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Relations among fluid intelligence, sensory discrimination and working memory in middle to late childhood – A latent variable approach

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ABSTRACT

Two factors that have been suggested as key in explaining individual differences in fluid intelligence are working memory and sensory discrimination ability. A latent variable approach was used to explore the relative contributions of these two variables to individual differences in fluid intelligence in middle to late childhood. A sample of 263 children aged 7–12 years was examined. Correlational analyses showed that general discrimination ability (GDA) and working memory (WM) were related to each other and to fluid intelligence. Structural equation modeling showed that within both younger and older age groups and the sample as a whole, the relation between GDA and fluid intelligence could be accounted for by WM. While WM was able to predict variance in fluid intelligence above and beyond GDA, GDA was not able to explain significant amounts of variance in fluid intelligence, either in the whole sample or within the younger or older age group. We concluded that compared to GDA, WM should be considered the better predictor of individual differences in fluid intelligence in childhood. WM and fluid intelligence, while not being separable in middle childhood, develop at different rates, becoming more separable with age.

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Despite this differential development, the relations among GDA, WM and fluid intelligence remains constant between the ages of 7 and 12 years.

1. Introduction

Human mental abilities and individual differences thereof have been of central interest since the very early days of psychology as an empirical discipline. Research in the area has not only targeted intelligence in adulthood; intelligence in childhood has equally been in focus. The first test of intelligence was designed to assess mental abilities in children (Binet–Simon scale; Binet & Simon, 1905), and individual differences in childhood intelligence remains a thriving field of enquiry. Yet even with more than a century of empirical research and a large number of models and theories, intelligence remains an elusive concept. Contemporary views emphasize that it is a broad and multi-faceted concept embracing various aspects of information processing (Hunt, 2011). But the question of which mechanisms of information processing are more respectively less essential in explaining individual differences in intelligence is still strongly debated (Deary, 2012; Demetriou, Mouyi, & Spanoudis, 2008; Hunt, 2011). Different information-processing mechanisms have been related to intelligence, including attention (Burns, Nettelbeck, & McPherson, 2009; Schweizer, Moosbrugger, & Goldhammer, 2005; Stankov, 1988), processing speed (Fry & Hale, 2000; Kail, 2007), sensory discrimination (Deary, Bell, Bell, Campbell, & Fazal, 2004; Meyer, Hagmann-von Arx, Lemola, & Grob, 2010; Troche & Rammsayer, 2009), and working memory (Conway, Getz, Macnamara, & Engel de Abreu, 2011; Cowan & Alloway, 2009).

Of these variables, sensory discrimination ability is probably one of the oldest contenders. Spearman (1904) reported an almost perfect correlation between a factor derived from performance on discrimination tasks (weight, hue, and pitch discrimination) and his general factor of intelligence (*g*). Research has since confirmed a close relation between general discrimination ability (GDA) – a collection of sensory discrimination abilities quantified in different tasks and different modalities – and intelligence (Deary et al., 2004; Troche & Rammsayer, 2009). Also shown to be strongly related to intelligence in both adults and children is working memory (WM; Ackerman, Beier, & Boyle, 2005; Engel de Abreu, Conway, & Gathercole, 2010; Swanson, 2011), with some researchers suggesting that WM is the best predictor of intelligence (Cowan & Alloway, 2009; Oberauer, Schulze, Wilhelm, & Süß, 2005). Very few studies have examined these variables together as dual predictors of intelligence. In the present study, a latent variable approach is used to explore the relation between WM and GDA and their relative contributions to fluid intelligence in children.

1.1. Definition of key concepts

Fluid intelligence. The literature on intelligence offers various models and theories of psychometric intelligence. Recent models describe individual differences in intelligence with a fairly small number of dimensions of mental ability, referred to as factors, including for example, verbal ability and visuo-spatial reasoning (Hunt, 2011). One prominent factor in these models and theories is fluid intelligence. Fluid intelligence is generally considered to be the ability to deal with new and unusual problems, or, in other words, the ability to flexibly adapt thinking to new problems and situations (Cattell, 1963). Tests of fluid intelligence typically assess deductive, inductive, and quantitative reasoning, where novel problems have to be solved or patterns detected (Hunt, 2011; Willis, Dumont, & Kaufman, 2011). For the present study, we chose the Culture Fair Test (Weiss, 2006) as a test of fluid intelligence, for several reasons: (1) wide use of such tests in studies of intelligence (Conway et al., 2011); (2) their relatively culture-free stimuli (Willis et al., 2011); and (3) the suggestion that fluid intelligence and *g* are equivalent (Hunt, 2011; Johnson & Bouchard Jr., 2005).