], Yongkun GUO[2], Xinjun WANG[2,3], Wai-Ting SIOK*[1]; [1]The Hong Kong Polytechnic University, Hong Kong SAR, China, [2]The Fifth Affiliated Hospital of Zhengzhou University, Zhengzhou University, Zhengzhou, China, [3]The Third Affiliated Hospital of Zhengzhou University, Zhengzhou University, Zhengzhou, China*

The neuroplasticity of the brain is a key biomarker for language recovery. Previous studies have shown that the anatomical structure of the brain adapts to internal and environmental changes. However, few studies have investigated the dynamic evolution of the brain within the critical period of recovery with multiple examinations. In this study, we present a detailed 6-month longitudinal case report of an aphasic patient who suffered from a unilateral stroke. The patient is a 60 years old, well-educated native speaker of Mandarin, right-handed male with no previous history of neurological diseases or psychiatric disorders. We carefully examined the neuroanatomical features of the brain and documented the patient's linguistic profile from the acute stage to the chronic post-stroke phase. The patient received intensive language therapies during rehabilitation. Language performances were assessed by a comprehensive aphasia battery for multiple times. Neuroimaging data which captured the anatomical and structural features of the brain were collected at three time points with an exact time interval of 2 months. We used Voxel-Based Morphometry (VBM) to detect changes in tissue volume, and diffusion tensor imaging (DTI) data to assess the microstructural integrity of white matter tracts. Ten healthy participants matched for age and educational level served as the control group. A pattern of gradual improvements in all tested linguistic domains was observed during the critical period. Gray matter (GM) analyses from the first MRI examination showed a cluster ($k = 303$, suprathreshold voxels) in the left hippocampus (voxel peaks: $x = -34.5$, $y = -15$, $z = -15$). The second and third MRI examinations revealed similar patterns. White matter (WM) analyses showed significant reductions in a large cluster (7,800 voxels) predominantly in the left hemisphere (voxel peaks: $x = -33$, $y = -75$, $z = 1.5$) and a smaller cluster (244 voxels) in the right hemisphere (voxel peaks: $x = 34.5$, $y = 7.5$, $z = 18$) during the first MRI examination. These differences were consistent in the second examination. Six months post-stroke, only one cluster (voxel peaks: $x = -37.5$, $y = -63$, $z = 31.5$) of WM in the left hemisphere survived the statistical threshold. The left hemisphere showed the highest WM volume reductions in regions beneath the middle occipital gyrus, inferior temporal gyrus, middle temporal gyrus, fusiform gyrus, angular gyrus, and supramarginal gyrus. The patient exhibited lower fractional anisotropy (FA) values in all target fiber tracts except for the left uncinate fasciculus (UF), indicating reduced structural integrity. Over the observation period, a gradual decrease in FA values was observed in the arcuate fasciculus (AF), superior longitudinal fasciculus I and II (SLF_I, SLF_II), inferior longitudinal fasciculus (ILF), middle longitudinal fasciculus (MdLF), and UF, suggesting fiber atrophy. In conclusion, this study presents a comprehensive examination of the dynamic evolution of the brain within the critical period of language recovery. Our results emphasize the beneficial effects of intensive language therapy. Neuroimaging results suggest

that disruptions in structural connectivity are a primary cause of aphasia and that fiber pathway degenerations may limit language recovery.

D58 - Functional specificity in multimodal large language models and the human brain

Chengcheng Wang[1], Zhiyu Fan[2], Zaizhu Han[2], Yanchao Bi[2], Jixing Li[1]; [1]City University of Hong Kong, [2]Beijing Normal University

Introduction. Different types of aphasia, such as Broca's and Wernicke's, exhibit specific impairments in language production or comprehension, suggesting that the human language system is composed of distinct subsystems. However, it remains unclear whether similar functional specificity exists in large language models (LLMs), which have demonstrated the ability to simulate various aspects of human language behavior. In this study, we utilized a multimodal LLM to simulate distinct types of aphasic behaviors derived from a picture description task. By selectively disabling layers and attention heads within the model, we investigated whether the lesioned model exhibits behavioral and brain patterns analogous to those observed in different types of aphasia. Methods. We utilized behavioral data and brain lesion maps from different types of aphasia collected at the China Rehabilitation Research Center and Beijing Normal University (Bi et al., 2015; Han et al., 2013). The dataset comprises 88 Chinese aphasic patients (29 females, mean age = 45.7 ± 13.2 years), who suffered from strokes or traumatic brain injuries. Their types of aphasia were diagnosed using a series of behavioral tasks, including the well-known "Cookie Theft" picture-description task from the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983). There are 6 different aphasia types in total, including motor, sensory, conduction, anomia, subcortical and global aphasia. The dataset also consists of 43 healthy controls (21 females, mean age = 49.3 ± 10.7 years). We employed the Visual-Chinese-LLaMa-Alpaca (VisualCLA; Yang et al., 2023), a multimodal LLM, to extract sentence-level embeddings from the transcribed speech of patients during the picture-description task. We then trained two feedforward neural networks (FFNNs) to classify these embeddings according to the corresponding aphasia types and brain lesion maps. To explore functional specificity within the multimodal LLM, we systematically disabled different numbers of layers and attention heads of the model, and prompted the lesioned models to describe the "Cookie Theft" picture. We evaluated the impact of disabling layers and attention heads on the model's output by comparing it to the speech patterns of aphasic patients and normal controls using the BLEU score (Papineni et al., 2002). Additionally, we applied the previously trained FFNNs to predict both the aphasia types and the lesioned brain maps based on outputs from the lesioned models. Results. We demonstrated that layers and attention heads in the multimodal LLM serve distinct functions in the language production task. Specifically, both the BLEU scores and classification results based on outputs from lesioned models suggest that models with a greater number of disabled layers exhibit behavioral patterns similar to multiple aphasia types, including motor, sensory, conduction, and anomia aphasia. In contrast, models with more disabled attention heads only displayed patterns resembling motor aphasia. These results highlight functional specificity within LLMs and provide insights into the underlying mechanisms differentiating various types of aphasia.

