Why Do More Boys Than Girls Have a Reading Disability? A Review of the Evidence

Lisa Limbrick, Kevin Wheldall and Alison Madelaine
Macquarie University, Australia

A number of explanations have been proposed in recent years to account for the observed preponderance of boys with a reading disability. The most notable explanations offered for gender differences in reading disability relate to differences in phonemic awareness, auditory processing, behaviour, neurology, variability in cognitive ability and reading motivation. The purpose of this article was to review the available evidence supporting each of these explanations. The impact of confounding variables, including sample selection, sample bias, intelligence, and socioeconomic status was also discussed. Although the different explanations have, to some degree, an impact on overall reading achievement, it does not appear that any single explanation wholly accounts for gender differences in reading ability, and that gender is not a strong or consistent predictor of reading success.

Keywords: gender, reading disability, instructional outcomes

The issue of gender differences in reading has received considerable attention in recent decades. A recurrent theme in the literature is that poor reading, or reading disability, is more prevalent in boys, although the degree of prevalence remains contentious (Limbrick, Wheldall, & Madelaine, 2008). While some have found that there are small or no gender differences in reading disability (Siegel & Smythe, 2005), others have reported gender ratios of up to 4.51:1 (Miles, Haslum, & Wheeler, 1998). As indicated by Limbrick et al. (2008), conflicting reported gender ratios for reading disability stem from methodological factors such as differences among the assessment measures, differences in cut-off points for severity ratings, and differences among the samples with regard to age (mean and range), referral basis (community or clinic), and cognitive ability. Furthermore, differences in these methodologies ultimately stem from differences in theoretical orientations; in other words, the explanations used to account for poor reading generally. For example, while some researchers approach poor reading from a neurological perspective (Liederman, Kantrowitz, & Flannery,

Lisa Limbrick was awarded the prestigious AASE Inc — NSW Chapter Lee Mills Award for 2010 . The Lee Mills Teacher Training Award is given yearly with the express purpose of encouraging research-based practice by individuals undertaking study to pursue a career directly related to the education of students with special education needs.

Note: This manuscript was accepted under the editorship of Jennifer Stephenson.

Address for correspondence: Lisa Limbrick, Macquarie University Special Education Centre, Building X5A, Macquarie University, NSW 2109, Australia. E-mail: lisa.limbrick@speced.sed.mq.edu.au

2005), others advocate a language approach (Catts, Fey, Zhang, & Tomblin, 1999). Estimates of the overall number of children with reading problems vary considerably depending upon the approach taken (Chan, Ho, Tsang, Lee, & Chung, 2007); so, too, do estimates of gender ratios for poor reading.

A number of explanations have been directly proposed to account for the reported preponderance of males with a reading disability. One explanation is that gender differences in phonemic awareness translate to gender differences in poor reading, or reading disability. Phonemic awareness is a subset of phonological awareness and critical in learning to read (Burt, Holm, & Dodd, 1999). If there are more boys than girls who are struggling with phonemic awareness, then this would account for the reported higher percentage of boys who struggle with reading.

A second explanation relates to auditory processing. Research indicates that there is a link between reading disability and auditory processing disorders (Sharma et al., 2006), and that there are twice as many boys presenting with auditory processing disorders than there are girls (Schminky & Baron, 2000). As a result, it has been hypothesised that gender differences in auditory processing account for the observed differences between boys and girls in rates of reading disability.

Gender differences in externalising problem behaviour (or troublesome behaviour) are a third explanation that has been proposed to account for gender differences in reading disability. A significant body of research has established a link between problem behaviour and reading disability (Smart, Prior, Sanson, & Oberklaid, 2001), and that externalising problem behaviour is displayed more often in boys than in girls (Beaman, Wheldall, & Kemp, 2007). It is unclear, however, whether the relationship between problem behaviour and poor reading is correlational, causal or reciprocal (Sanson, Prior, & Smart, 1996; Spira, Bracken, & Fischel, 2005), particularly when there is evidence to support each relationship. Problem behaviour may be a valid explanation for gender differences in poor reading depending on the evidence, particularly evidence indicating problem behaviour causes poor reading.

A fourth explanation relates to neurological differences between boys and girls. Evidence suggests that boys are more left lateralised, whereas girls are more bilateralised, and these differences are evident in reading tasks (Coney, 2002; Phillips, Lowe, Lurito, Dzemidzic, & Mathews, 2001). Research shows that boys and girls access different neural pathways when undertaking reading and reading-related tasks, and this has been hypothesised to explain observed differences between boys and girls in reading outcomes and rates of reading disability.

A fifth explanation relates to gender differences in cognitive ability scores. It has been demonstrated that boys show greater variability on cognitive ability measures, which results in a preponderance of boys at the extreme ends of the distribution (Lohman & Lakin, 2009). Girls, on the other hand, tend to cluster more closely around the mean (Lynn & Mikk, 2009). This phenomenon is also evident across a range of educational domains. In terms of reading, there are often more boys than girls in the bottom of the distribution. It is hypothesised, then, that more boys are identified as having a reading disability because of this greater variability in reading scores.

A final explanation to account for the observed preponderance of boys with a reading disability is gender differences in reading motivation. Girls have been reported to have an overall higher level of motivation for reading than boys (Kelley & Decker, 2009; Mucherah & Yoder, 2008) and value reading more than boys (Baker & Wigfield, 1999). If girls are more motivated than boys to read, and motivation plays an important role in reading achievement (Mucherah & Yoder, 2008), then this may explain why girls

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

outperform boys in reading. Like problem behaviour, however, the relationship between motivation and reading is not clearly understood, which has implications as to whether reading motivation leads to poor reading or vice versa.

As will be discussed, each of these explanations is empirically supported to some degree, but there is also evidence to the contrary. In other words, there is also evidence to suggest that such gender differences are not significant or non-existent, or that significant results are confounded by other methodological or social variables. Examining the evidence supporting these explanations is important for several reasons. First, identifying whether any of the explanations sufficiently account for the observed greater prevalence of boys with reading disability has implications for the direction of future research. Understanding the nature of the relationship between gender and reading could assist in determining whether boys might require different forms of remediation, and what forms of remediation would be most beneficial, whether it be motivational, behavioural, neurological, and so forth.

