Achievement Gap in Reading Is Present as Early as First Grade and Persists through Adolescence

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Objectives To determine if differences between dyslexic and typical readers in their reading scores and verbal IQ are evident as early as first grade and whether the trajectory of these differences increases or decreases from childhood to adolescence.

Study design The subjects were the 414 participants comprising the Connecticut Longitudinal Study, a sample survey cohort, assessed yearly from 1st to 12th grade on measures of reading and IQ. Statistical analysis employed longitudinal models based on growth curves and multiple groups.

Results As early as first grade, compared with typical readers, dyslexic readers had lower reading scores and verbal IQ, and their trajectories over time never converge with those of typical readers. These data demonstrate that such differences are not so much a function of increasing disparities over time but instead because of differences already present in first grade between typical and dyslexic readers.

Conclusions The achievement gap between typical and dyslexic readers is evident as early as first grade, and this gap persists into adolescence. These findings provide strong evidence and impetus for early identification of and intervention for young children at risk for dyslexia. Implementing effective reading programs as early as kindergarten or even preschool offers the potential to close the achievement gap. *(J Pediatr 2015;167:1121-5).*

D evelopmental dyslexia is the most common neurobehavioral disorder in children, affecting 17%-21% of school-age population.[1,2] Dyslexia is also the most comprehensively studied of the learning disabilities, affecting 80% of all children identified as learning-disabled.[3] First described over a century ago, dyslexia is defined as an unexpected difficulty in reading for an individual's chronological age or intelligence.

At its core, dyslexia is a problem with a component of spoken language, phonological processing: that is, getting to the elemental sounds of speech, affecting both spoken and written language. As dyslexic children progress in school, given good instruction, reading accuracy often improves; however, lack of fluency (the ability to read not only accurately, but rapidly and with good intonation) persists and remains a lifelong problem. The landscape in dyslexia is changing rapidly. For example, in 2014 the Congressional Committee on Science, Space, and Technology held a hearing on "The Science of Dyslexia," and many new state laws now urge recognition of dyslexia.[4,5] For the last decade, school policies have often emphasized that all children should be reading by third grade, a policy that perhaps has contributed to the delay of dyslexia diagnosis until after third grade.[6]

Here we report findings demonstrating that the achievement gap in reading between typical and dyslexic readers is evident as early as first grade and persists. We demonstrate further that typical and dyslexic readers do indeed differ in the trajectories of their reading scores and verbal IQ over time, from childhood to adolescence. Of particular importance, we demonstrate that such differences are not so much a function of increasing disparities over time but instead because of differences already present in first grade between typical and dyslexic readers.

Methods

The data for this report came from the Connecticut Longitudinal Study, a sample survey of Connecticut children entering public kindergarten.[1,7-10] The analyses presented here involve data from the 414 individuals who were first assessed in first grade and followed annually. Of the participants, 55.2% are females and 44.8% males. The sample contains Caucasians (84.3%), African Americans (11.2%), Asians (0.9%), Hispanics (2.0%), and other children with unknown ethnicity (1.6%). This sample from Connecticut was similar to the racial and ethnic composition of the nation at the time of the study.[11]

| WISC-R | Wechsler Intelligence Scale for Children-Revised |
| WJ | Woodcock-Johnson Psycho-Educational Test Battery |

Table I. Variable estimates from a growth model of WJ reading components

|	Typical	Dyslexic
Passage comprehension		
Mean intercept μ_0	.293 (.047)*	−1.170 (.071)
Mean slope μ_s	.421 (.006)*	.490 (.012)
Variance intercept σ_0^2	.612 (.047)	.288 (.061)
Variance slope σ_s^2	.007 (.001)	.008 (.002)
Covariance σ_{0s}	−.054 (.006)	−.009 (.012)†
χ^2 (df)		221 (90)
BIC		5326
Word identification		
Mean intercept μ_0	.286 (.044)*	−1.236 (.079)
Mean slope μ_s	.398 (.005)*	.463 (.011)
Variance intercept σ_0^2	.584 (.049)	.448 (.078)
Variance slope σ_s^2	.006 (.001)	.008 (.002)
Covariance σ_{0s}	−.051 (.005)	.035 (.009)
χ^2 (df)		577 (90)
BIC		2935
Word attack		
Mean intercept μ_0	.307 (.059)*	−1.232 (.057)
Mean slope μ_s	.345 (.007)‡	.339 (.014)
Variance intercept σ_0^2	.928 (.084)	.093 (.039)
Variance slope σ_s^2	.007 (.001)	.011 (.002)†
Covariance σ_{0s}	−.062 (.008)	−.001 (.008)†
^{2} (df)		669 (90)
BIC		7003

