Representational Similarity Analysis of the Neural Representations of Orthographic-Phonologic and Orthographic-Semantic Mappings Across Development: A Proposal

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Introduction

- Children show lower activation of left inferior frontal gyrus and left angular gyrus compared with adults on tasks that map orthography (O) to phonology (P).[1]
- Taking a decoding approach (O → P) in reading contributes more to reading success than a semantic (S) whole word approach (O → S), as observed in children with reading disabilities.[2]
- Using Representational Similarity Analysis (RSA) and a pre-trained Artificial Neural Network (ANN), we can compare brain data with models of outside the brain.[3]

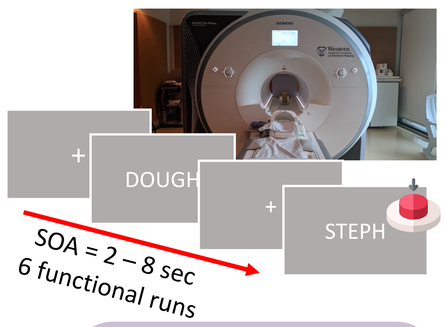
Research Questions:

1. Using univariate and searchlight analyses, can we identify brain regions in which O, P, S, O-P mappings, and O-S mappings are represented within the brain?
2. Using RSA, how do individual differences in reading skill (children vs. adults) impact the strength of O, P, S, O-P, and O-S representations within each ROI?

Methods

Participants:

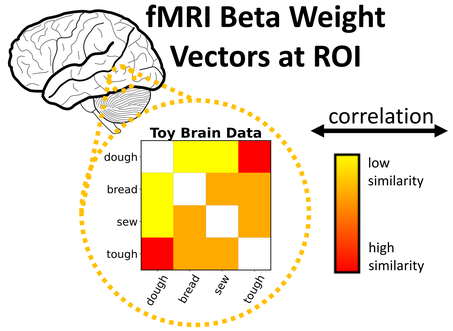
- Adults (N = 50)
- Children (N = 50)
- Monolingual English
- Neurologically healthy



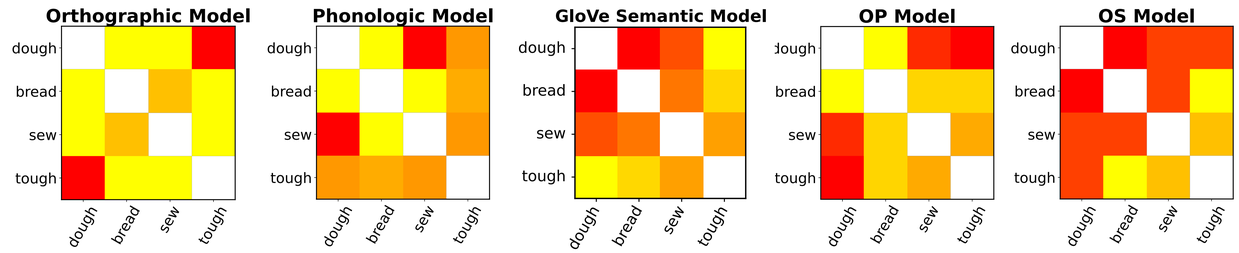
Session 1:
Behavioural Task
- Word Naming Task: 464 monosyllabic words controlled on sub-lexical dimensions[4]
- Standardized Reading Measures

Session 2:
Neuroimaging Task
- Fast jittered event-related design
- Silent Word Reading Task and Name Detection

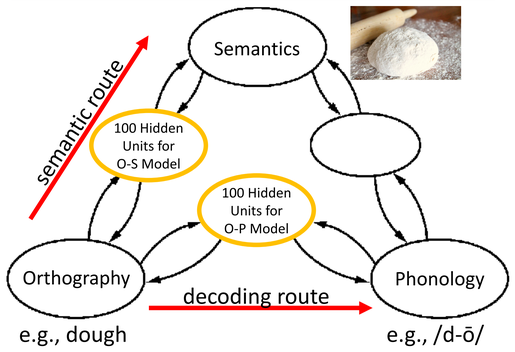
Representational Similarity Analysis



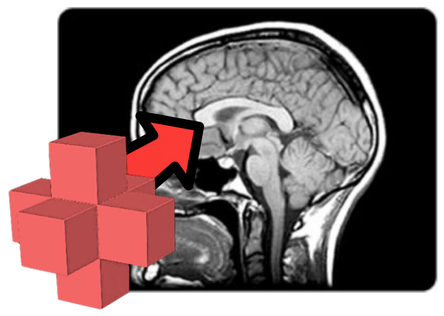
Toy Models: word x word representational dissimilarity matrices



Using Hidden Units of a Pre-trained ANN[4]

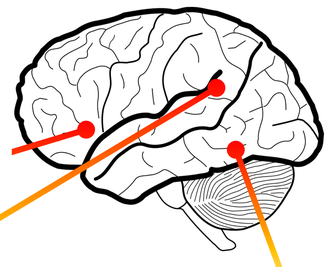


Searchlight Analysis



Predicted Results

- Children may show lower similarity to O and O-P models than adults in lIFG.
- Children may show greater similarity to S and O-S models than adults in lAG and lvOT.
- Strength of correlations between brain activity and models reflect reading skill.



Implications

- Combining machine learning with fMRI research opens doors to using more powerful research techniques to study the neuroscience of reading.
- Examines relationship between strength of neural representations of reading processes on reading skill and development.
- Maps brain regions for O, P, S, and specifically O-P and O-S processing – a challenging intermediate process to map using typical neuroimaging techniques.

References & Acknowledgements

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NSERC CRSNG