To identify neural substrates underlying the development of executive functions, the Study employs three subtests of the Cambridge Neuropsychological Test Automated Battery: (1) Spatial Span Task ("Span"); (2) Spatial Working Memory Task ("WorkingM"); and (3) Intradimensional/Extradimensional Set-shifting Task ("Shift"). These tasks complement standard neuropsychological measures of intelligence, memory, fluency and motor dexterity. The core MRI protocol includes 3D-volumetric T1-weighted and dual-echo T2-weighted acquisitions; these are processed by a fully automated image-analysis system yielding estimates of grey matter (GM) and white matter (WM) volumes of the cerebral lobes, as well as GM and WM “density” maps.

Performance in the three tasks is strongly age-dependent (Span [length]: r=0.74, n=423; WorkingM [errors]: r=-0.76, n=376; Shift [stages completed]: r=0.49, n=418). At the same time, age affects GM&WM densities in a region-specific manner. In order to assess age-independent relationships between brain and behaviour, we used multiple regressions and revealed the following structural predictors of performance: (1) the maximum length of spatial span was predicted by WM density in a subregion of the medial frontal lobe (local max X=0, Y=22, Z=45; t=11.6); (2) the number of errors in the WorkingM task was predicted by WM density in another subregion of the medial frontal lobe (X=8, Y=-3, Z=64; t=-9.4); and (3) the number of stages completed in the Shift Task was predicted by the GM density in a subregion of the left prefrontal cortex (X=-46, Y=40, Z=41; t=-6.2). These results suggest that cognitive performance varies as a function of structural GM&WM properties in specific brain regions.