Doctoral Dissertation Defense Announcement

“An Experiential Account of Semantic Category Organization in the Brain”

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Date: Friday, May 24th, 2024
Time: 10:00 AM (CST)
Defense Location: Bolger Auditorium (H1400)

Zoom: https://mcw-edu.zoom.us/j/93970319709?pwd=M1h5SVQ4Y3BkeFR2UktuWYVYrdhoZz09
Meeting ID: 939 7031 9709 Passcode: Semantic
Graduate Studies:
Cognitive Neuroscience
Medical Genetics: Undiagnosed and Rare Disease
Introduction to Precision Medicine
Foundations of Public Health
Artificial Intelligence (at UWM)
Functional MRI Contrast Mechanisms
Nuclear Magnetic Resonance
Ethics and Integrity in Science
Research Ethics Discussion Series
Biophysics Journal Club
Biophysics Seminar Course
Reading and Research
Doctoral Dissertation
There have been extensive efforts to understand how concepts are represented in the brain. One phenomenon that has received much attention is the loss of knowledge seemingly restricted to a single category of items. This clinical observation, combined with many functional magnetic resonance imaging studies that find differential activation across the cortex depending on the category of the stimuli, has led to a general view of category related functional organization across the cortex. One class of models put forward to explain this phenomenon are experiential models of cognition. These models posit that those regions of the cortex involved in experiencing an object (e.g., perceiving an object) are also involved in representing semantic knowledge about the object. The idea that some perceptual, or experiential, information (e.g., color, sound, shape, touch, etc.) is differentially important across categories of concepts, combined with the well accepted view that some regions of the brain preferentially process a particular type of perceptual information, has long been held as a potential explanation for the category related organization of the cortex. However, while this hypothesis has motivated the development of several models of semantic cognition, the ability of a specific experiential model to explain category related organization of the cortex has hitherto not been explicitly examined. Experiential models, like the one examined in this dissertation, propose that, ultimately, all semantic knowledge is grounded in what is experienced.

This dissertation first describes and validates a dataset that is well suited for addressing some of the core predictions of experiential models of cognition. Following data validation, evidence for the categorical organization of the semantic system was found via both univariate and multivariate analysis. Then, encoding models constructed for each point on the cortical surface demonstrated that experiential features can be used to predict both activation category contrasts, as well as activation patterns for individual stimuli across categorical boundaries. It was further observed that the ability of a comparable non-experiential semantic model to generalize across categories is accomplished using the same information that is in the experiential model.

The subsequent chapter examines a relatively understudied yet distinctly represented category of concepts: body parts. We found that a robust network of regions was significantly more involved in the representation of body part concepts compared to concepts from other concrete object noun categories. The implicated set of areas was shown to be predicted by experiential features using several analysis techniques. The distribution of involved regions also provides possible insight as to why semantic representations of body part concepts are often spared relative to concepts from other categories.
Lastly, feature sensitivity maps across the cortex were generated for a set of 14 experiential features. These maps were observed to hierarchically converge as the distance from canonical primary sensory cortices increased. The maps are also individually discussed with reference to prior literature. Results were mixed with regard to how well individual feature maps matched expectations derived from prior literature, and possible reasons for this are discussed.

Taken together, the results of this dissertation offer strong support for many of the core predictions of an experiential account of concept representation.
Stephen Mazurchuk  
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**Education**

2019 – present  
Ph.D. Candidate  
Medical College of Wisconsin, Department of Biophysics  
Advisor: Jeffrey R. Binder, M.D.

2017 – 2019  
Medical Student (M1-M2)  
Medical College of Wisconsin, Medical Scientist Training Program

2013 – 2017  
B.S. in Biomedical Engineering  
SUNY Buffalo

**Research Experience**

2019 - Present  
Doctoral Student  
Medical College of Wisconsin, Department of Biophysics  
Advisor: Jeffrey R. Binder

2015 – 2016  
Funded Summer Researcher (2 years)  
University of Wisconsin – Milwaukee, Department of Physics  
Advisor: Peter Schwander, PhD

2014  
Summer Research  
University at Buffalo, Department of Biomedical Engineering  
Advisor: Jonathan Lovell, PhD

**Publications**


Abstracts

Mazurchuk S, Conant LL, Binder JR, Fernandino L. Artifact concepts are more reliably represented than animal concepts across the cortex. Poster at: Society for the Neurobiology of Language; 2023


Mazurchuk S, Fernandino L, Tong JQ, Conant L, Binder J. Experiential and Taxonomic Semantic Representations in the Cerebellum. Poster at: MCW Graduate Student Symposium. 2022; Virtual


Mazurchuk S, Fernandino L, Tong JQ, Conant L, Binder J. An Experiential Basis for Posterior Middle Temporal Gyrus Body Part Concept Representation. Poster at: Cognitive Neuroscience Society. 2022 Jun 1; San Francisco, CA

Tong J, Binder J, Mazurchuk S, Humphries C, Conant L, Fernandino L. Event associated experiential features are involved in event representation at brain
regions preferentially representing event concepts. Poster at: Society for the Neurobiology of Language; 2021 Oct 1; Virtual


Leadership Development

2021 – 2023 Biophysics graduate student representative
2020 – present MD-PhD Student Interviewer

Community Involvement

2018 – present Volunteer – Kinship Community Food Center
2022 – present Volunteer – UPLIFT Teens
2021 – present Volunteer – MCW BrainExpo
2020 STEP-UP – MCAT Tutor
2017 – 2018 Volunteer – Saturday clinic for the uninsured
2017 – 2018 Volunteer – Greater Milwaukee Free Clinic