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Gender ratios for reading difficulties

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Abstract

The prevalence of reading difficulties is typically higher in males than females in both referred and research-identified samples, and the ratio of males to females is greater in more affected samples. To explore possible gender differences in reading performance, we analyzed data from 1,133 twin pairs in which at least one member of each pair had a school-history of reading problems and from 684 twin pairs from a comparison sample with no reading difficulties. Although the difference between the average scores of males and females in these two samples was very small, the variance of reading performance was significantly greater for males in both groups. We suggest that a greater variance of reading performance measures in males may account at least in part for their higher prevalence of reading difficulties as well as for the higher gender ratios that are observed in more severely impaired samples.

Keywords

Dyslexia; Gender Ratio; Prevalence; Reading Disability; Variance

The ratio of males to females in samples of children with reading difficulties varies widely depending upon the method of ascertainment. In studies where subjects are ascertained employing clinical or referral methods, gender ratios range from 2:1 to 15:1 males to females (e.g., Finucci & Childs, 1981; Vogel, 1990); however, in research-identified samples, gender ratios are closer to 1:1 (e.g., Harlaar, Spinath, Dale, & Plomin, 2005; Hawke, Wadsworth, Olson, & DeFries, 2007; Shaywitz, Shaywitz, Fletcher, & Escobar, 1990; Stevenson, 1992). Nevertheless, in both referred and research-identified samples, greater numbers of males with reading problems have typically been reported. For example, in a recent review of sex differences in reading disability, Rutter *et al*. (2004) reported the gender ratios in four independent epidemiological studies in which the samples had been ascertained using research criteria. In all four of the studies, significantly more males than females with reading disabilities

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were reported. Moreover, gender ratios for reading difficulties are greater in more severely affected samples (Hawke *et al*., 2007; Olson, 2002).

Several biological and environmental hypotheses have been proposed to account for this gender difference in prevalence rates including X-linked recessive inheritance (Symmes & Rapoport, 1972), differences in brain functioning due to differential exposure or sensitivity to androgens (Geschwind, 1981; Nass, 1993; Tallal & Fitch, 1993), immunological factors, sexual imprinting, perinatal complications, and differential resilience to neural insult (Liederman, Kantrowitz, & Flannery, 2005). It has also been suggested that females may be less susceptible to environmental factors such as teaching methods and socioeconomic status (Geschwind, 1981), and that genetic influences may be more important as a cause of reading difficulties in females than in males (DeFries & Gillis, 1993; Stevenson, 1992). However, in this brief report, we suggest a more parsimonious explanation for the greater prevalence of reading difficulties in males and for higher gender ratios with increasing severity.

We recently analyzed reading performance data [a composite measure of Reading Recognition (REC), Reading Comprehension (COMP) and Spelling (SPELL) subtest scores from the Peabody Individual Achievement Test (Dunn & Markwardt, 1970)] from 1,133 twin pairs in which at least one member of each pair had a positive school history of reading difficulties (Group I) and from a comparison sample of 684 twin pairs with no reading difficulties (Group II). (See Hawke *et al*., 2007, for a more detailed description of the measure and method used for sample ascertainment.) As expected, the difference between the means of the two groups was large [$F(1, 3624) = 1415.82$, $p < 0.001$, $\eta^2 = 0.28$]. In contrast, the difference between the mean scores of males and females was very small [$F(1, 3624) = 0.671$, $p = 0.41$, $\eta^2 = 0.0001$]. However, the variance of males was larger than that of females in both Group I [$F(1166, 1094) = 1.31$, $p < 0.001$] and Group II [$F(630, 731) = 1.18$, $p = 0.02$]. Similar results were previously reported by Reynolds *et al.* (1996), who found that the phenotypic variance for oral reading performance was greater for males than for females in the Virginia Twin Study of Adolescent Behavioral Development, and that the mean scores of males and females were not significantly different. Other investigators (e.g., Hedges & Nowell, 1995; Machin & Pekkarinen, 2008) have also previously noted that mental test scores of males consistently have larger variances than those of females even though average gender differences are relatively small.

This increased variance in males can account for the paradoxical finding that the prevalence of reading difficulties is higher in males than in females and that this gender ratio increases in more severely impaired samples, even in the absence of a difference between their means. For example, the ratio of the standard deviation (SD) of reading performance in males to that in females in Group I is 1.15. Therefore, using diagnostic cutoffs corresponding to −1.0, −2.0 or −3.0 SDs in males would correspond to −1.15, −2.30 and −3.45 SD cutoffs in females. Consequently, using the −1.0 SD cutoff for males, 15.9% of the males would be selected and 12.5% of the females would be selected, resulting in a gender ratio of 1.27. However, using cutoffs that correspond to −2.0 or −3.0 SDs in males, the gender ratios would be 2.13 or 4.33, respectively. Figure 1 illustrates how a greater proportion of males than females will be included in selected samples, and how this gender ratio will increase as a function of severity, even when their population means are exactly equal.

