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# The genetic and environmental etiologies of individual differences in early reading growth in Australia, the United States, and Scandinavia

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ABSTRACT

This first cross-country twin study of individual differences in reading growth from post-kindergarten to post-second grade analyzed data from 487 twin pairs from the United States, 267 twin pairs from Australia, and 280 twin pairs from Scandinavia. Data from two reading measures were fit to biometric latent growth models. Individual differences for the reading measures at post-kindergarten in the United States and Australia were due primarily to genetic influences and to both genetic and shared environmental influences in Scandinavia. In contrast, individual differences in growth generally had large genetic influences in all countries. These results suggest that genetic influences are largely responsible for individual differences in early reading development. In addition, the timing of the start of formal literacy instruction may affect the etiology of individual differences in early reading development but have only limited influence on the etiology of individual differences in growth.



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## Introduction

Understanding why children vary in their early reading development is the goal of much research. The focus of the current study was on the genetic and environmental etiologies of individual differences in early reading development, specifically rates of growth, within the first years of primary school. What sets this study apart from previous biometrical growth modeling research of early reading development is our inclusion of identical and fraternal twin data from Australia and Scandinavia (i.e., Norway and Sweden) in addition to the United States. This allows us to address the question of how genetic and environmental influences on individual differences in early word reading and nonword reading growth vary cross-nationally and cross-linguistically.

Recent behavioral genetic research has begun exploring the genetic and environmental etiologies of individual differences in growth on reading in three different U.S. twin samples (Christopher et al., in press; Hart et al., in press; Logan et al., in press; Petrill et al., 2010). Rather than focusing on static time points, these biometric growth curve studies have explored whether the genetic and environmental factors that drive differences as children start to read continue to affect subsequent reading growth across the early grades.

In our previous study (Christopher et al., in press), we fit biometric growth models to reading and spelling data from twins in the state of Colorado. The twins were tested starting at either the end of kindergarten (for two fluency- and accuracy-based word reading and non-word reading measures) or the end of first grade (for reading comprehension and spelling) and were tested through the end of fourth grade. The results showed that for all four measures, genetic factors were the main influences on individual differences at the end of first grade (the intercept), with small and nonsignificant shared environmental influences. Patterns of genetic and environmental influences for growth on the measures from first grade to fourth grade also showed strong and significant genetic influences. Spelling and reading comprehension also showed evidence of moderate, although not significant, shared environmental influences. We concluded that, for our measures and sample, variance in both reading and spelling ability at the end of first grade and subsequent growth was driven primarily by genetic influences. In addition, we found that, overall, there was very little variance in rates of growth on the measures compared with the much larger variance at the intercept; thus, our twins appeared to grow on the reading and spelling measures at roughly the same rate.

Recent studies from a twin sample in the state of Ohio have used biometric growth modeling to test the etiology of individual differences in early reading development. The first study (Petrill et al., 2010) found moderate genetic and strong shared environmental influences on three reading measures (letter identification, word reading, and decoding) at the first assessment wave (the intercept) when the twins ranged from 4.33 to 7.92 years of age ($M = 6.07$). Individual differences in linear growth on the three reading measures over the next two yearly assessment waves, however, were driven solely by shared environmental influences.

Logan and colleagues (in press) expanded on Petrill and colleagues' (2010) study by including three additional yearly assessment waves up until the twins' mean age was 12.17 years by including a reading comprehension measure, by fitting the data to nonlinear growth models, and by testing how the estimates of genetic and environmental variance at each wave changed as the children aged (i.e., by running multiple additional models that centered the intercept at each subsequent assessment wave). Individual differences for growth (both linear slope and quadratic growth) on word reading and nonword reading now had both genetic and shared environmental influences, although only shared environmental influences were significant for growth on reading comprehension. In addition, Logan and colleagues found that the estimates of genetic and shared environmental influences at the intercept varied depending on the wave on which the intercept was centered. Whereas their main analyses set the intercept at the first assessment wave when the children were between 4 and 7 years old, the later assessment waves had much smaller amounts of variance overall and recentering the intercept at later waves resulted in shared environmental estimates sharply declining and genetic estimates increasing compared with when the intercept was centered at the first wave. Although overall variance in each assessment wave declined over time, these results suggest that the declines were due largely to decreases in shared environmental variance rather than decreases in genetic or