Genetic and environmental underpinnings of spatial abilities and their role in predicting academic achievement and success in STEM

Kaili Rimfeld, King's College London; Nicholas Shakeshaft, King's College London; Kerry Schofield, King's College London; Margherita Malanchini, Goldsmiths College, University of London; Maja Rodic, Laboratory for Cognitive Investigations and Behavioral Genetics, Tomsk State University; Yulia Kovas, Goldsmiths College, University of London; Robert Plomin, Kings College London.

Spatial abilities encompass several factors that are differentiable from general cognitive ability (intelligence). Importantly, spatial abilities have been shown to be significant predictors of many life outcomes, even after controlling for intelligence. Quantitative genetic studies have shown that diverse measures of spatial ability are moderately heritable (30–50 %), although some important aspects of spatial ability such as navigation and map-reading have been neglected. Little is known about the factor structure of spatial measures or their links with academic achievement, especially STEM subjects (science, technology, engineering, mathematics). For these reasons, we launched a program of research creating novel online gamified measures of diverse spatial abilities including mental rotation, spatial visualization, spatial scanning, navigation, and map-reading. We piloted the measures on 100 unrelated individuals; all measures produced good test–retest reliability (0.7 on average). The battery was administered online to 1000 twin pairs (age 19–21) from the UK representative Twins Early Development Study (TEDS). Phenotypically, the results provided some evidence for the multifactorial nature of spatial ability, independent of intelligence, despite substantial correlations among the factors. Univariate genetic analyses yielded moderate heritability for all tests and factors. One of the most interesting findings was that these spatial factors correlated with success in STEM subjects, especially with achievement in mathematics, even after controlling for intelligence, and genetic factors largely accounted for these phenotypic associations TEDS is supported by a program grant to RP from the UK Medical Research Council [G0901245; and previously G0500079], with additional support from the US National Institutes of Health [HD044454; HD059215]. NS and KR are supported by Medical Research Council.