

Representational Similarity Analysis of the Neural Codes in Word Reading

Deanne Tak On Wah¹ (dwah@uwo.ca), Marc Joanisse^{1,2}

¹ Department of Psychology, University of Western Ontario, London, Canada,

² Haskins Laboratories, New Haven CT, USA



Western
Centre for Brain
and Mind



NSERC
CRSNG



Introduction

- Contemporary models of word reading suggest two distinct neural pathways:
 - Dorsal-route decoding pathway** from orthography to phonology to semantics (O-P-S)
 - Ventral-route whole word pathway** from orthography to semantics (O-S)¹
- O-S cues in words are more reliable when decoding O-P information is unreliable²
- Adult skilled readers may rely more on a ventral pathway, reflecting O-S processing, than a dorsal-route decoding pathway¹
- Individuals differ in their degree of sensitivity to O-S information (i.e., imageability), which may be related to neural representations³
- Here we investigate how these neural codes are represented in the reading brain using representational similarity analysis and whether individual differences in the strength of O-S representations predict sensitivity to imageability

Methods

Participants

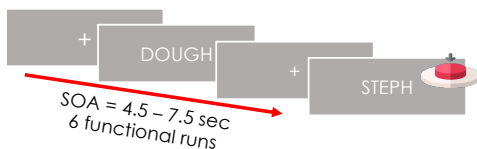
- Age: 29.2 ± 13.6 (range: 18 – 67)
- N = 50; F = 33, M = 15, NB = 1

Session 1: Behavioural Session

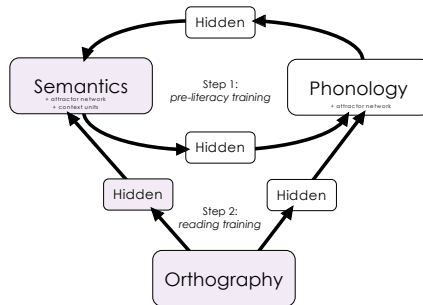
- Demographics & Language History Questionnaire
- Word Naming Task: 464 monosyllabic words controlled on sub-lexical dimensions
- Standardized Reading Measures

Session 2: Neuroimaging Session

- Silent Word Reading Task (232 words) and Name Detection
- Fast jittered event-related design

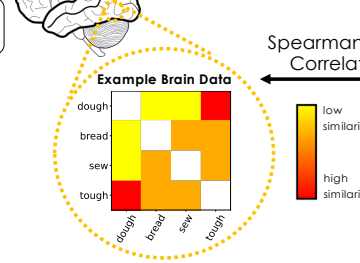


Connectionist Model⁴



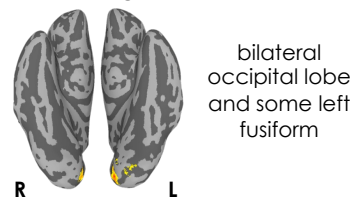
Representational Similarity Analysis: Searchlight Analysis⁵

fMRI Beta Weight Vectors per Word

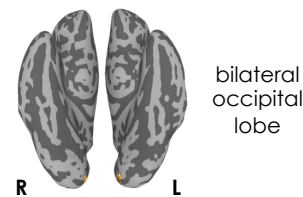


Searchlight Model Fit Analysis

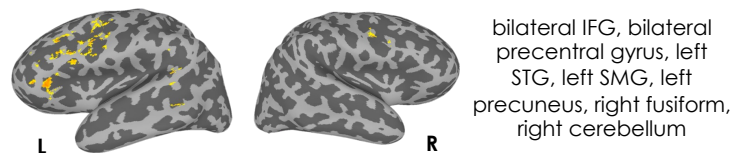
Orthographic Similarity



O-S Similarity

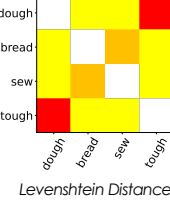


Semantic Similarity

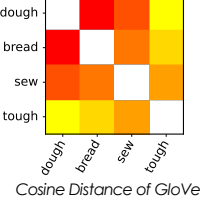


Example Theoretical Models word x word representational dissimilarity matrices

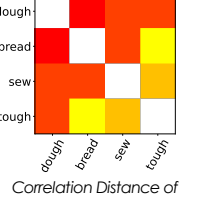
Orthographic Model



GloVe Semantic Model

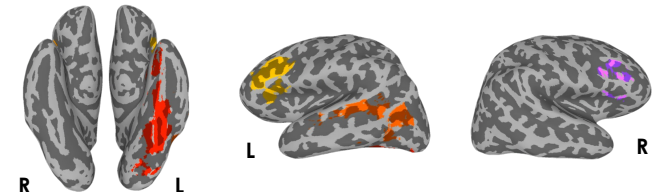


OS Model



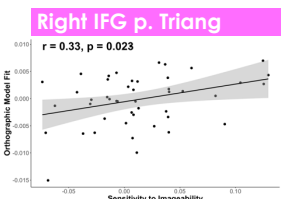
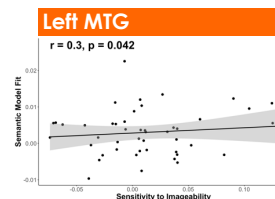
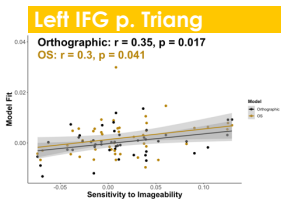
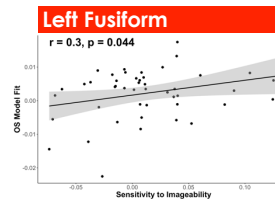
Individual Differences Analysis

Functional Regions of Interest



Sensitivity to Imageability Effects

individual measure of how word imageability affects naming speed



Summary

- Semantic representations follow left hemisphere dominant distributed network, while O-S processing follows a ventral sight recognition pathway
- Evidence for top-down O-S predictive influences in occipital lobe
- Stronger semantic and O-S representations in ventral stream regions (i.e., left Fusiform, left MTG, left IFG pars triangularis) were related to greater sensitivity to imageability
- Contributions to the growing literature using multivariate neuroimaging analysis techniques to address component processes of reading

References

- Pugh, K. R., (2000). Functional neuroimaging studies of reading and reading disability (developmental dyslexia)
- Strain, E., Patterson, K., & Seidenberg, M. S. (1995). Semantic Effects in Single-Word Naming
- Graves, W. W., et al. (2014). Anatomy is strategy: Skilled reading differences associated with structural connectivity differences in the reading network.
- Chang, Y.-H., & Monaghan, P. (2019). Quantity and Diversity of Preliteracy Language Exposure Both Affect Literacy Development: Evidence from a Computational Model of Reading
- Kriegeskorte, N., Mur, M., & Bandettini, P. (2008). Representational similarity analysis—Connecting the branches of systems neuroscience