D59 - Computational operations of phrasal composition in the brain

Shaonan Wang[1], Songhee Kim[2], Jeffrey Binder[2], Liina Pylkkänen[3]; [1]Institute of Automation Chinese Academy of Sciences, [2]Medical College of Wisconsin, [3]New York University

Specifying the computational operations underlying phrasal composition is crucial for developing neurobiological theories of language. While our understanding of when and where basic phrasal composition affects neural activity has matured in recent years (Pylkkänen, 2019), we still lack detailed computational characterizations. Additionally, research has not yet connected basic composition with theories of distributed semantic features of single concepts (Binder et al, 2016). This work bridges the gap by asking: Are combinatory operations primarily determined by linguistic relations (e.g., Verb+Noun vs. Adj+Noun), experiential features of concepts, or both? Also, what composition operation does the brain use to combine individual features of concepts (e.g., social vs. sensory)? To investigate how the brain selects compositional operations for combining concepts, we used magnetoencephalography (MEG) and human-annotated semantic features with a novel semantic encoding approach. Our stimulus set included 216 phrases across six linguistic relations: ScalarAdj+Noun ("small cake"), IntersectiveAdj+Noun ("green cake"), Verb+Noun ("eat cake"), HasNounNoun ("glitter cake"), ForNounNoun ("birthday cake"), and MadeOfNounNoun ("corn cake"). The 107 component words and phrases were rated by participants for 65 semantic features (Binder et al, 2016). Thirty native English speakers participated in a MEG experiment with a semantic matching task. With the ratings data, we first examined how each feature's phrasal rating is derived from those of words, assuming the following basic composition operations - Addition: (w1 + w2)/2; Multiplication: (w1 × w2)/6; Word1: w1; Word2: w2. Particularly, we calculated the 'composition error' (i.e., predicted rating from the rules – observed rating), which turns out to be mediated by both linguistic relations and semantic features (Wang et al, submitted). Then, using MEG data, we: i) calculated the projection matrix from feature ratings to brain activations using linear regression; ii) generated predicted activations for features combined by one of four composition operations; and iii) identified brain regions and time scales with activations closely matching the predictions via spatiotemporal clustering. Our findings show that composition operations depend on both linguistic relations and semantic features. For instance, intersective Adjective-Noun phrases primarily use additive operations for attention-related features and are influenced by the first word's color attributes. Different brain regions perform distinct functions, all of which together help in creating meaning. For example, when processing a pattern-verb pair, the left medial parietal lobe is inclined towards addition, while the right insular lobe prefers multiplication. This division of labor aids in the understanding of verb-noun phrases. Activation in most feature-relation pairs is rapid, starting at 200ms for 'Word1'

operations—faster than the 300ms onset for 'Word2', indicating immediate semantic processing post-stimulus. Some regions, like the inferior frontal lobe, specialize in specific combinations such as Adjective-Noun, while others show no activation for certain operations. This highlights a distributed and specialized neural architecture for phrase composition, designed to optimize the processing of linguistic relations and experiential features per the demands of specific tasks. This study bridges linguistically guided research on composition and theories of the distributed semantic feature space, suggesting that the neural implementation of composition reflects both abstract linguistics relations and experiential semantic features.