Second, it would be useful to determine whether any of the explanations identify gender as a strong or reliable predictive variable in reading. In recent years several strong predictors of reading outcomes have been well established, such as phonemic awareness. If gender is identified in any of the above explanations as a strong predictive variable of reading outcomes, then this should also be established for future investigations. For instance, to what degree is gender thought to impact reading outcomes in terms of behaviour or motivation? Furthermore, are these observed differences a result of the behaviour or motivation, or in the actual reading? In the current state of research, discrepancies among reported gender ratios of poor reading have made it difficult to ascertain whether there are reliable or consistent differences between boys and girls in reading, or whether these differences are a result of other confounding variables.

The purpose of this review is to examine the validity of phonemic awareness, auditory processing, behaviour, neurology, and variability in cognitive ability scores, and motivation as explanations for gender differences in reading. Articles were included in this review if they met specific inclusion criteria: (a) published in a refereed academic journal; (b) reported findings of an empirical study; and (c) published in the past decade, although some highly influential earlier studies will be included (for example, Shaywitz, Shaywitz, Fletcher, & Escobar, 1990). A number of key descriptors were used in searching for relevant articles, including 'boy(s)', 'gender', 'reading', 'disability', 'dyslexia', 'reading difficulty', 'low progress reading', and 'poor reading'. Key descriptors pertaining to each explanation were also used. These descriptors were used in various combinations on a number of educational and psychological online databases, including Expanded Academic, Informaworld, PsychInfo and ERIC. Additional searches were conducted in Google Scholar. The age range of participants in selected studies was predominantly between 6 years and 12 years. Several studies also included results for 15-year-old students who participated in the Programme for International Student Assessment (PISA), which is administered across 41 countries.

The six explanations explored in this review will be discussed in separate sections. Each section will commence with a brief resume of the argument, followed by a discussion of the available empirically based evidence. The impact of confounding variables will be discussed where applicable, including sample selection and sample bias, intelligence, and socioeconomic status. Implications for future research in gender and reading will also be discussed.

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Phonemic Awareness

Over the past 30 years it has become well established that phonological awareness is one of the strongest predictors of reading success (Gernand & Morgan, 2007; Linklater, O'Connor, & Palardy, 2009; Savage & Carless, 2004), and accounts for more variance in reading ability than any other factor, including intelligence, age and socioeconomic status (Burt et al., 1999). Singleton, Horne, and Thomas (1999), for instance, reported that phonological awareness accounted for up to 54% of variance in reading. Phonological awareness is an awareness or knowledge of sound structure and the capacity to manipulate these sounds (Burt et al., 1999; Linklater et al., 2009), and is generally accepted to constitute three primary subsets: syllabic, intrasyllabic, and phonemic awareness (Burt et al., 1999). Phonemic awareness is considered critical in learning to read, and involves the capacity to discriminate and manipulate phonemes within words orally (Phillips, Norris, & Steffler, 2007). It may be plausible, then, that if there are gender differences in phonemic awareness, then this may be a contributing factor to the reported greater prevalence of boys with a reading disability.

Extensive research has been conducted in the area of phonemic awareness (as a subset of phonological awareness; Phillips et al., 2007), and despite the wealth of research available, few studies have examined gender differences (Gernand & Morgan, 2007). From the evidence available, it has been demonstrated that girls perform better than boys in phonological development (Dodd, Holm, Hua, & Crosbie, 2003; Gernand & Morgan, 2007) and language acquisition (Halpern & LaMay, 2000; McCormack & Knighton, 1996). Recent studies have found that girls perform significantly better than boys in phoneme segmentation tasks (Linklater et al., 2009; Moura, Mezzomo, & Cielo, 2008), accessing and using phonological name codes (Majeres, 2006), and achieve a higher rate of phonemes pronounced correctly (Dodd et al., 2003). Gender differences in phonological or phonemic awareness, however, appear to vary with the nature and complexity of the task at hand. For example, Moura et al. (2008) reported that girls had superior phonemic synthesis and segmentation skills, as well as 'phonemic reversion for words with two or three phonemes' (p. 53). Boys, on the other hand, were significantly better at 'phonetic synthesis for words with seven phonemes, and phonemic reversion for words with four or five phonemes' (p. 53). In this sample of children aged between 7:2 and 8:8 years, boys and girls differed according to task complexity, although it was acknowledged that these gender differences, albeit statistically significant, were very small.

Linklater et al. (2009) also found, in a sample of 401 kindergarten students, that girls demonstrated significantly better phoneme segmentation skills; however, boys and girls performed similarly in terms of initial sound fluency. By the end of kindergarten, girls had made faster progress in initial sound fluency, but boys had made faster progress in phonemic segmentation. Although girls were higher in both initial sounds fluency and phonemic segmentation at the end of kindergarten, Linklater et al., similar to Moura et al. (2008), concluded that the gender differences were extremely small, and gender was not a significant predictor of later reading success.

Of the studies exploring the role of gender in phonemic awareness, it appears that some have found differences that, although significant, are relatively small. Other studies have reported no gender differences at all. Savage and Carless (2004), for example, assessed a sample of 435 children at ages 4–5, 5:8 and 7 years on a range of phonological abilities, including phonemic tasks such as segmenting and blending, to ascertain the predictive validity of phonological ability for curriculum and academic test performance. Phonological awareness was a strong predictor for reading, mathematics

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

and science. While gender was a significant predictor for writing, mathematics and science, there were no significant differences between boys and girls on any of the phonological or phonemic tests. A further study (Savage, Carless, & Ferraro, 2007) found that phonological abilities at age 5 years significantly predicted academic outcomes at age 11 years (including reading, writing, English, mental arithmetic, mathematics, science). Gender predicted several academic outcomes, but no differences in phonological ability were reported. This included tasks such as phoneme blending and segmentation.

In a more recent study, Papadopoulos, Spanoudis, and Kendeou (2009) examined phonological abilities in the Greek language. In a sample of 280 Greek-Cypriot kindergarten and Year 1 children (141 boys), a range of phonological skills were assessed across 10 tasks. Four of those tasks measured phonemic abilities, and included initial sound oddity, sound isolation, phoneme elision (repeating a word after deleting a recognised phoneme), and phoneme blending. Across kindergarten and Year 1 there were no significant differences between boys and girls in any of the phonological abilities measured, including those tasks measuring phonemic awareness. In addition, kindergarten boys scored slightly higher than kindergarten girls in the phonemic tasks.

