

Single Word Reading in Reading Disability depends on word frequency

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Introduction: Reading Disability (RD) is the most common type of learning disability and it is characterized by a disruption in word recognition and decoding. In comparison to typically developing readers (TDR), individuals with RD show under-activation in left occipitotemporal and temporoparietal regions, and over-activation in homologous right hemisphere regions on functional imaging tasks examining neurobiological response to words and pseudowords. These findings have been interpreted as evidence of a disruption of the entire functional network supporting word reading skill. Recently, (Pugh, Frost et al. 2008) showed that adolescents with RD exhibited activation patterns that varied with regard to characteristics of word stimuli, such that individuals with RD showed patterns of activation more similar to TDR on high frequency words that were also have highly imageable. These findings suggest that the neural network in adolescents with RD may simply be poorly trained, not disrupted. In the current study, we attempted to replicate the Pugh et al. (2008) findings of increased activation related to word frequency in a separate sample of adolescents, but without the confound of word imageability, which has known facilitory effects for individuals with RD. We hypothesized that even when controlling for imageability effects, individuals with RD will have within group activation differences in the left hemisphere that correspond to three levels (High > Low > Pseudoword) of word frequency (how common a word is in typical language). Furthermore, compared to the TDR group, we expect that individuals in the RD group will have greater engagement of left hemisphere posterior regions during the high frequency words. In contrast, during the pseudoword task, the more difficult words will elicit activation in the compensatory, right hemisphere brain regions.

Methods: MRI data was acquired with a 3.0 T Philips Gyroscan NT (at the F.M. Kirby Research Center at the Kennedy Krieger Institute) with an eight-element synergy head coil optimized for SENSE imaging. The event related fMRI paradigm required participants to view individual words that appeared in the center of the screen; for each stimulus, the participant decided whether the stimulus is a real word (in which case they push a button with their right index finger) or a pseudoword (in which case they push a button with their left index finger). Real words varied such that half were high frequency and half were low frequency. For the present study, data was collected on 27 TDR and 19 individuals with RD in the age range of 10 to 14 years and was analyzed using Statistical Parametric Mapping (SPM2). ANOVAs were used to analyze differences in activation patterns between words versus pseudowords and between high versus low frequency words. All analyses are reported at $p < .001$, uncorrected, with a cluster extent threshold of 70 voxels.

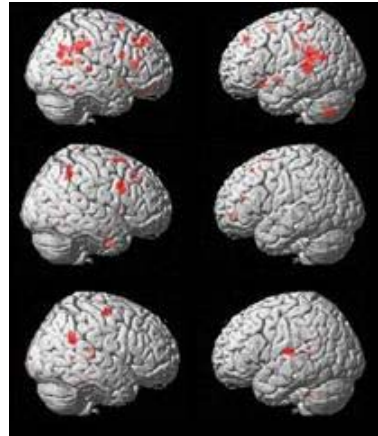


Fig 1. Statistical maps of increased signal change in the RD group on the three in-magnet tasks. The top row of figures shows lateral views for the PseudoWord task. The middle row of figures shows lateral view for High Frequency Words task. The lower row shows lateral views for Low Frequency Words task. All activations are greater than $p < .001$, uncorrected.

Results: As shown in Fig 1., our findings indicate that, in contrast to the few signal differences between RD and TDR groups for high frequency words, many more differences were seen for less familiar words and pseudowords. For low frequency words, RDs showed greater activation than TDRs in right angular gyrus. For pseudowords, RDs also showed greater activation than TDRs in left superior temporal gyrus and several right hemisphere regions.

Discussion: Similar to Pugh et al. (2008), our findings suggest modulation of neurobiological response depending on the type of words presented; however, our findings also suggest that this modulation was present regardless of the word imageability level.

Citations:

Pugh, K. R., S. J. Frost, et al. (2008). *J Cogn Neurosci* **20**(7): 1146-1160.