D60 - Differences in White Matter Fiber Density and Fiber-bundle Cross-section in Children who Stutter compared to Controls: a Fixel-based Analysis

Hasini Weerathunge[1], Fiona Höbler[1], Mike Angstadt[1], Andrew Yahn[2], Ho Ming Chow[3], Soo-Eun Chang[1]; [1]Department of Psychiatry, University of Michigan, Ann Arbor, Michigan, United States of America, [2]Functional MRI Laboratory, University of Michigan, Ann Arbor, Michigan, United States of America, [3]Department of Communication Sciences & Disorders, University of Delaware, United States of America

Previous diffusion weighted MRI (DWI) studies in developmental stuttering have reported reduced fractional anisotropy (FA) in speech-related fiber pathways (Chow and Chang 2017; Chang et al., 2015). FA is a surrogate measure of white matter integrity and the most commonly reported measure of white matter microstructure. However, this voxel-averaged quantitative measure is not fiber-specific, and have poor interpretability, especially in brain regions with high probability of multiple fibers crossing at different orientations. These crossing fibers lead to an artificially lower FA value. With regards to children who stutter (CWS), inferior frontal gyrus (IFG) is one such location where FA has been found to be significantly different from age- and sex-matched children who do not stutter (CWNS). Fixel-based analysis is an advanced analysis method that can inform within-voxel microscopic fiber density and macroscopic morphology in a combined manner, while resolving crossing fiber-based variations in diffusion tensor imaging (DTI)-based measurements. In this study, we applied a fixel-based framework to investigate measures of fiber density (FD), fiber-bundle cross-section (FC), and fiber density and cross-section (FDC). We conducted a whole-brain tractography analysis to investigate the white matter structural connectivity differences in CWS compared to age- and sex-matched CWNS. We expected the group differences in fixel-based measures to be consistent with previous findings in white matter morphology studies to provide confirmation and further clarity on potential biological bases of white matter microstructural differences in CWS compared to CWNS. A total of 96 high quality DTI scans from 45 CWS and 51 CWNS between 3 and 10 years of age were retrospectively analyzed for this cross-sectional study. DWI data (Refer to Chow and Chang 2017 for sequence parameters) were processed using MRtrix3 (version RC3; Tournier et al., 2019) according to the fixel-based analysis pipeline provided via MRtrix3 documentation. For fixel-based analysis, tissue-specific response functions for white matter, grey matter, and cerebrospinal fluid were generated using a single-shell multi-tissue response function estimation method (Dhollander et al., 2016, 2018). Multi-tissue constrained spherical deconvolution algorithm (CSD; Tournier et al., 2004, 2007) was used to estimate the orientation of fiber(s) in each voxel. Fixel-based measures were analyzed voxel-wise to examine group differences using a General Linear Model (GLM). The connectivity-based fixel enhancement (CFE) approach was used to generate connectivity-based smoothing and statistical inference at the whole-brain level (Raffelt et al., 2015). Non-parametric permutation tests (5000 iterations) were used to identify differences in the fixel-based measures between CWS and CWNS, and family-wise error (FWE)-correction was applied to generate corrected p values (pFWE < .005). Preliminary results showed that CWS exhibited increased FC relative to CWNS in brain foci previously identified to show FA differences in developmental stuttering, including the bilateral IFG, bilateral motor, right prefrontal, medial premotor and superior cerebellar regions. The FD measure and the combined fiber density cross-section measure however did not show statistically significant differences between the groups. The fixel-based measures provide initial evidence that the nature of the white matte morphology differences observed in stuttering may be related to fiber bundle cross-section variations rather than fiber density.

D61 - Elementalism: a clinical framework for testing the neurobiology of language

T R Williamson[1,2,3,4]; [1]University of the West of England, [2]Southmead Hospital, North Bristol NHS Trust, [3]University of Oxford, [4]University of Southern California

Studying the neurobiology of language has produced a wealth of insights into the features, functions, and dynamics of language-specific systems in the brain (Fedorenko et al., 2024; Matchin & Hickok, 2020). The fruits of these endeavours are clear, illustrating the possibility for non-invasive semantic decoding (Tang et al., 2023), the apparent subcomponents of syntactic abilities (Grodzinsky et al., 2021), and the cross-linguistic patterns of language-related representations in the brain (Malik-Moraleda et al., 2022). This research is invaluable for general characterisations, but it alone provides insufficient grounds to motivate the investigation of the neural substrates of core subcomponents of language within the context of designing neurosurgical language tests. This is because its primary goal is not to (or cannot; Kuchcinski et al., 2015) establish what those core subcomponents are, nor is it to determine precise structure-function relationships of those subcomponents with certain neural parcellations. Knowledge of both of these is essential for the design of tests administered on neuro-oncology patients during awake craniotomy with direct electrical stimulation. While clinical protocols for intraoperative linguistic procedures exist (De Witte et al., 2015), they are not based in contemporary or complete understanding of the neurobiology of language and undertake little pre-clinical validation of location-function claims. Moreover, they presuppose that neurolinguistic explananda are adequately encapsulated by descriptions of linguistic systems suitable for the surface or output level (Luppi et al., 2022), such as in being delimited into natural kinds from behaviour like ‘semantics’, ‘syntax’, etc. that were never designed to engage