Nonsignificant gender differences in phonological awareness, and more specifically phonemic awareness, have also been reported for preschool children. Burt et al. (1999) assessed 57 children (without disability) on word production, phonological variability, non-word imitation, syllable segmentation, rhyme awareness, alliteration awareness, phoneme isolation and phoneme segmentation. Socioeconomic status and age both correlated significantly with the majority of tasks, but gender did not. Boys and girls did not differ on any of the phonological tasks, including phonemic tasks. Others have reached similar conclusions (Gernand & Morgan, 2007; Phillips et al., 2007). Fluss et al. (2009) found that while gender was not a significant predictor, other factors including socioeconomic status accounted for 24.2% of variance in reading. Similar findings are also consistent across a number of countries, including Canada (Phillips et al., 2007), Finland (Puolakanaho et al., 2007), and France (Fluss et al., 2009).

Although a considerable number of interventions are available to improve phonological and phonemic awareness (see, e.g., Treutlein, Zöller, Roos, & Schöler, 2008), there is little evidence to suggest that boys and girls require separate forms of remediation. Savage and Carless (2004) indicated that gender differences in phonological and phonemic awareness at school entry are so small, that boys and girls should be treated similarly. Likewise, Linklater et al. (2009) concluded that even though rates of growth for boys and girls differed, this did not lead to any differences in reading outcomes. As a result, they encourage educators to 'focus on the desired outcomes and provide the appropriate instruction for achieving them regardless of gender' (p. 22). Moura et al. (2008) also suggested that separate interventions were not warranted.

Phonemic awareness is critical to early reading development and later reading success, but evidence suggesting that gender differences in phonemic awareness, or even phonological awareness, accounts for more boys than girls with a reading disability is sparse. A number of studies have reported significant gender differences in phonemic or phonological awareness, although it has been conceded that these differences are relatively small. Other studies have reported small or no differences at all between boys and girls. Additionally, there is evidence to suggest that boys and girls have different strengths in aspects of phonological awareness depending on the nature and complexity of the task. It does not appear, however, that these differences consistently predict later reading success. Although differences in phonemic awareness may account for

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

differences in reading ability, it does not appear that they account for observed gender differences in reading disability.

Auditory Processing Disorders

Aside from phonemic awareness, another line of research postulates that gender differences in auditory processing may account for why there have been more boys than girls reported as having a reading disability. A number of studies have suggested a link between reading disability and auditory processing disorders (Amitay, Ben-Yehudah, Banai, & Ahissar, 2002; Sharma et al., 2006; Walker, Shinn, Cranford, Givens, & Holbert, 2002). Auditory Processing Disorder (APD), or Central Auditory Processing Disorder (CAPD), is commonly defined as problems with how auditory information is processed in the brain (National Institute on Deafness and Other Communication Disorders, 2009), particularly recognising and discriminating sounds (Moore, 2007). It is believed that a deficiency in auditory processing can affect fundamental phonological skills which are essential for reading (Dlouha, Novak, & Vokral, 2007; Heim et al., 2008; Sharma et al., 2006; Veuillet, Magnan, Ecalle, Thai-Van, & Collet, 2007). APD has been often associated with reading disorders (Moore, 2007; Sharma, Purdy, & Kelly, 2009), and is said to be exacerbated by background noise, such as a typical classroom environment (Veuillet et al., 2007). The disorder is often difficult to evaluate, however, because it can overlap with other disorders such as attention or language impairments (Dawes & Bishop, 2009). Although there is no 'gold standard' for measuring APD (Domitz & Schow, 2000, p. 1), it is often assessed by a range of behavioural tests (speech and noise) and electrophysiological tests (measuring the brain's response to sounds; Schminky & Baron, 2000).

Similar to research on phonological awareness, there is also a plethora of research on APD and reading disorders (see, e.g., Jutras et al., 2007; Sharma et al., 2009; Veuillet et al., 2007), but very few studies reporting data on gender (van Kesteren & Wiersinga-Post, 2007). In previous years it has been suggested that there are twice as many boys with APD than girls (Chermak & Musiek, 1997; Schminky & Baron, 2000), although these findings are mixed.

Rowe, Rowe, and colleagues (2006, 2006a, 2004) are among the handful of researchers who have addressed the issue of APD, reading disorders and gender. Rowe and Rowe (2006) found that a large number of children who were referred for literacy and/or behavioural assessments also presented with auditory processing difficulties, and the majority of these referred children were boys. Furthermore, in a summary of research findings based on a large sample of children in Victoria, Rowe, Rowe, and Pollard (2004) reported a strong relationship between reading achievement, attention and behaviour, and auditory processing. Boys were approximately 1 year behind girls in auditory processing development. In a sample of 9,028 children (4,471 males, 4,557 females) aged 4:7 years to 12 years, significant gender differences in favour of girls were found on two auditory processing tasks, being digit span and a sentence length task. Although these findings are significant, it should be noted that Rowe and Rowe (2006) indicated that the majority of students referred to specialists are boys. Previous findings have demonstrated that there are often more boys than girls in referred samples (Hawke, Wadsworth, Olson, & DeFries, 2007). Because it has been demonstrated that APD is often comorbid with problem behaviour, and problem behaviour is more prevalent in boys (as will be discussed in the following section), it is unclear whether more boys are referred for APD because APD is more prevalent in boys, or whether problem behaviour

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

precipitates more frequent referrals for boys. Additionally, Rowe, Rowe, and colleagues have measured AP by tasks involving repetition of sentence length and digit span. Although sentence length and digit span tasks measure AP in part, these studies did not include measures of electrophysiological tasks. Finally, no effect sizes were reported in these studies, and therefore the degree to which gender differences in APD accounts for gender differences in poor reading is ambiguous.

Interventions specifically for boys with auditory processing difficulties are minimal. Of the few researchers who advocate intervention programs for boys, Rowe and Rowe (2006) indicate that the strategies are effective for all students, regardless of gender. Rowe and Rowe have developed a teacher professional development program to encourage communication in the classroom, and devised an Auditory Processing Assessment Kit for purchase, which includes a sentence length and digit span assessment, which can be administered by teachers.

