Grey and white matter metrics demonstrate distinct and complementary prediction of differences in cognitive performance in children: Findings from ABCD (N= 11 876)

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Abstract

Individual differences in cognitive performance in childhood are a key predictor of significant life outcomes such as educational attainment and mental health. Differences in cognitive ability are governed in part by variations in brain structure. However, studies commonly focus on either grey or white matter metrics in humans, leaving open the key question as to whether grey or white matter microstructure play distinct or complementary roles supporting cognitive performance. To compare the role of grey and white matter in supporting cognitive performance, we used regularized structural equation models to predict cognitive performance with grey and white matter measures. Specifically, we compared how grey matter (volume, cortical thickness and surface area) and white matter measures (volume, fractional anisotropy and mean diffusivity) predicted individual differences in cognitive performance. The models were tested in 11,876 children (ABCD Study, 5680 female; 6196 male) at 10 years old. We found that grey and white matter metrics bring partly non-overlapping information to predict cognitive performance. The models with only grey or white matter explained respectively 15.4% and 12.4% of the variance in cognitive performance, while the combined model explained 19.0%. Zooming in we additionally found that different metrics within grey and white matter had different predictive power, and that the tracts/regions that were most predictive of cognitive performance differed across metric. These results show that studies focusing on a single metric in either grey or white matter to study the link between brain structure and cognitive performance are missing a key part of the equation.

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