the reality of neurocognitive function. This talk proposes 'Elementalism' as an approach to better determine the core subcomponents, or 'elements', of linguistic and cognitive behaviour with associated neural substrates for the purposes of neurosurgical language test design. It starts by rejecting the segmentation of language into components that descriptions of behaviour suggest (semantics, syntax, etc.) as unsuitable for correspondence to the reality of neurological function. Instead, elements should be defined mathematically with respect to their contribution to a particular neuropsychological process, where any element ought to be necessary or probable for that process as determined only through neurostimulation (e.g., TMS or DES) inhibiting that process, which enables psychometric standard-setting for neurosurgical language tasks. Elements and processes together determine the 'minimal competence' required to exhibit a given level of communicative complexity which is modelled in a hierarchy from one-word to discursive utterances that is essential for locating a neuro-oncology patient's idiolectal competence and subsequently selecting tasks appropriate to them. Reviewing literature into the neurobiology of language and neurosurgical language testing enables the prospective identification of possible elements: switching (Sierpowska et al., 2018), retrieval (Damasio et al., 2004), and merge/composition (Chang et al., 2018; Li et al., 2024), which are discussed in the context of ongoing and future research within the Elementalism framework. Concluding remarks are offered tentatively about (a) what other elements may be discoverable, (b) the possibility of Elementalism enabling new avenues for uncovering the neurobiological ontology of language, (c) characterising the kinds of language that impaired, developing, non-human, and artificial cognitive systems have.

D62 - Not just noise: Using aperiodic EEG activity to study listening effort in speech comprehension

Sarah J. Woods[1], Jack W Silcox[1], Brennan R. Payne; [1]University of Utah

Introduction Previously considered artifactual noise, aperiodic neural activity present in EEG has recently been shown to reflect an important and functionally relevant signal that is sensitive to individual differences and cognitive task manipulations. Given this sensitivity of aperiodic activity to cognitive factors, it could serve as neural index of listening effort, or the cognitive resources allocated to accomplish a listening task. In order to assess the potential of aperiodic EEG to index LE in speech comprehension, we conducted secondary analyses of two datasets in which participants listened to speech in quiet or in moderate background noise, shown to induce increases in listening effort. Methods We decomposed EEG power spectra into periodic (i.e., alpha oscillation) and aperiodic EEG (i.e., broadband 1/f spectral slope and offset) activity in young normal-hearing adults (Study 1, N = 31) and then replicated our results in an older adult sample with a variety of levels of hearing acuity ranging from normal hearing to moderate hearing loss (Study 2, N = 48). Participants in both groups listened to a total of 240 sentences with 120 presented in quiet and 120 presented with the addition of +3 dB SNR speech-shaped background noise while continuous EEG was recorded. Procedures for the two studies were nearly identical save three changes to better accommodate the older adult participants. First, older adults were pre-screened with the Montreal Cognitive Assessment. Next, young adult participants were presented with the stimuli binaurally and older adults were presented in their better-hearing ear. Finally, younger adults were presented with the stimuli at a fixed level of 50 dB HL for all participants whereas older adults were presented with the stimuli at a level 40 dB over their personal speech-reception threshold, up to a maximum level of 70 dB HL. Results In both samples, we found the spectral slope and offset to be sensitive to the acoustic challenge manipulation, such that the broadband slope flattened (i.e., decreased) and overall offset decreased with increasing acoustic challenge. In both groups, this aperiodic effect showed a strong pre-frontal distribution. In contrast, whereas aperiodic activity predicted acoustic challenge in both age groups EEG alpha power was only predictive in the younger group. Of note, periodic activity was only significant when accounting for the change in underlying aperiodic activity. Finally, we present how individual differences in age, sex, cognitive functioning and hearing acuity relate to both periodic and aperiodic activity in speech comprehension. Discussion Collectively, our findings suggest that aperiodic neural activity may be an important neural feature to study in effortful speech comprehension. Specifically, we argue that the change in aperiodic activity we observed across both studies may reflect compensatory effort-related shifts in the balance between excitatory and inhibitory synaptic inputs in prefrontal neural circuits, effects that are distinct from previously-reported increases in narrowband parietal alpha activity. These findings have implications for not only for understanding the cognitive processes used while comprehending speech under effortful conditions but also for the processing of EEG data more generally.

D63 - Online Transcranial Magnetic Stimulation Reveals the Dynamic Interaction Between Language Control and Processing in Bilingual Word Production

Junjie Wu[1], Yannan Ji[1], Xinping Pu[1], Qiping Wang[2], Guoli Yan[1], Xin Wang[3]; [1]Tianjin Normal University, Tianjin, China, [2]Beijing Normal University, Beijing, China, [3]Macquarie University, Sydney, Australia

Language production in bilinguals relies on the collaborative interaction of two neural systems — the language control system (e.g., the right inferior frontal gyrus, rIFG) and the language processing system (e.g., the left superior temporal gyrus, lSTG). However, the causal dynamics between these two systems during bilingual language production remain elusive. To explore this, our study applied online transcranial magnetic stimulation (TMS) to the rIFG and lSTG in 21 Chinese-English bilinguals performing a language-switching task. TMS was administered within seven 100-ms time windows (TW1-TW7) following the picture presentation. We observed TW-specific enhancements of language control, evidenced by significant decreases in switching costs relative to sham stimulation. This phenomenon occurred during stimulation of the rIFG in TW1, TW2, TW4, and TW5, and of the lSTG in TW2 and TW5. These findings indicate a double-strike top-down control mechanism underpinned by the pathway from the rIFG to the lSTG, potentially during stages of

the language task schema and the lemma selection. Our study provides the first causal evidence of the dynamic interaction between language control and processing systems during bilingual word production.

