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 has been studied widely since the late 1990s, 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). In this method, reading comprehension ability is predicted from component skills such as nonverbal IQ, word decoding, and vocabulary. 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 by comparing reading comprehension skill to a value predicted by the individual’s other abilities rather than population norms. Despite these advantages, this method has not been used in any neurobiological investigations of S-RCD. Further, only one study of brain structure has considered S-RCD, revealing reduced gray matter volume for S-RCD relative to TD in prefrontal cortex, 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. Individuals whose actual comprehension scores fell within a 15% CI around the regression line were considered TD. Those with scores below a 65% CI around the regression line were placed into the S-RCD group, and those above the 65% CI into the UGC group. 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, which has been implicated in some language tasks (Bedny & Thompson-Schill, 2006; Peyrin et al., 2011). 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.