Functional and structural evidence underlying the role of thalamus in dyslexia

Pedro Paz-Alonso

Basque Center on Cognition, Brain, and Language, Spain

Neuroimaging research with typical and atypical readers has underscored functional and structural differences within regions supporting cortico-subcortical interactions during reading processes. Specifically, compared to typical readers, individuals with dyslexia exhibit left thalamic hypoactivation associated with phonological deficits in reading tasks. Moreover, postmortem studies have evinced the presence of alterations in the medial and lateral geniculate nuclei of the thalamus of dyslexic individuals. This evidence highlights the critical role of this region in language and is consistent with theoretical accounts indicating that the thalamus is a central hub tuned by cortical areas to the relevant properties of visual and auditory inputs. Nevertheless, to date, no studies have specifically examined the relation between thalamic function and structure in dyslexic readers using a multimodal MRI approach. The present study was aimed at investigating evidence from functional and structural neuroimaging indexes to examine thalamic regional and connectivity differences in typical and dyslexic readers in relation to their performance on a task that discriminates between these groups: the Rapid-Automatized-Naming (RAN) task. We collected MRI data from 51 children and adults, typical and dyslexic readers matched on age, gender and IQ. Functional scans were collected while participants named RAN arrays of numbers, letters, objects, colors and control conditions tailored to each participant's naming speed. BOLD parameter estimates extracted from a left thalamus functional ROI, identified across participants from activation blocks versus control conditions, revealed that typical readers engaged this region more strongly than readers with dyslexia. Whole-brain functional connectivity analysis using thalamic ROIs as seeds showed significant coactivation of this region with primary visual cortex (V1) for control readers, but not for the dyslexic readers. Structural analyses revealed that thalamic volume, V1 cortical gray matter, and white-matter integrity of the optic radiations connecting thalamic lateral geniculate nucleus with V1 were all significantly associated with the performance of dyslexic, but not control, readers on the RAN task. Hierarchical regression analyses entering age in step 1, regional

thalamic and V1 volumes in step 2, and optic radiations fractional anisotropy as step 3 as predictors explained about 50-70% of the performance of dyslexic, but not control, readers on the RAN task. These results highlight the crucial role of the thalamus in dyslexia, constituting the strongest neuroimaging converging evidence linking its function and structure, at the regional level and via its connections with the visual cortex.