D64 - Semantic neighborhood effects with anterior temporal lobe stimulation

Cheng Xiao[1], Sophie Arheix-Parras[1], Karim Johari[2], Nicholas Riccardi[1], Rutvik H. Desai[1]; [1]University of South Carolina, [2]Louisiana State University

Introduction. When processing the meaning of a word, not only are the specific semantic characteristics of the single word retrieved, but the relevant features of its semantic, orthographic, and phonological neighbors are also activated (Buchanan et al., 2001; Carreiras et al., 1997; Yates et al., 2004). Semantic neighborhood effects and especially their neural basis, are not well understood. The present study used HD-tDCS (High-Definition Transcranial Direct Current Stimulation) to investigate the role of the anterior temporal lobe (ATL) in processing both taxonomic and thematic semantic neighborhood distance (SND) in abstract and concrete word processing. Given that in some theories, the temporo-occipital cortex (TOC) is thought to be involved in lexical access (Hickok & Poeppel, 2000, 2004), we also stimulated TOC in a control experiment. Methods. Fifty-four healthy right-handed native English speakers participated in the two experiments targeting the left lateral ATL (28 participants) and left TOC (26 participants). They underwent two separate HD-tDCS sessions (real anodal, sham) that lasted approximately 20 minutes each, on separate days. The stimuli are 304 nouns that included 152 abstract and 152 concrete words based on Brysbaert's (2014) concreteness ratings. Taxonomic SND was defined based on vector embeddings that emphasize taxonomic, as opposed to associative relationships (Reilly & Desai, 2017). Associative (i.e., thematic) SND was defined based on measures from Shaoul and Westbury (2006). There was no correlation between concreteness and SNDs. The stimuli were divided equally into two versions for real and sham sessions, counterbalanced across participants. Participants were instructed to press the 'j' or 'k' keys to indicate whether the word was abstract or concrete for each trial as quickly as possible without making errors. All parameters were identical for both ATL and TOC experiments, except for the stimulation site. The order of stimulation conditions and the key assignments were also counterbalanced across participants. We collected the reaction time (RT) of each participant. Results. ATL experiment: The semantic judgment RT was significantly faster in the sham condition compared to the real condition (β=-78.743, SE=10.418, t=-7.558, p<0.001). A linear mixed-effects regression model revealed a significant interaction of associative SND and stimulation type (β =-332.963, SE=164.396, t=-2.025 p=0.043) while accounting for the other psycholinguistic variables. This indicates that stimulating the ATL increased RT for words with sparse associative neighborhood to a greater extent. A marginal interaction between taxonomic SND and the type of stimulation was found (β=-0.385, SE=0.206, t=-1.863, p=0.063), suggesting a trend similar to that seen with associative SND. TOC experiment: There was no difference between the real and sham conditions (β=13.389, SE=9.565, t=1.400, p=0.162). No significant interaction was observed between stimulation type and either SND (associative SND: β =-6.952, SE=150.241, t=-0.046, p=0.963; taxonomic SND: β= 0.223, SE=0.189, t=1.184, p=0.237). Conclusion. The present study highlighted the effects of associative and taxonomic semantic neighborhood on semantic judgments mediated by the left ATL. These results suggest a role of the ATL in processing words with sparse semantic neighborhoods, but are inconsistent with models that propose ATL as a 'taxonomic hub.'

D65 - Neural Substrates of Action Verb Embodiment in First and Second Language

Jing Yang[1], Siyi Tu[2]; [1]Zhejiang University

There has been increasing neural evidence suggesting that semantic processing in first language (L1) relies on lexical representations grounded in the sensory and motor systems. However, the neural underpinnings of the embodiment of semantic processing in second language (L2) and the distinctions between L1 and L2 embodiment effect, however, remain largely unknown. The current study used functional magnetic resonance imaging to explore the neural substrates of L1 and L2 embodiment in 26 non-proficient Chinese-English bilinguals. Our participants were presented with verb pairs and were asked to make judgments on the semantic relatedness of the two verbs visually presented in a sequence. The unrelated conditions involved three types of verb pairs in both languages: 1) same-effector verb pairs, unrelated (SU, e.g., kick-run); 2) different-effector pairs, unrelated (DU, e.g., kick-grasp); 3) non-effector pairs, unrelated (NU as baseline, e.g., delay-emit). We compared the participants' responses to same-effector verb pairs with those to the different-effector verb pairs, all in the semantic-unrelated trials, in order to look into the neural mechanism of effector-related embodiment. Compared with the performance in the baseline condition NU, participants' responses were significantly faster in DU condition in L1, and in both DU and SU conditions in L2. The fMRI results revealed that, left middle frontal gyrus (MFG), superior/middle temporal gyrus (STG/MTG), inferior parietal lobule (IPL), supplementary motor area (SMA), precentral and postcentral cortex were more activated in the DU condition compared with the NU (baseline) in both L1 and L2, suggesting an active interaction between the representation system (motor regions) and the semantic control system (IFG, MTG, IPL) during verb similarity judgment. DU, compared with SU, displayed greater activation in motor regions (SMA, precentral/postcentral gyrus) in L1, and semantic control regions (MTG, IPL) in L2. Taken together, our findings suggest that, when embodied information facilitates decision, L2 recruits control and representation systems similar to L1 to process embodied words; when embodied information is task-irrelevant, the representation system was less involved in L2 but equally activated L2.

