Intergenerational Transmission of Functional Connectivity Profiles in Isolated Reading and Math Networks:

A Scoping Review and Study Proposal

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Scoping Review

Definitions:

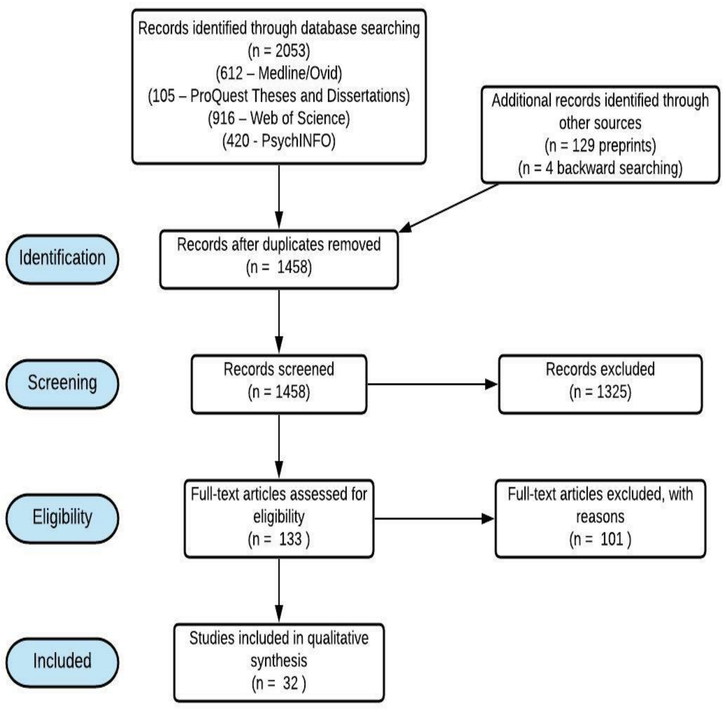
- **Scoping Review:** method to determine the scope of the body of literature on a topic
- **Resting State:** measuring brain activity while awake, but at rest
- **Functional Connectivity:** a procedure which can identify temporally correlated spatially distinct neurophysiological events

Why Resting State?

- During rest, the brain is active
- Resting state functional connectivity (rsFC) displays how different parts of the brain interact at rest, indicating long-term developmental trends
- Temporal correlations indicate to some degree, shared activity profiles
- These trends can be analyzed to better understand math processing in individuals

How does the resting brain contribute to the study of mathematical thinking?

- Direct observation of neural mechanisms
- How distinct brain regions work together to partake in math processing through temporal correlations
- Predicting networks involved in mathematical thinking
- Contributing to the study of math learning disabilities at the neurobiological level



Introduction

- **Intergenerational Transmission (IT):** transfer of personal values, abilities, behaviours, and traits, from parents to children
- Studying IT can help us understand the transfer of personal traits, including both cultural and genetic factors
- Both reading and math ability are highly heritable ($r = 0.65$)[1] in early school age, but the origins of this shared academic ability are not fully understood
- We will use *rsFC* to assess IT of neural development related to reading and math at the neurobiological level.
- Parents and Children: Measuring Academic skills using Neuroimaging; a study dedicated to understanding how parents' math and reading skills influence children's skills using brain imaging
- **Parent-Child Dyad:** biological parent and child pairing

Using whole-brain rsFC analysis, is it possible to identify parent-child dyads accurately on the basis of their reading and math-related networks?

Methods

Sample

Mother-child dyads with children aged from 10-14 years old

- N = 102
- 55 children, 47 mothers
- 47 families

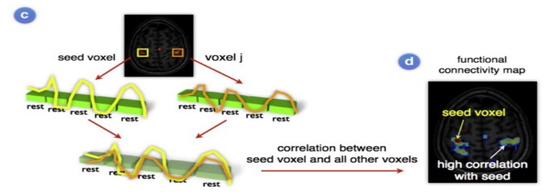
To Analyze Math Networks

ROIs: left inferior and superior parietal lobule and precuneus, right inferior parietal lobule and precuneus, left inferior and middle frontal gyrus, left superior frontal gyrus, left insula, right insula, right middle frontal gyrus, left middle frontal gyrus, right middle frontal gyrus.