Although there are few studies reporting gender data, there is evidence to suggest little or no significant gender differences in auditory processing, even in referred samples. Ghanizadeh (2009) recently examined the comorbidity of APD, attention deficit/hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), separation anxiety disorder (SA) and gender, on a sample of 104 children (mean age 8:5 years). Auditory dysfunction was measured by a checklist of screening signs for APD and included hypersensitivity to sounds (HES) and hyposensitivity to sounds (HOS), which are two common aspects of APD. In this referred sample, where there were 73.1% boys, there were no significant gender differences in either HES or HOS.

A lack of gender differences in APD has also been evidenced in non-referred samples. Domitz and Schow (2000), for example, devised a CAPD battery of four commonly used tests (Selective Auditory Attention Test, Pitch Patterns, Dichotic Digits, and Competing Sentences) and assessed a non-referred sample of 81 Grade 3 students. Although girls scored slightly higher on the tasks than boys, most of these differences were not significant. Rowe et al. (2004) also reported data on a random sample of 889 Victorian children at school entry, and although they found significant gender differences on literacy tasks (BURT Word Reading Test, South Australian Spelling Test) and attentiveness, the interaction between digit span and gender was not significant.

There are several potential explanations for the disparities in reported research findings. First, very few empirical studies on APD and reading disability report gender data. As indicated by van Kesteren and Wiersinga-Post (2007), the majority of studies on auditory processing and reading do not report outcomes by gender, and therefore the role of gender is ambiguous. Discrepancies among the few reported findings, then, are difficult to interpret. It may be possible that researchers find no gender differences when analysing data and therefore do not report them, but in the absence of empirical evidence, it cannot be said with certainty whether gender differences in auditory processing do or do not play a role in reading ability.

Second, as discussed earlier, because there is not a widely accepted method of diagnosing APD, evidence suggests that different tests and measures yield different results (Sharma et al., 2009). Rowe, Rowe, and colleagues (2004, 2006) reported significant gender differences in measures of repetitive sentence length and digit span, while others have found nonsignificant gender differences in hypersensitivity/hyposensitivity (Ghanizadeh, 2009) or in pitch patterns, dichotic digits or selective auditory attention (Domitz & Schow, 2000). Furthermore, because APD is often comorbid with other disorders, such as behaviour, correct diagnosis is further perplexed. As indicated by Sharma et al. (2009), diagnosis often depends on which specialist is consulted in the first instance, whether it is

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

auditory or behavioural in nature. It remains unclear, then, whether real gender differences are present in APD, or whether more boys are identified with APD because more boys exhibit externalising problem behaviour. As discussed earlier, sample bias may also account for discrepancies in reported findings.

In sum, APD is often comorbid with behavioural and attentional problems (Rowe & Rowe, 2006), language impairments (Reddy & De Thomas, 2007) and reading difficulties (Moore, 2007). Because of the complex nature of APD and its relationship with other disorders, it is unclear whether gender differences in reading are the result of auditory processing difficulties, or due to attentional, behavioural or language difficulties. The lack of consistency in measures for APD, as well as the scarcity of studies reporting gender, also contributes to discrepant findings. It has been previously reported that the ratio of boys to girls with APD is approximately 2:1, although it has been demonstrated that a number of studies have employed referred samples. On the other hand, others have found no gender differences in APD at all, in either referred or non-referred samples. Evidence suggesting that APD accounts for why there may be more boys than girls with a reading disability, therefore, is minimal.

Problem Behaviour

Another explanation that has been proposed relates to problem behaviour. It is well established that a link between problem behaviour and poor reading exists (Rowe & Rowe, 1999; Smart et al., 2001) and that this link is stronger for boys than for girls (Trzesniewski, Moffitt, Caspi, Taylor, & Maughan, 2006; Willcutt & Pennington, 2000). A number of studies have reported that boys have significantly lower levels of reading ability as well as higher levels of problem behaviour (Fleming, Harachi, Cortes, Abbott, & Catalano, 2004; Skårbrevik, 2002). Evidence also suggests that boys are more likely to display externalising problem behaviour (such as troublesome behaviour or 'acting out'; Beaman et al., 2007) whereas girls are more likely to experience internalising problem behaviour (such as anxiety; Levy, Hay, Bennett, & McStephen, 2005). It remains unclear, however, whether the relationship between reading disability and problem behaviour is merely correlational or causal, and if the latter, the direction of causality (Rowe & Rowe, 1999; Sanson et al., 1996; Spira et al., 2005). This relationship has important implications in determining whether boys' externalising problem behaviour accounts for a greater proportion of boys reported to have a reading disability.

One line of research supports the proposition that problem behaviour leads to later reading disability or poor reading (Hinshaw, 1992). Smart et al. (2001), for example, investigated the degree to which intelligence, early poor reading, early problem behaviour and family factors affected later reading ability. They found that intelligence and early problem behaviour contributed to later poor reading for boys, but not for girls. This suggests that boy's poor reading, and subsequent gender differences in reading ability, may be partly a result of problem behaviour.

On the other hand, there is also evidence to suggest that poor reading leads to problem behaviour, especially for boys. For example, Bennett, Brown, Boyle, Racine, and Offord (2003) assessed a large random sample of kindergarten and Grade 1 students on the Ontario Child Health Study-Revised scales for conduct disorder, as well as reading using the Wide Range Achievement Test (WRAT). They evaluated reading ability at school entry, and assessed behaviour approximately 30 months later, concluding that early poor reading contributed to later problem behaviour. This finding would suggest that gender differences in problem behaviour do not account for gender differences in

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

poor reading. Instead, boys' problem behaviour may be the result, not the cause, of poor reading. Evidence suggests there may be nearly as many girls who are poor readers, but because girls' problem behaviour tends to be more internalised, and therefore less disruptive, they are less likely to be identified (Bauermeister et al., 2007; Biederman et al., 2005; Levy et al., 2005).