D66 - Cognitive control traits and states modulate lexical competition during word production

Sifan Zhang[1], Keyi Kang[1], Haoyun Zhang[1]; [1]University of Macau

Word production involves monitoring multiple lexical items and selecting the target item (e.g., sofa, couch; Nozari et al., 2016). Previous studies have demonstrated that cognitive control traits (i.e., long-term ability) and states (i.e., short-term status) might facilitate the ability to resolve lexical competition during language comprehension (Hsu et al., 2017; Ness et al., 2023). The current study investigates the influence of cognitive control in competition resolution during word production, using behavioral and fMRI techniques. Neuropsychological testing was administered prior to the MRI session, during which AX-CPT, Flanker and Simon tasks were used to evaluate the participants' cognitive control traits (Braver et al., 2009; Simon & Wolf, 1963). An overall Z score across the three tasks was calculated. During the MRI session, participants performed a picture naming task. The lexical competition was manipulated via name agreement. Compared to higher name agreement items (e.g., a picture of a keyboard only has one proper name), lower name agreement items (e.g., a picture of a wrapped box has multiple alternative names, box, gift, or present) would elicit stronger lexical competition. Cognitive control states were manipulated by a Stroop trial preceding the naming trial. Specifically, conflict Stroop trials ("GREEN" printed in blue) would elicit a higher focused control state compared to non-conflict Stroop trials ("BLUE" printed in blue). A 2 (Control trait, higher vs. lower) × 2 (Control state, higher vs. lower) × 2 (Name agreement, higher vs. lower) mixed design was formed. Behaviorally, pictures with higher name agreement were responded better (i.e., faster response time RT and higher accuracy ACC) compared to pictures with lower name agreement, indicating the interference effect from lexical competition. Neurally, the activation level of the whole brain of participants under the lower name agreement condition was significantly higher than that under the higher name agreement condition (manifested in Inferior Frontal Gyrus, IFG). Additionally, compared to the non-conflict Stroop trials, the conflict Stroop trials (i.e., more focused control states) facilitated the subsequent picture naming performance, reflected by faster RT, yet not reflected in whole-brain activation. In addition to the effects from cognitive control states, participants who exhibited superior control traits (indicated by a lower merged Z-score from three cognitive tasks) demonstrated higher naming accuracy, but also longer reaction times. In addition to the whole brain analyses, we are currently conducting the dynamic causal modeling analysis (DCM, Friston et al., 2019) to estimate the time-varying connections between the regions involved in cognitive progress and word production, under different conditions. Overall, the preliminary results indicated that cognitive control traits and states significantly modulated the lexical competition during word production.

D67 - Dissociating the effects of semantic predictability and plausibility in dynamic environments: A computational trial-by-trial EEG analysis

Meihua Zhao[1,2], Wenjia Zhang[3], Qi Chen[4], Suiping Wang[1,2]; [1]South China Normal University, Guangzhou, China., [2]Philosophy and Social Science Laboratory of Reading and Development in Children and Adolescents (South China Normal University), Ministry of Education, Guangzhou, China., [3]Xi’an International Studies University, Xi’an, China., [4]Shenzhen University, Shenzhen, China.

Environmental statistical structures play a significant role in language prediction processing. Previous sentence comprehension studies have found the larger N400 effect in higher global predictive validity blocks, suggesting the top-down prediction strategy is reinforced. However, the N400 is not a direct index of a lexical prediction, also reflect prediction violation and bottom-up prediction error correction. It remains an ongoing debate how Environments influence semantic prediction. Furthermore, no study has contrasted how the statistical structures of environments influence two distinct semantic predictability and plausibility processing. Here, we addressed these issues by conducting a comprehensive trial-by-trial computational modeling analysis of EEG data. We first employed a normative Hierarchical Gaussian Filter (HGF) model to simulate individual learning trajectories in an uncertain and dynamic environment. Then, we performed generalized linear regression (GLM) analyses to clarify the association between single-trial EEG signals (ERPs and time frequencies) and model parameters. We observed that the N400 component was associated with 2nd-level belief during sentence predictability processing. In contrast, the P600 component was linked to 2nd-level belief in plausibility processing. Additionally, the gamma-band (30-40Hz) was influenced by 2nd-level belief in both semantic processing. Specifically, in plausibility processing gamma-band was modulated by 2nd-level precision weighted prediction error (pwPE). Together, these findings indicated dissociation neural effects underlying the processing of predictability and plausibility in dynamic environments, with prediction-driven strategy in predictability processing, but prediction error-driven mechanisms in plausibility processing. Our computational modeling study goes beyond classical ERP analyses, highlighting the hierarchy and flexibility of prediction mechanisms in sentence comprehension in dynamic environments.