To Analyze Reading Networks

ROIs: left fusiform gyrus, left precentral gyrus, left middle frontal gyrus, left superior temporal gyrus, left precuneus, bilateral inferior frontal gyri, left inferior occipital gyrus, left medial frontal gyrus and right superior parietal lobule.

How resting-state fMRI data is collected and analyzed:



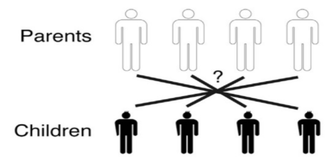
Is it possible?

If YES:

- Neurobiological substrates of IT can contribute to understanding how traits transfer between parents and children
- Brain network similarity is indicative of trait transfer across generations

If NO:

- Neurobiological substrates do not support IT as much as previously thought
- Parent brain networks are not predictive of children's brain networks with regards to math and reading



Takagi et al., 2021

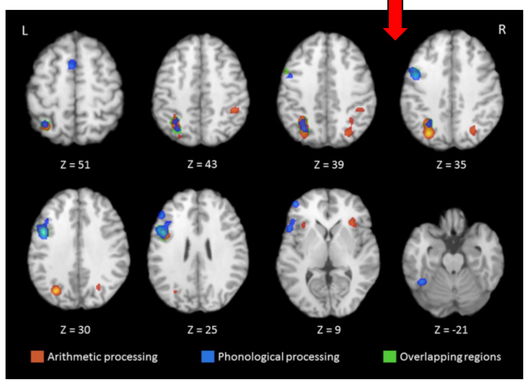
Analytical Approach and Predicted Results

1. Establish math and reading related networks

These networks have been isolated based on existing literature and meta-analyses

2. Seed region selection

The purpose of the seed region selection is to construct whole-brain rsFC maps



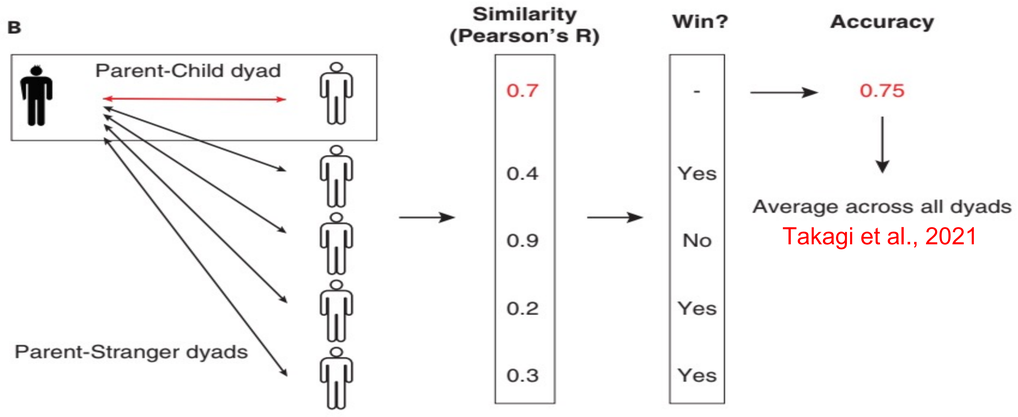
Pollack & Ashby, 2018

3. Compute rsFC profiles for each participant

rsFC raw data from each participant will be used to compute a rsFC profile. Each voxel representing a Pearson's R Correlation value

4. Assess the parent-child dyad relationship.

"Are rsFC maps more predictive of the parent-child dyad relationship, than the random adult-child pairing relationships?



References

1. Kovas, Y., Voronin, I., Kaydalov, A., Malykh, S. B., Dale, P. S., & Plomin, R. (2013). Literacy and numeracy are more heritable than intelligence in primary school. *Psychological science*, *24*(10), 2048-2056. 2. Pollack, C., & Ashby, N. C. (2018). Where arithmetic and phonology meet: The meta-analytic convergence of arithmetic and phonological processing in the brain. *Developmental cognitive neuroscience*, *30*, 251-264. 3. Takagi, Y., Okada, N., Ando, S., Yahata, N., Morita, K., Koshiyama, D., ... & Tanaka, S. C. (2021). Intergenerational transmission of the patterns of functional and structural brain networks. *iScience*, 102708.