A third view hypothesises that problem behaviour and poor reading cause each other (Morgan, Farkas, Tufis, & Sperling, 2008). In a recent longitudinal study, Trzesniewski et al. (2006) assessed a large sample of twins on the Test of Word Reading Efficiency (TOWRE) as well as measures of conduct disorder and antisocial behaviour. They found that poor reading at age 5 years led to problem behaviour at age 7 years, and vice versa. For girls, however, while problem behaviour at age 5 years led to poor reading at 7 years, poor reading did not lead to later externalising problem behaviour. If the relationship between problem behaviour and poor reading is reciprocal, this would indicate that while problem behaviour may play a significant role in poor reading, the extent to which it accounts for gender differences in poor reading remains unclear. It is also worth noting that behaviour and reading problems may be a result of the 'Matthew Effect' (McIntosh, Horner, Chard, Dickey, & Braun, 2008; Morgan et al., 2008), where students who are poor readers, or display problem behaviour, fall even further behind (McIntosh et al., 2008). Good readers, on the other hand, tend to read more and become even better readers, and therefore the gap widens between good and poor readers.

Based on current research on behaviour and reading problems, interventions can vary depending on whether problem behaviour is thought to precede reading problems, or vice versa (Morgan et al., 2008). Overall, however, a number of researchers agree that successful intervention should target both problem behaviour and reading difficulties simultaneously (Bennett et al., 2003; Morgan et al., 2008), particularly for boys (Trzesniewski et al., 2006). Additionally, despite the fact that behaviour problems and reading problems are distinctly different disorders (de Jong, Oosterlaan, & Sergeant, 2006), breakthroughs in neurological research suggest that attention, as a cognitive process in the brain, also plays a role in reading problems. Shaywitz and Shaywitz (2008) have suggested that interventions for behaviour problems or ADHD, then, may also benefit poor reading or dyslexia.

Aside from the debate as to whether problem behaviour causes poor reading or vice versa, a further line of research suggests that boys' problem behaviour does not account for gender differences in poor reading, but instead accounts for gender differences in the number of boys identified as poor readers. Studies show that boys' externalising behaviour hastens more frequent referrals to special education services, and therefore more boys than girls are identified as poor readers. Because many studies employ referred samples, it has been assumed that many more boys have reading problems (Hawke et al., 2007; Liederman et al., 2005; Shaywitz et al., 1990). Conversely, a number of studies have demonstrated that while they found significant gender differences in problem behaviour, they did not find significant gender differences in reading. Smart et al. (2001), for example, examined reading comprehension and behaviour longitudinally at 7–8 years and then at 13–14 years. They found no significant gender differences in reading comprehension or spelling at 13–14 years, with minimal gender differences in improvement rates. On the other hand, significantly more boys were reported by teachers and parents as high risk for behaviour problems. In addition, while externalising problem behaviour did affect reading and spelling, intelligence and socioeconomic status were factors more likely to influence achievement.

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Sanson et al. (1996) conducted a large longitudinal study from birth to 6 years, examining measures of reading (such as reading comprehension and vocabulary) as well as behaviour. Overall, nonsignificant gender differences were found in reading, but significant gender differences were found in problem behaviour. Sanson et al. concluded that although there were no gender differences in the frequency of reading disability, more boys were identified as having a reading disability due to a higher co-occurrence of behaviour problems. Other studies have reported similar findings (see, e.g., Matthews, Ponitz, & Morrison, 2009; Willcutt & Pennington, 2000). Collectively, these findings indicate that problem behaviour does not account for gender differences in reading, but instead accounts for a greater prevalence of boys identified as poor readers.

Although problem behaviour and poor reading are frequently comorbid, it remains unclear whether the relationship between problem behaviour and poor reading is causal, correlational or even reciprocal. Evidence suggests that significantly more boys than girls are identified as having externalising problem behaviour, but whether this behaviour accounts for gender differences in poor reading remains unresolved. The fact that the majority of studies focus on boys, and few studies have examined problem behaviour and poor reading for girls, further complicates the issue. A growing body of evidence suggests that the greater prevalence of boys identified as poor readers is due to sample selection rather than to actual gender differences in reading skills. While the nature of this relationship continues to be debated, one thing is clear: irrespective of gender differences in reading skills, more boys are identified as poor readers as a result of problem behaviour.

Neurology

A further explanation to account for more boys than girls identified as having a reading disability is neurological in origin. In recent years, neurological research into reading has been considerably advanced by using brain imaging techniques, such as functional magnetic resonance imaging (fMRI; Hudson, High, & Al Otaiba, 2007), a technique which measures blood flow in areas of the brain (Shaywitz & Shaywitz, 2007). Severe reading disability, or dyslexia, is considered to be neurological in origin (Hudson et al., 2007). The human brain is divided into right and left hemispheres, where different regions or lobes within these hemispheres are responsible for different reading and reading-related activities. For example, it is thought that the frontal lobe controls speech, the parietal lobe controls spoken and written language and is linked with memory, the occipital lobe controls vision, which can identify letters, and the temporal lobe controls verbal memory (Hudson et al., 2007). Two additional areas of importance are the left parietotemporal system (involved in word analysis, decoding, and comprehension) and the left occitotemporal area (involved in automatic access to whole words and fluent reading; Hudson et al., 2007; Shaywitz et al., 2004). Different reading and reading-related activities therefore activate different regions in the brain. There is evidence to suggest, however, that people with reading difficulties exhibit different brain activation patterns to those who are normal readers (Shaywitz & Shaywitz, 2008).

In terms of gender, evidence suggests that boys are more brain lateralised than girls, and display a greater left lateralisation in reading and reading-related tasks (Boles, 2005; Coney, 2002; Phillips et al., 2001). Girls, on the other hand, display greater bilaterality (Kansaku, Yamaura, & Kitazawa, 2000; Shaywitz et al., 1995; Wallentin, 2009). These gender differences have been observed in passive-listening tasks (Phillips et al., 2001), phonological tasks (Coney, 2002; Shaywitz et al., 1995), and grammatical tasks (Jaeger et al., 1998).