D68 - Neural Substrates and Functional Connectivity for Chinese Character Processing in Children

Wen-Wen Zhuang[1,2], Yu-Qian Hu[2], Li-Hai Tan[1,2,3]; [1]College of Life Science and Technology, Jinan University, Guangzhou, China, [2]Center for Language and Brain, Shenzhen Institute of Neuroscience (SION), Shenzhen, China, [3]Neuroscience and Neurorehabilitation Institute, University of Health and Rehabilitation Sciences, Qingdao, Shandong, P.R. China

Introduction: Chinese characters are complex logographs with multiple strokes, demanding specialized visual perception processes for orthographic analyses. It is known that the link between V1 and the left middle frontal cortex plays a crucial role in children's reading development[1]. However, it remains unclear whether the left middle frontal gyrus is connected to the visual word form area (VWFA) during children's orthographic judgment. Therefore, it is essential to clarify the role of visual perception in Chinese orthographic processing. Methods: Forty-seven native Chinese children (27 males, 20 females, 6.5-11.58 years) participated in the Chinese and Korean component search tasks to judge whether characters contained the '口'

component. Additionally, they fixate on a central crosshair serving as the baseline. Recorded performances indicated comparable task difficulty. Individual activation t-maps were generated using the general linear model based on preprocessed fMRI data. To analyze the main effect of the two tasks, one-sample t-tests were performed by contrasting each task with the baseline. Besides, hierarchical subtraction identified differential orthographic processing (P<0.05, FDR corrected). Regions of interest (ROIs) were extracted by intersecting the activation maps with the Brodmann map. The time series was then extracted to construct connectivity matrices for each task utilizing a correlation analysis approach. Finally, paired t-tests (FDR, P<0.05) were used to identify significant changes in connectivity across different task conditions. Results: Chinese orthographic processing engages a network spanning frontal, temporal, and occipital lobes. Activation areas were selected from the activation map as ROIs, including the bilateral middle frontal gyrus (BAs 9/46)[2], left inferior frontal gyrus (BAs 44/45), bilateral middle temporal gyrus (BA21)[3], bilateral primary visual cortex (V1, BA17)[1], and VWFA (BA37)[4]. Paired t-tests on the functional connectivity revealed that the Chinese component search task showed significantly increased connectivity between the left BA46 and both the left BA17 and BA37, and between the right BA46 and the right BA9. In the Korean component search task, significant increases in connectivity were observed between the left BA37 and both the left BA21 and the left BA37, and between the right BA37 and the right BA21. Conclusion: The connectivity index offers deeper insights into the orthographic networks, highlighting brain connectivity during Chinese orthographic processing. The results revealed the left middle frontal gyrus exhibits crucial connections with V1 and VWFA during Chinese orthography, indicating that the left middle frontal gyrus plays a crucial role in Chinese orthography beyond its traditional visual processing functions. Reference 1. Yang, X., et al., Failure of resting-state frontal-occipital connectivity in linking visual perception with reading fluency in Chinese children with developmental dyslexia. Neuroimage, 2021. 233: p. 117911. 2. Tan, L.H., et al., The neural system underlying Chinese logograph reading. Neuroimage, 2001. 13(5): p. 836-46. 3. Yan, X., et al., Convergent and divergent brain structural and functional abnormalities associated with developmental dyslexia. Elife, 2021. 10. 4. Cohen, L., et al., The visual word form area: spatial and temporal characterization of an initial stage of reading in normal subjects and posterior split-brain patients. Brain, 2000. 123 (Pt 2): p. 291-307.

D69 - The Language of Thought is not Language: Evidence from Formal Induction

Hope Kean[1], Alexander Fung[1], Paris Jaggers*[2], Joshua Rule[3], Yael Benn[4], Joshua Tenenbaum[1], Steve Piantadosi[3], Rosemary Varley[2], Evelina Fedorenko[1]; [1]MIT, [2]UCL, [3]UC Berkeley, [4]Manchester Metropolitan University*