BIC, Bayesian information criterion.
SEs are in parentheses. N_1 (typical) = 335, N_2 (dyslexic) = 79. Dyslexia based on achievement and discrepancy definitions at third grade. All parameter estimates are derived from data in z-scores from the first measurement occasion.
*Significant difference (typical $\neq$ dyslexic).
†Parameter with $P > .05$.
‡Nonsignificant difference (typical = dyslexic).

Measures

Annually from 1st to 12th grade, participants completed 3 reading subtests from the Woodcock-Johnson Psycho-Educational Test Battery (WJ).[12] In addition, at grades 1, 3, 5, 7, and 9, participants were assessed on the Wechsler Intelligence Scale for Children-Revised (WISC-R).[13] In the current analyses, we consider the 4 verbal components of the WISC-R (vocabulary, information, comprehension, and similarities) as well as the reading subtests from the WJ (passage comprehension, word identification, and word attack).

Dyslexia was evaluated using a composite of the word reading subtests from the WJ battery (reading cluster, a composite of passage comprehension, word identification, and word attack) and the full-scale IQ score from the WISC-R. Dyslexia was determined if a participant's score was below 90 on the reading cluster score or if there were a difference of 1.5 SDs between the IQ and the reading cluster score, a difference that refers to the standardized residuals calculated from the regression of IQ on the reading scores. It is well established that reading and dyslexia occur along a normal distribution,[8] and similar results would be obtained whether the discrepancy is set at 1 or 1.5 SD. If participants met criteria for dyslexia in either grade 2 or grade 4, they were classified as dyslexic; if not, they were classified as typical.

To examine changes in the target variables across the grades, we used growth curve models (equivalent to multilevel or hierarchical linear models) that include grade as the underlying time dimension.[14-16] Details of the growth
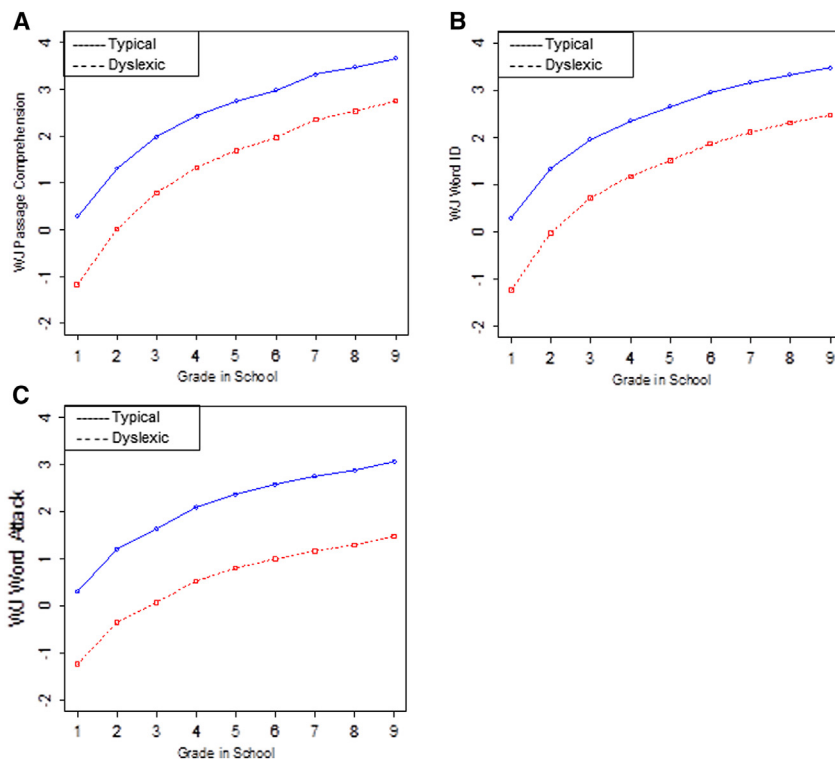
Figure 1. Smoothed predicted trajectories of reading across grades for both reading groups. **A**, Passage comprehension. **B**, Word identification. **C**, Word attack.