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Some neurological studies have reported that gender differences in reading ability may depend on the task undertaken. In other words, neurological differences between boys and girls may be task specific. Pugh et al. (1996) found that men displayed greater brain activation with semantic tasks, compared to phonological tasks, but women displayed no differences in brain activation between semantic and phonological tasks. Burman, Bitan, and Booth (2008) demonstrated that, on language tasks such as spelling and rhyming, boys activated different parts of the brain depending on whether the task was presented visually or auditorily. Task accuracy also depended on modality of presentation. Girls, on the other hand, activated the same part of the brain regardless of whether the task was visual or auditorily. Burman et al. concluded that boys and girls use different parts of the brain to process the same task. In a similar vein, Clements et al. (2006) found that boys appear more left lateralised than girls on phonological tasks, and bilateral for visuospatial tasks. Conversely, girls are more bilateral for phonological tasks and right lateralised on visuospatial tasks.

Gender differences in reading are also evident according to task complexity. Jaeger et al. (1998) found significant gender differences in the pattern of brain activity depending on the complexity of the task. While both men and women displayed bilateral patterns of activation during a simple reading task (reading aloud verbs and regular words), only men showed greater left hemisphere laterality for a complex task (speaking past tense of regular verbs, irregular verbs and nonce verbs). Conversely, women were more bilaterally activated during both complex and simple tasks. Gender differences emerged as the complexity of the task increased. Others have also identified gender differences according to task difficulty (Gur et al., 2000).

While many neurological studies provide data on the efficacy of intervention, very few studies to date explore intervention specifically for boys. Burman et al. (2008), for example, indicated that boys may benefit from an improvement in sensory processing, given that task accuracy depended on the modality of word presentation (visual vs. auditory). Shaywitz and Shaywitz (2008), on the other hand, suggest that there is a link between the inferior parietal cortex, attention, and reading, and conclude that attention (and disruption) is a causal factor for reading difficulties. It is possible, then, that intervention may lie in the treatment for behavioural problems such as ADHD. Although their study was not gender-specific, as discussed in the previous section it is well established that behavioural problems are more common in boys than in girls (Shaywitz et al., 1990; Willcutt & Pennington, 2000).

While there is a considerable body of neurological evidence to support gender differences in reading, there are likewise numerous studies demonstrating little or no significant differences. Molfese et al. (2006) suggested that while there were differences in the brain between boys and girls, there were no differences related to reading. Wallentin (2009) reviewed a number of studies on lateralised behaviour, including language tasks (recalling one-syllable words) and response time, and there were no significant differences reported. Wallentin also concluded that gender was not a significant predictor in verbal fluency, despite acknowledging that verbal fluency was one of the most cited tasks in the literature for demonstrating gender differences. Sommer, Aleman, Somers, Boks, and Kahn (2008) also reported no gender differences in verbal fluency, verb generation, and language comprehension tasks. Shaywitz et al. (1995), while reporting significant gender differences in phonological tasks, found no significant differences between boys and girls in orthographic and semantic tasks.

Boles (2005) demonstrated that gender accounts for only 0.09% to 1.0% of variability across a number of tasks, and concluded that a greater variability in

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

performance can be evidenced within the gender groups rather than between them. As a result, gender (as a variable) appears to have little predictive value. In a similar vein, Molfese et al. (2006) found that boys and girls responded to reading tasks in similar ways, and concluded that 'as far as a reading deficit is concerned, the impact on boys and girls will be the same' (p. 361).

Neurological research on gender differences in reading has rapidly grown over the past decade, although reported findings have been somewhat mixed. It is possible that differences in neurological imaging techniques may account for differences in reported findings; likewise, differences in the types of tasks and task complexity also vary considerably between studies (Clements et al., 2006). Variability has also been identified among studies in relation to the reading skills that are actually measured (e.g., phonological, semantic, comprehension tasks; Clements et al., 2006). Age is another factor that may affect results (Shaywitz & Shaywitz, 2007), particularly if, as has been suggested, girls often have superior language from an earlier age (Burman et al., 2008). It is difficult to ascertain, therefore, whether any differences in the brain between boys and girls are significant in reading and reading-related tasks, and therefore account for the observed preponderance of boys with a reading disability, or whether reported gender differences are the result of methodological variability among studies (Kaiser, Haller, Schmitz, & Nitsch, 2009).

Variance in Cognitive Ability

A further explanation hypothesised to account for why there may be more boys than girls with a reading disability relates to observed gender differences in cognitive abilities. Gender differences in cognitive abilities have been a topic of interest for more than one hundred years (Ellis, 1894; Thorndike, 1914). Although relatively small gender differences have been reported in overall intelligence scores over the years (Colom, Juan-Espinosa, Abad, & García, 2000; Deary, Thorpe, Wilson, Starr, & Whalley, 2003; Galsworthy, Dionne, Dale, & Plomin, 2000), a number of studies have demonstrated gender differences within specific cognitive abilities (Halpern & LaMay, 2000; Johnson, & Bouchard, 2007). Boys have reportedly been superior in spatial abilities (Voyer, Voyer, & Bryden, 1995), whereas girls have scored higher on verbal abilities (Halpern & LaMay, 2000; Vogel, 1990), although such differences have been inconsistent throughout the literature (see, e.g., Hyde & Linn, 1988).

Gender differences have also been reported in the variability of scores in cognitive abilities (Dykiert, Gale, & Deary, 2009). Boys tend to demonstrate greater variability than girls in scores on cognitive ability measures, resulting in an over-representation of boys at the extreme ends of the distribution (Lohman & Lakin, 2009). Boys have been shown to display greater variability on verbal, quantitative, and nonverbal abilities (Strand, Deary, & Smith, 2006). Girls, on the other hand, show smaller variations in cognitive ability scores, and therefore cluster more closely around the mean (Lynn & Mikk, 2009). For example, Strand et al. (2006) conducted a large study in the United Kingdom, employing more than 320,000 students aged 11–12 years. By performance on the Cognitive Abilities Test (CAT), Strand et al. demonstrated that boys' scores were more variable than girls' scores on all three cognitive abilities measured (verbal, quantitative, and non-verbal reasoning). More boys than girls were represented in the top and bottom ends of the distributions. Recently, Lohman and Lakin (2009) replicated Strand et al.'s study in the United States, analysing student performance on the CogAT, an American version of the CAT, for a sample of 318,599 students between grades 3 to 11. Confirming Strand et al.'s findings, Lohman and

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Lakin also reported greater variability in scores for boys. This greater variability for boys may explain why there are many more boys identified as gifted or with a learning or intellectual disability (Deary et al., 2003).