The human capacity for inductive reasoning lies at the heart of our ability to learn and think about the world around us, as well as engage in formal thought (e.g., mathematical reasoning). The format of the mental representations that mediate thought remains debated: thoughts can be expressed symbolically, schematically, diagrammatically, in mathematical expressions, but can also be cast into a linguistic format. According to one popular hypothesis about the representational format of thoughts—the “language of thought” (LOT) hypothesis (Fodor, 1975)—thoughts are built out of smaller atomic pieces, just like programs are built out of a small collection of operations, or sentences are built out of words. Some have further explicitly argued that the language of thought is natural language (Chomsky, 1993, 1995; Davidson, 1967, 1975; Dennett, 1991, 1996, 2017; for earlier claims, see Wittgenstein, 1921). We here challenge this claim using a combination of neuroimaging and behavioral investigations of patients with aphasia. In both studies, we use a formal rule induction paradigm (Rule et al., 2024). Participants are presented with an input number list and told what the output list looks like (e.g., 1 4 7 → 7 4 1); their task is to infer the underlying transformation rule. They can then test their hypothesis on a new input list, until they guess the correct rule. The rules can involve a combination of mathematical, list, and structural operations, and require some formal representation (in e.g. first-order logic or lambda calculus) to solve. In Experiment 1, we measured healthy adults’ brain responses using fMRI while they performed the rule induction task; in the control condition, participants were told what the rule was and simply had to apply it to the input list. The response in the language brain areas (Fedorenko et al., 2024) during the critical rule induction condition were low, close to the low-level baseline. Instead, another system—the Multiple Demand system (Duncan et al., 2020)—showed robust responses to the rule induction task, and stronger responses during the induction, compared to the application, condition. Thus, the language areas in healthy adults are not engaged much during formal rule induction. Next, in Experiment 2, we asked whether the rule induction task can be performed without the language system by testing two individuals with global aphasia. These participants have sustained massive damage to the Perisylvian language cortex and display severe language difficulties in both comprehension and production. In spite of this severe linguistic impairment, one participant (age=50) performed better than a control group of n=40 age-matched participants on the rule induction task, and the other (age=78) performed similarly to the controls. Moreover, both participants with aphasia were able to nonverbally communicate (with symbols, numbers, and gestures) a subset of the rules which they had inferred. Overall, our results demonstrate that the left-lateralized fronto-temporal language network is not significantly engaged in and not necessary for the induction of formal rules, thus falsifying the variant of the LOT hypothesis, whereby natural language is the medium of thinking and reasoning.

D70 - Capturing Invariant Neural Processes for Aphasia Rehabilitation Using Transfer Learning and Group Dynamics

Aditya Singh[1], Tessy Thomas[1], Nitin Tandon[1]; [1]UT Health

Recent advancements in neural recording technologies have revolutionized language neurobiology and motor speech, enabling brain-computer interfaces (BCI) that restore speech functions. However, real-time speech decoding models, customized to individual data from the intact sensorimotor

cortex, struggle to generalize, particularly for aphasia patients with disrupted language networks. To address this, we developed deep learning models capable of integrating information across patients, tasks, and anatomical constraints. This approach allows us to use transfer learning techniques to enhance individual patient data performance by leveraging a healthy cohort's dataset with better coverage, more training data, and intact motor-speech networks. To prove the reliability of this deep learning architecture, we aimed to robustly predict target words for a single-word naming production task in an aphasic patient with extensive sensorimotor lesions and dysfluent speech. We trained a seq2seq phoneme decoder on sEEG broadband gamma activity from variable electrode coverage constrained by clinical epilepsy monitoring and compared it to a word-level SVM classifier. Tested on utterances of single words with at most 3 phonemic errors during articulation, the phonemic decoder achieved 67% word decoding accuracy, comparable ($p=0.21$) to human observer performance at 74% for predicting the correct word based on hearing the patient's overt speech. The SVM word classifier was significantly worse at 49% accuracy ($p<0.05$), with chance performance being 12% accuracy. Additionally, the seq2seq model could predict words held out from the training set at 35% accuracy by reconstructing held-out words at the phonemic level, a feat impossible for a word-based classifier. We developed a group variant of the seq2seq model, simultaneously training a shared recurrent layer on neural datasets from six individuals with normal language functions and dense sensorimotor cortex coverage. We then leveraged transfer learning techniques to bridge these learned shared latent dynamics into the decoder for the aphasic patient. Pre-articulatory word decoding performance was significantly improved using this technique ($p<0.05$) compared to training solely on the patient's dataset. However, the most significant improvement in decoding performance was for trials where the patient could not respond, wherein by utilizing this group-level pre-trained recurrent layer fine-tuned to the subject's own dataset, we achieved a 20% performance increase in decoding the semantically cued target word. Here, we show the ability to retain a latent feature space through subject-invariant pre-training that can be fine-tuned for datasets with limited information. By leveraging multi-site, multi-subject cortical activity, models are initialized on a flexible set of neural codes, improving performance for patients with dysfunctional language networks or brain lesions and offering a robust approach to creating a neural state shunt for speech rehabilitation. This comprehensive methodology not only advances BCI design and neural decoding techniques but also has profound implications for how we understand the neurobiology of language, how to capture invariant neural processes at a single trial level for group models, and how to translate these scientific findings to give a patient the ability to talk fluently again.