654.27

The functional connectomics underlying dyslexic adaptation deficits

David E. Osher, Zeynep M. Saygin, Tyler Perrachione, John D. E. Gabrieli
McGovern Institute for Brain Research and Department of Brain and Cognitive Sciences, MIT

BACKGROUND

- Dyslexia has recently been characterized by weak adaptive responses to written text, among other stimulus categories, which suggests a deficient ability to take advantage of consistent, predictable information to enhance perception. This could lead to impaired perceptual learning of phonological and orthographic categories across development and ultimately to disadvantaged reading abilities.
- Structural connectivity is among the most important constraints on a network, since it defines the domains of information that can be processed; as such, the magnitude of adaptation to high-level perceptual categories such as words is likely constrained by the structural properties of perceptual networks in cortex.
- We examined the predictive connectivity fingerprints of brain regions that showed lower adaptation responses in dyslexic as compared to typical readers.

METHODS

- Diffusion-weighted images were acquired from 26 typically reading controls and 22 participants with dyslexia (EPI: 74 slices, isotropic along 30 directions, b-value 700s/mm^2). Automated cortical & subcortical parcellation was performed on each subject's T1 scan using Freesurfer. This defined 167 regions, which were then registered to each subject's DWI. Probabilistic tractography was carried out using FSL-FDT with 5000 streamline samples, from each region to all other regions.
- We also acquired adaptation responses in fMRI BOLD signal to blocks of repeated stimuli and registered these functional images to each subject's DWI (Fig. 1).
- For each region, we modeled the adapted BOLD responses as a function of connection probability using a GLM, in which connectivity differences between the groups were explored with respect to function.

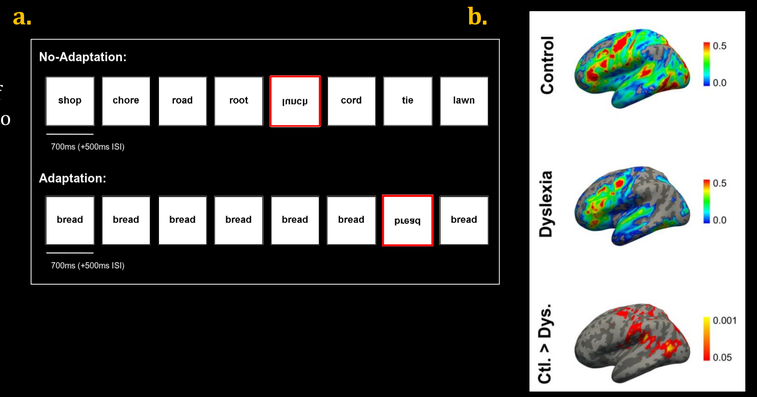
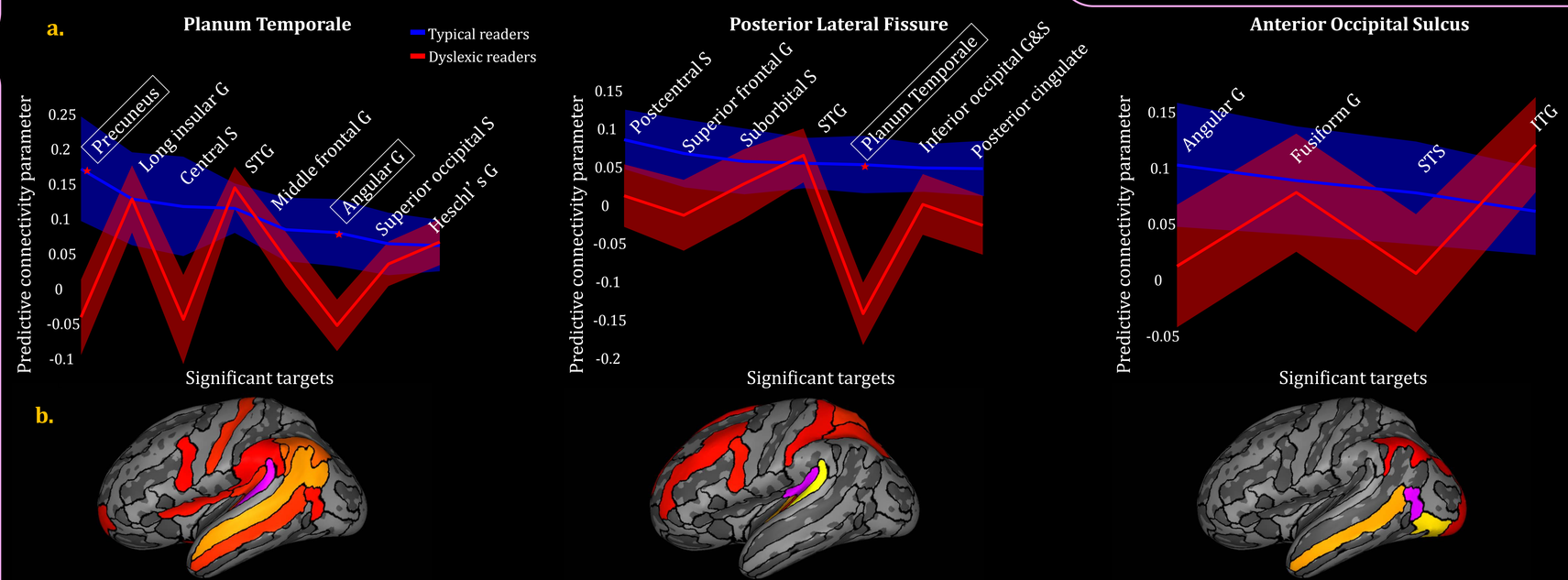


Figure 1. fMRI adaptation task.
a) Participants viewed a stream of single words and had to respond to inverted words. Adaptation was assessed by contrasting blocks of repeating vs nonrepeating word streams. b) Dyslexic readers exhibited diminished adaptation effects for written words, particularly around the left supramarginal gyrus.

Figure 2. Aberrant predictive connectivity patterns in dyslexic readers explain diminished adaptation responses in Wernicke's area, but not in early visual cortex.
Predictive connectivity coefficients were elucidated via GLM, relating the adaptation responses as a function of anatomical connectivity. a) Significant predictors for typical readers are plotted alongside the same predictors for dyslexic readers. Significant differences in model coefficients are boxed and starred. b) All significantly different predictors are displayed on an inflated surface, color-coded with their F-statistics contrasting typical readers with dyslexic readers. The seed regions (planum temporale, posterior lateral fissure, and anterior occipital sulcus) are colored magenta.



Correspondence to: dosher@mit.edu

SUMMARY

The regions in which deficient word adaptation was most strongly observed in dyslexic readers were near Wernicke's area (including planum temporale and posterior lateral fissure) and in anterior occipital cortex. In these anterior temporal seeds, many of the regions whose connectivity predict strong adaptation responses in typical readers were significantly deficient in dyslexic readers, especially in frontal and parietal regions involved in attention and executive control. Conversely, the adaptation deficits observed in early visual cortices did not involve high-level feedback and was much more local: the deficits here were best explained by connectivity with visual cortices.

ACKNOWLEDGEMENTS

This research was supported by the Ellison Medical Foundation. TKP was supported by a NSF graduate research fellowship. We thank the Athinoula A. Martinos Imaging Center at the McGovern Institute for Brain Research at MIT.