There is growing evidence to suggest that boys' variability is not limited to cognitive abilities, but rather is manifest across a wide range of abilities, including reading. Emerging research indicates that boys display greater variability than girls in reading scores, which in turn results in more boys being represented in the tail of the distribution. As a consequence, more boys are identified as having a reading disability (Hawke, Olson, Willcutt, Wadsworth, & DeFries, 2009). In a recent study, Hawke et al. (2009) demonstrated greater male variance in reading scores in a large twin study. Two groups of twins (one group with reading disability, one group without) were assessed on the Peabody Individual Achievement Test (PIAT), which included measures of reading recognition, reading comprehension, and spelling. In the reading difficulty group, boys' scores were significantly more variable on all three measures; in the non-reading difficulty group, male variance was significantly greater for reading comprehension and spelling, but not reading recognition (recognising printed words and reading words aloud). Hawke et al. concluded that greater male variance is related to gender differences in reading recognition, reading comprehension and spelling.

Others have reported similar findings. Machin and Pekkarinen (2008) examined gender differences in reading scores for the 2003 Programme for International Student Assessment (PISA), in which 15-year-old students across 41 countries participated. Reading ability in the PISA has been shown to be equivalent to the verbal comprehension component in intelligence testing (Lynn & Mikk, 2009). Boys' reading scores were significantly more variable than girls' scores and this result was robust across all countries. Lynn and Mikk (2009) also examined reading scores on the PISA for the years 2000, 2003 and 2006, as well as results for two Progress in International Reading Literacy Studies (PIRLS) for 2001 and 2006. By performance on the PISA, boys displayed significantly greater variance in reading across all countries. Greater variance for boys was also evidenced in both PIRLS studies. In 2006, for instance, the variance for boys' scores was greater than girls' scores by 8%. Others have found similar gender differences for variance in reading scores, even though differences in overall means between boys and girls were not statistically significant (Reynolds et al., 1996). Similar patterns in means and distributions are likewise evident in writing, mathematics and science (see, e.g., Nowell & Hedges, 1998). The fact that greater male variance in scores is seen in a number of academic areas, as well as cognitive abilities, indicates that greater variance in reading scores may be part of a larger phenomenon.

While there is evidence to suggest that gender differences in variance on cognitive abilities might explain observed gender differences in reading disability numbers, others have disputed the view that intelligence has much influence on reading acquisition (Siegel & Smythe, 2005). Throughout the literature one of the most used methods of identifying poor readers has been discrepancy formulae, which is premised on the assumption that reading ability can be predicted by performance on intelligence tests. Emerging evidence suggests, however, that this method of identification is not only illogical, but flawed (Siegel & Smythe, 2005). As indicated by Siegel and Smythe (2005), intelligence tests do not measure skills critical to reading, such as fluency and accuracy. Similar conclusions have also been reached by others (O'Malley, Francis, Foorman, Fletcher, & Swank, 2002; Stanovich, 1999). Furthermore, research indicates that there is little cognitive difference between low-progress readers and those identified as having a reading disability by discrepancy methods (Fletcher et al., 1994; O'Malley et al., 2002;

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Stanovich, 1999). As indicated by Stanovich (1999), there is also no evidence to suggest response to remediation differs according to intelligence.

Others have reported that cognitive ability, or intelligence, does not wholly explain gender gaps in reading. Although girls have been shown to score higher on measures of verbal cognitive ability, gender only accounts for approximately 3% of variance (Galsworthy et al., 2000). Furthermore, Strand et al. (2006) indicated that cognitive abilities, such as reasoning, are strongly associated with educational attainment, particularly in English. Although boys' scores in reasoning were significantly more variable than girls, this variability could not fully account for the considerably larger gender gaps found in national assessments, particularly at the bottom end of the distribution. Additionally, Strand et al. indicated that factors such as socioeconomic status account for considerably more variance in scores compared to gender, which is extremely small. This conclusion is supported elsewhere (Fluss et al., 2009).

Finally, it should be noted that the majority of studies on cognitive abilities have largely focused on means rather than variances (Lohman & Lakin, 2009); likewise, the same is true for studies in gender differences in reading. The hypothesis that boys' variance in cognitive abilities may account for a greater prevalence of boys identified with reading problems remains largely unexplored. Potentially erroneous conclusions regarding gender differences in reading, however, may arise in the absence of widespread research. For example, in a large meta-analysis, Hyde (2005) proposed the gender similarities hypothesis, where boys and girls are more alike than different for a range of cognitive and educational abilities. Across a number of studies examining reading comprehension, vocabulary, verbal reasoning and language, among other skills, Hyde reported very small effect sizes and concluded that gender differences were minimal, and varied depending on the context. Lohman and Lakkin (2009) also reported small effect sizes for gender mean differences. When they further analysed the data, however, they found significant gender differences in the variability of scores. Lohman and Lakin indicated that had they limited their analysis to differences in means (which were minimal), and not explored gender differences in variances (which were significant), they would have drawn very different conclusions.

There is evidence to suggest that the greater variability in boys' cognitive abilities accounts for a greater preponderance of boys with reading disability. Conversely, others have found that the influence of intelligence on reading acquisition is generally regarded as not a critical factor. Despite the fact that intelligence is not a precursor to reading ability, and the fact that it has been demonstrated that boys' show greater variability in scores across a range of cognitive and educational domains, it appears that boys' greater variability in reading scores is part of a larger phenomenon. This greater variability in reading scores, then, may account for why more boys have been identified as having a reading disability. Given the scarcity of studies exploring this trend, however, more research is needed to investigate the validity of this explanation.

