Functional connectivity patterns of the visual word form area are stable during learning

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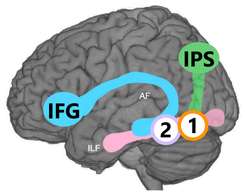
Introduction

- Reading depends on specialized circuitry in the visual cortex, the Visual Word Form Area (VWFA).
- Subregions of the VWFA have distinct functional and structural properties (White et al., 2019; Caffarra et al., 2021):
  - **VWFA-1** is sensitive to visual features.
  - **VWFA-2** processes higher level language information



Caffarra et al., BSAF 2021

- We recently found that VWFA-1 and VWFA-2 show distinct *functional connectivity* patterns with visual attention and language networks in children and adults. These patterns were not associated with reading ability in a large, *cross-sectional* sample (Yablonski et al., *BioRxiv*).

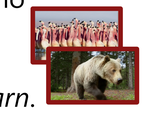
Do these connectivity patterns manifest in the brains of children with dyslexia?

Do these patterns change with reading improvement?

Longitudinal intervention study

Participants: Children with dyslexia (N=27, 8-13y old) participated in an intensive 8-week reading intervention program. They completed reading assessments and functional MRI scans before the intervention, and at multiple follow up timepoints. Here we present data acquired 4 months after completing the intervention.

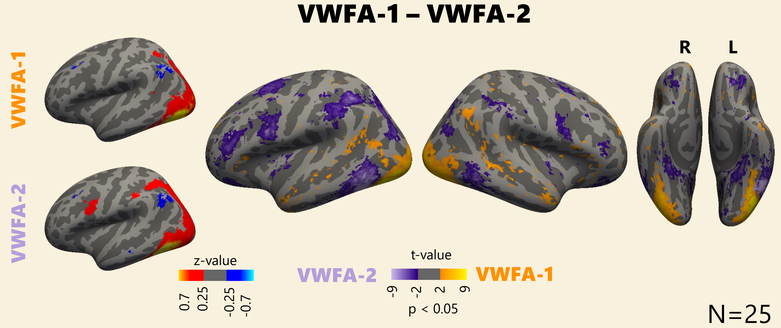
Functional scan: Children watched two 5min nature movies (no language content). TR/TE= 820/30ms; Voxel size= 2.4mm isotropic, 750 volumes.
Data were preprocessed with *fmriprep* and analyzed with *nilearn*.



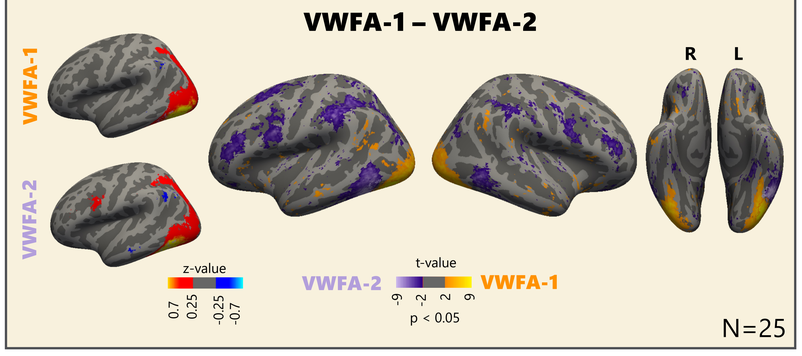
Analysis: We used VWFA-1 and VWFA-2 as seeds for whole-brain functional connectivity analysis. We compared connectivity maps using paired t-tests across subjects. We followed with ROI-to-ROI correlation analysis to assess the connectivity strength between ventral visual ROIs and frontal language regions using LME models.

VWFA-1 and VWFA-2 show distinct patterns of functional connectivity

Before the intervention

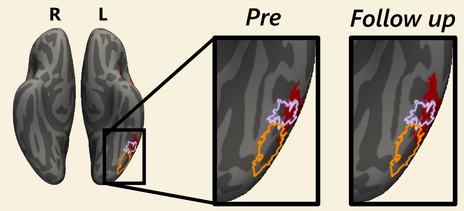


≈ *After the intervention*

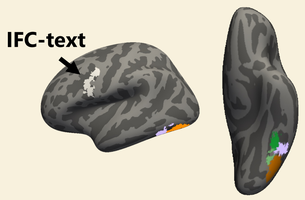


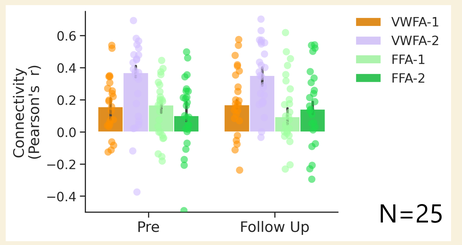
Frontal text-selective regions are strongly correlated with VWFA-2

Connectivity maps of a frontal text-selective ROI overlap with VWFA-2 both before and after the intervention

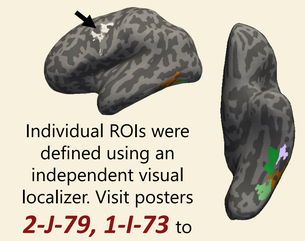


Using template ROIs
(Kubota et al., 2022)

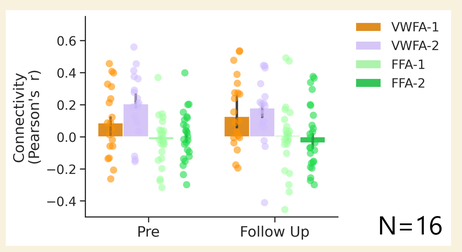




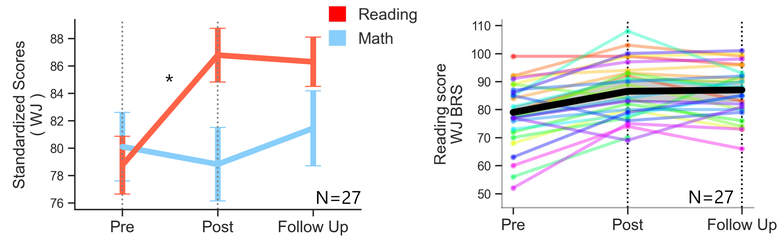
Using individual ROIs



Individual ROIs were defined using an independent visual localizer. Visit posters ***2-J-79, 1-I-73*** to learn more!



Intervention drives specific reading improvement



Following the intervention standard reading scores increased by 8 points on average (t=10.2, p<0.0001), while math scores decreased (t=-2.6, p=0.009).

Discussion

- **Adjacent VWFA subregions are functionally coupled with distinct networks:**
  - VWFA-2 is strongly correlated with frontal language regions.
  - Frontal text-selective regions are uniquely correlated with **VWFA-2**, compared with VWFA-1 and face-selective regions.
- **These patterns remain stable over a time period of 6 months** and did not change with reading improvement. This replicates our prior cross-sectional findings (Yablonski et al., *BioRxiv*) in a longitudinal sample of children with dyslexia.
- We suggest that this functional organization is an intrinsic stable property of the ventral visual cortex.
- *More data coming soon!*

References

1. White et al. (2019). Parallel spatial channels converge at a bottleneck in anterior word-selective cortex. *PNAS*
2. Caffarra et al. (2021). Anatomy and physiology of word-selective visual cortex: from visual features to lexical processing. *BSAF*
3. Kubota et al. (2022) White matter connections of high-level visual areas predict cytoarchitecture better than category-selectivity in childhood, but not adulthood. *Cerebral Cortex*
4. Yablonski et al. (under review) The transition from vision to language: distinct patterns of functional connectivity for subregions of the visual word form area. *BioRxiv*

Acknowledgements

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