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General intelligence and reading performance in adults: is the genetic factor structure the same as for children?

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Abstract

Genetic and environmental influences on reading ability and disability in children are undergoing active exploration, but the same is not true for adults. This study made use of data from the Minnesota Study of Twins Reared Apart ($N = 239$, age range 18–79) to evaluate whether a basic model of genetic and environmental influences on general intelligence and reading performance in children (Brooks, Fulker, & DeFries, 1990) appeared to fit adult data. In addition, we developed a related model of the phenotypic relationships that better fit our adult data. The key difference in our phenotypic model was that our measure of reading comprehension was linked with general intelligence rather than with reading performance. We believe that, though automaticity in reading performance is associated with improved reading comprehension in children, this may not be true in adults and may help to explain our result. In addition, we estimated somewhat higher heritabilities for reading measures than have typically been found for children (0.77 and 0.74 for two measures of word recognition, 0.51 for a measure of reading comprehension, and 0.76 for a measure of spelling), along with a genetic correlation between general intelligence and reading performance of 0.68.

Keywords: Heritability; General intelligence; Reading performance; Twins reared apart

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1. Introduction

Over the past 15 years, scientific understanding of the genetic and environmental etiology of reading ability and disability in children has expanded greatly. Research has gone from observing and estimating genetic influence on reading and correlated intellectual abilities (e.g. Brooks et al., 1990; Stevenson, Graham, Fredman, & McLoughlin, 1987) to preliminary identification of quantitative trait loci that may influence particular phonological and orthographic skills (e.g. Gayan, 2001; Grigorenko, 2001). There is also evidence that quantitative trait loci may have effects that vary with level of general intelligence (Knopik et al., 2002). Understanding of the etiology of reading ability and its associated intellectual abilities in adults has, however, not developed to the same extent. This is understandable, as children's ability to read is key to success in school, and success in school is increasingly critical to success in adulthood. In addition, intervention is generally considered to be much more effective in childhood. Still, it is important to understand these relationships in adults as well as children. The extent to which they may be similar or different provides useful information about cognitive developmental processes that could affect interventions developed to address reading difficulties in both children and adults.

Measures of intelligence and reading performance are highly correlated (Strang, 1968), with the correlations being higher in older children and adults than in very young children (Stanovich, Cunningham, & Freeman, 1984). It is also clear that, among children, there is covariance among reading performance measures unexplained by general intelligence (Brooks et al., 1990). Component processes contributing directly to reading performance in children, including word recognition, phonological decoding, orthographic coding, and phoneme awareness, have been identified and their genetic and environmental influences assessed (Olson, Wise, Connors, Rack, & Fulker, 1989). A question addressed in this study was to what degree there exists a similar separate reading performance factor in the cognitive ability profile of adults.

To address this question, we developed a model based on the model of general intelligence and reading performance developed by Brooks et al. (1990) in children. Their phenotypic model, developed using 12.5-year-old control (unaffected) twin pairs from the Colorado Twin Study of Reading Disability (DeFries, Fulker, & LaBuda, 1987), consisted of a measure of general intelligence and three reading performance measures. It showed clearly that a reading performance factor was necessary to explain the variance in the reading measures, after allowance for covariation between reading and general intelligence. Heritability estimates of the reading performance measures ranged from 0.21 for spelling to 0.45 for word recognition. A second question we addressed in this study concerned the extent of genetic influence on the latent general intelligence and reading performance factors in adults, and the degree to which they might be related.

One way that reading performance in adults differs significantly from that in young children is that reading has been extensively practiced in adults, and has therefore had the opportunity to become automatized. Research with the Stroop Word-Color Test (Stroop, 1935), which requires skilled readers to process an irrelevant word even though it inhibits their ability to carry out the intended task, provides evidence for such automatization. This automatization appears even in rather poor adult readers (Golden, 1978; Johnson, Bouchard, Segal, Keyes, & Samuels, 2003), though it takes awhile to develop in children (Cox et al., 1997). A question commonly addressed in this domain is whether and under what conditions the automatized reading process occurs involuntarily. Though earlier results tended to suggest that the reading process does occur invol-