Structural Brain Differences in Good and Poor Comprehenders Identified through a Regression-Based Quantitative Method

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Specific Reading Comprehension Disorder (S-RCD) is characterized by poor reading comprehension despite intact decoding ability (see Landi & Ryherd, 2017 for a recent review). Although this disorder was identified in the early 1980’s, and has been studied widely since the late 1990’s, no standardized method of classifying individuals with S-RCD has emerged. Most studies use a cutoff based classification approach in which S-RCD participants have a standard reading comprehension score below some criterion as well as a discrepancy between decoding and reading comprehension measures. However, this method creates an artificial dichotomy where individuals with scores close to the cutoff criterion can be treated as qualitatively different. To address these weaknesses, some researchers have begun using a regression-based method to select S-RCD and typically-developing (TD) groups (e.g., Tong, Deacon, Kirby, Cain, & Parrila, 2011; MacKay, Levesque, & Deacon, 2017). In this method, reading comprehension ability is predicted from lower-level skills, such as nonverbal IQ, word decoding, vocabulary, and phonological awareness. If an individual’s actual comprehension score is much lower than their predicted comprehension score, they are considered to have S-RCD. If their actual comprehension score is similar to their predicted comprehension score, they are classified as TD. Finally, individuals whose actual comprehension scores are higher than predicted are labeled unexpected good comprehenders (UGC). This method increases the separation between groups and more carefully tailors group selection criteria to the individual. Despite these advantages, this method has only been used in a handful of studies and has not been used in any neurobiological investigations of S-RCD. Further, only one study of brain structure has considered S-RCD; this study revealed reduced gray matter volume for S-RCD relative to TD in prefrontal cortex, which is consistent with previous findings of impaired executive function in this population (Bailey, Hoeft, Aboud, & Cutting, 2016).

In the current study, we investigated brain structure in three comprehension groups (S-RCD, TD, and UGC) identified using the regression-based quantitative method. To classify participants, we predicted reading comprehension score from age, decoding ability, nonverbal IQ and vocabulary. We used a 15% confidence interval around the regression line to define TDs and a 65% confidence interval to define UGC and S-RCD individuals. From an original sample of 172 adolescents (ages 13-25), this method identified 20 TD, 22 S-RCD, and 25 UGC individuals. Exploratory whole-brain analysis comparing gray matter volume and cortical thickness between these groups revealed reduced gray matter volume for TD individuals relative to UGCs in the left superior parietal lobule, a region involved in allocating visual attention (Peyrin, Demonet, N’Guyen-Morel, Le Bas, & Waldois, 2010). The current investigation is the first to use the regression-based group classification method to investigate the relationship between comprehension skill and brain structure. Findings highlight the importance of studying UGCs, who also have discrepant comprehension and decoding profiles, in addition to those with S-RCD and TD to gain a broader perspective on how brain structure is related to reading comprehension skill profiles.