Thus, the higher prevalence of reading difficulties in males, especially in more highly selected samples, may be due to their greater variance for reading performance. Because our measure of reading performance is a composite measure of three subtest scores, variance differences for males and females on one or all of these measures, and/or gender differences in correlations among the three measures, could lead to gender differences in variance for reading performance. In fact, variances of males are significantly larger than those of females for REC, COMP, and SPELL in Group I and for REC and SPELL in Group II [Group I: REC, F(1169,

1094) = 1.28, $p < 0.001$; COMP, F(1166, 1094) = 1.20, $p = 0.001$; SPELL, F(1170, 1094) = 1.19, $p = 0.002$; Group II: REC, F(633, 731) = 1.15, $p = 0.03$; SPELL, F(634, 732) = 1.18, $p = 0.02$], and phenotypic correlations among the measures are consistently higher in males than in females in both groups. These results clearly suggest that the greater variance of our composite measure of reading performance for males is due to the gender differences in phenotypic variances and covariances of REC, COMP, and SPELL. Future research is warranted to assess why the variances of reading-related measures are higher in males than in females.

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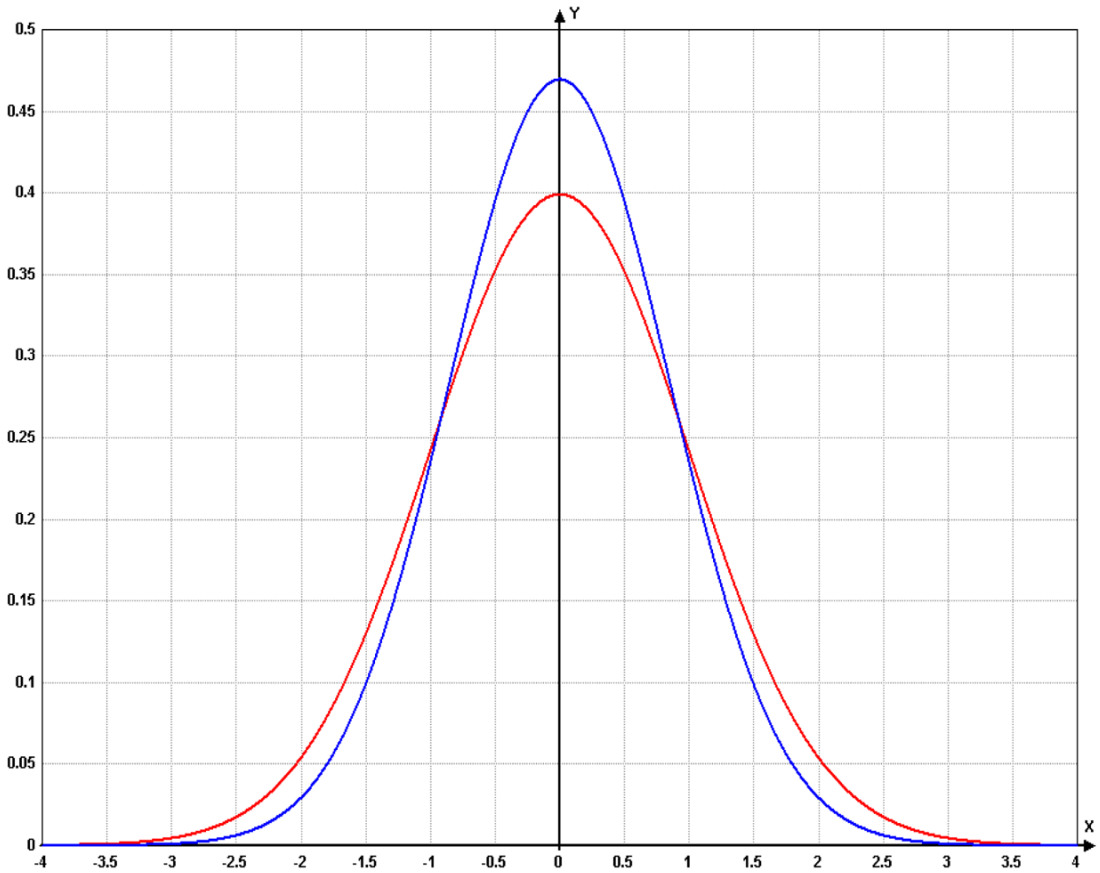

Figure 1.
Theoretical distributions of scores for males (red distribution, SD = 1.0) and females (blue distribution, SD = 0.85).