Children with developmental language disorder (DLD) struggle to learn their native language for no apparent reason. While DLD is a common disorder, with prevalence estimated at 7%, we know relatively little about what characterizes the brains of children with DLD. In the current study, we examined the link between cerebellar connectivity and variation in language learning abilities in children aged 10-15 years. Cortico-cerebellar circuits, alongside cortico-striatal systems, have been shown to contribute to complex sensorimotor skill learning, such as that involved in the acquisition of spoken language. Furthermore, a growing literature suggests that the cerebellum is involved in higher-order cognitive functions, including working memory. Children with DLD typically present with co-occurring motor-speech deficits, as well as atypical performance in procedural memory tasks which may also depend on the cerebellum. In this work we used diffusion-weighted imaging to assess microstructural properties of the cerebellar peduncles, which constitute the main input and output fiber pathways of the cerebellum.

Data were acquired from 77 typically developing children (TD), 58 children with DLD, and 27 children with history of speech-language problems (HSL) as part of the Oxford BOLD study (boldstudy.wordpress.com). We used probabilistic tractography to identify the middle (MCP), and inferior (ICP) and superior cerebellar peduncles (SCP) in each hemisphere by applying a published protocol (Bruckert et al. 2019, Cerebellum). Mean fractional anisotropy (FA) values for each tract were extracted and entered in a beta regression using generalized linear mixed models with group, hemisphere (in ICP and SCP) and their interaction as fixed effects, and subjects as random effects.

We found a significant effect of group in the ICP such that mean FA in this peduncle was lower in children with DLD compared with TD; the HSL group was not significantly different to either group. The group effect remained significant after controlling for whole brain FA, age, sex, and motion (during scan acquisition). In order to gain a better understanding of the microstructure underlying the FA differences in the ICP, we examined mean radial diffusivity (RD), an index of myelination, and axial diffusivity (AD), an index of axonal integrity. Differences were driven by significantly lower AD in the DLD group compared with the TD group. FA in the ICP was not associated with the level of impairment in language or verbal
memory factors, which captured children’s performance on standardized language and memory tests.

Tracing studies have shown that the ICP carries fibers from the inferior olivary nucleus, the vestibular nuclei, as well as spinocerebellar fibers, transmitting sensory information to the cerebellum. Consequently, the observed group differences in the microstructural properties of the ICP suggest potentially suboptimal transfer of sensory input in children with DLD. In contrast, there was no evidence of differences in children with DLD in the SCP that carries cerebellar outputs to the cerebrum via the midbrain or in the MCP that provides inputs from the cerebrum via the pons. This negative finding contrasts with previous findings in young adults with DLD and expectations of impairment in cortico-cerebellar pathways.