Differences in subcortical structures in children with developmental language disorder
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Seven percent of children have unexplained difficulties acquiring their first language and meet diagnostic criteria for developmental language disorder (DLD). Children with DLD perform poorly on tasks dependent on corticostriatal learning systems, such as sequential procedural memory tasks (Krishnan et al., 2016). Previous studies report structural abnormalities in the striatum in DLD (Badcock et al., 2012; Lee et al., 2013; Pigdon et al., 2019). In contrast, performance on episodic and semantic memory tasks, dependent on the integrity of the medial temporal lobe, appear relatively unimpaired in DLD (Krishnan et al., 2016).

As part of the Oxford BOLD study, we collected structural and functional MRI data in the largest sample of children with DLD to date. Here, we measured the volumes of subcortical structures via automatic segmentation of T1-weighted scans in Freesurfer. We predicted that the dorsal striatum (caudate nucleus and putamen) would be abnormal in children with DLD and that the medial temporal lobe (amygdala and hippocampus) would be unaffected. A total of 122 children aged 10–15 years had usable segmentations following automated quality control (Klapwijk et al., 2019). Of those, 51 met criteria for DLD (age-appropriate non-verbal IQ and performance of >1 SD below the mean on at least two of five standardized language assessments) and 71 were typically developing (TD). An additional 27 children had a history of speech and language difficulties but did not meet criteria for DLD currently (HSL).

Volumes of subcortical structures were normalized by total intracranial volume (ICV). Adjusted volumes were compared between TD and DLD groups with linear mixed models with hemisphere, group, and their interaction as factors and participant as a random factor. The volume of the right caudate nucleus was significantly smaller in DLD compared with TD (significant interaction hemisphere × group, p=.008). No other structures were significantly different between the groups, although all showed a trend (group or hemisphere × group, p<.06).

To explore whether these subthreshold differences were discriminative when considered together, support vector machine classifiers (linear SVM; 5-fold cross-validation) were trained using volumes and ICV as predictors. The relevance of each predictor was assessed via recursive feature extraction, and significance was determined via permutation testing. Maximum classification accuracy was achieved with four subcortical volumes: right caudate nucleus, right amygdala, left caudate nucleus, and left hippocampus (66.5% accuracy, p=.0004). Interestingly, a classifier trained only on the medial temporal lobe volumes achieved similar above-chance accuracy to that of the optimal classifier (64.5% accuracy, p<.002). The optimal classifier largely classified the individuals in the HSL group as TD rather than DLD (21:6), suggesting that their brain volumes corroborate the behavioral results in which they did not meet DLD criteria.

In summary, univariate measures of subcortical volumes suggest that there are structural differences in the caudate nucleus in children with DLD, consistent with previous findings and predictions. Multivariate analyses, however, suggest patterns of differences in both the striatum and medial temporal lobe may exist in DLD. Further analyses will focus how these data relate to language and motor measures.