Motivation for Reading

A final explanation in this review relates to gender differences in motivation for reading. It is well established that motivation plays an important role in reading achievement (Aarnoutse & Schellings, 2003; Martin, 2003; Mucherah & Yoder, 2008), and is critical in the development of literacy skills (Meece & Miller, 2001). Motivation has been previously defined in a number of ways, such as a drive to learn (Martin, 2003), a positive attitude towards reading (Baker & Wigfield, 1999), and a focus on beliefs, goals

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

and values (Wigfield, 1997). Motivation is multidimensional by nature (Martin, 2003; Coddington & Guthrie, 2009), involving aspects of intrinsic and extrinsic goals, self-efficacy and social aspects of motivation (Mucherah & Yoder, 2008); task mastery (Meece & Miller, 2001), attribution styles (Meece, Bower Glienke, & Burg, 2006); and value of schooling and learning focus (Martin, 2003). Many other facets of motivation have also been identified (see, e.g., Baker & Wigfield, 1999; Martin, 2003; Meece et al., 2006; Wigfield & Guthrie, 1995). Motivation can be general or domain specific, vary according to age and years of schooling, and change depending on motivational goals (Meece & Miller, 2001). Struggling readers are often low in dimensions of motivation, including self-efficacy and confidence, and are more likely to display work-avoidant or self-handicapping strategies (Guthrie & Davis, 2003).

A number of studies have demonstrated gender differences in reading motivation, where girls have an overall higher motivation for reading than boys (Kelley & Decker, 2009; Lepola, 2004; Mucherah & Yoder, 2008). Martin (2004) found that boys are more negative towards school, whereas girls have a greater reading enjoyment, reading pleasure and enjoy talking about books. Others have also reported that girls place a higher value on reading than boys do (Baker & Wigfield, 1999). It remains unclear, however, whether the relationship between reading and motivation is causal or correlational. In other words, are girls better readers because they have higher levels of motivation, or vice versa? Reviewing the evidence on gender differences in motivation and reading, therefore, should be viewed with consideration of this question.

In a recent review, Meece et al. (2006) examined gender differences in motivation across a range of educational domains, including reading. Four theories of motivation were discussed, including attribution, expectancy-value, self-efficacy, and goal theories. There were few gender differences in motivation according to theories of attribution and goal orientations. For expectancy-value theories (including competency beliefs and value beliefs), boys and girls commence school with similar ability beliefs, but boys decline more rapidly in their ability beliefs over the years. In terms of value, girls place greater emphasis on reading, whereas boys tend to value sports. According to the self-efficacy theory of motivation, gender differences relate to age and grade of students. For example, in primary school years, effect sizes for gender differences in motivation were very small (0.09), whereas effect sizes were considerably larger for high school (0.66). Meece et al. also indicated that results in this study were also moderated by socioeconomic status and ethnicity.

Others have also reported small gender differences in reading motivation. Kelley and Decker (2009), for example, found that although girls had a significantly higher motivation for reading than boys, gender only accounted for 3% of the variance in reading motivation. Additionally, girls were found to value reading significantly more than boys, but overall only 4% of variance in motivation was accounted for by gender. Self-concept, on the other hand, accounted for 52% of students' motivation to read, and value of reading accounted for 48% of variance. Conversely, effect sizes for gender were very small. It should be noted, however, that this study examined student-reported levels of reading motivation on the Motivation to Read Profile (MRP) Survey, and did not include data on actual reading performance.

On the other hand, several studies have reported reading motivation as well as reading performance by gender. Mucherah and Yoder (2008), for example, examined reading motivation, as well as reading by performance on the Indiana Statewide Testing for Educational Progress (ISTEP+), for 388 middle school students. Using the Motivation for Reading Questionnaire (MRQ; see Wigfield & Guthrie, 1997), 11 aspects

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

of motivation were examined: reading efficacy, reading challenge, reading curiosity, aesthetic enjoyment, importance, reading work avoidance, competition in reading, recognition for reading, reading for grades, social reasons for reading, and compliance. Results showed that girls were significantly higher in social reasons for reading, reading for grades, compliance, and importance. Girls also had higher reading efficacy and read more challenging material compared to boys. Mucherah and Yoder found that reading efficacy, reading challenge, reading for aesthetic enjoyment and reading for social reasons were significant predictors of performance on the ISTEP+.

Gender differences in reading performance have also been found in regard to reading activity and reading preferences. Baker and Wigfield (1999) examined the relationship between motivation, reading achievement, and reading activity (i.e., reading a book for fun). Using the MRQ, significant correlations were found between reading achievement and motivation for girls, but not for boys: girls were higher in compliance (reading to meeting others' expectations), recognition (reading for tangible recognition) and reading for grades. Boys, on the other hand, scored higher in work avoidance (desire to avoid reading) and competition (desire to outperform others). Topping, Samuels, and Paul (2008) explored gender differences in preference for fiction and non-fiction reading on a sample of 45,670 students. Boys tended to read less often than girls, and preferred non-fiction to fiction books. Girls, on the other hand, demonstrated both higher reading quality and quantity than boys, and read more fiction. Effect sizes for gender differences in reading achievement, however, were small across grades, ranging from -0.005 to 0.134.

While there are a number of interventions for increasing boys' general academic motivation (see, e.g., Martin, 2003, 2004), few studies focusing on reading advocate interventions specifically for boys. Interventions for increasing reading motivation, regardless of gender, should focus on increasing the aspects of motivation correlated to reading success. Research indicates that girls are higher in self-efficacy and reading more challenging material, and these aspects of motivation are strong predictors of performance on standardised reading tests (Mucherah & Yoder, 2008). Reading programs for boys, then, might aim to increase self-efficacy and encourage the reading of more challenging material, appropriately selected (Topping et al., 2008). Such programs, however, would also be beneficial for poorly motivated girls. While the nature of the relationship between reading and motivation remains unclear, the design of interventions could focus on improving both. Finally, research suggests that both boys and girls might benefit from programs designed to increase intrinsic motivation in reading (Guthrie & Davis, 2003). A number of studies have demonstrated how programs that increase reading involvement also increase performance on comprehension tests (Mucherah & Yoder, 2008). Reading programs that increase extrinsic motivation are also beneficial, but limited: once the reward for reading improvement is removed, the interest in reading declines (Mucherah & Yoder, 2008).

Reading achievement is strongly correlated with reading motivation (Mucherah & Yoder, 2008), and studies show that girls have higher levels of motivation for reading than boys (Baker & Wigfield, 1999; Lepola, 2004), although gender has been shown to account for only a small percent of variance. Girls often score higher in aspects of motivation such as self-efficacy, reading challenging material, and competency beliefs, which are often linked to reading success. It is not clear whether levels of reading motivation precede reading ability or vice versa, therefore the degree to which motivation accounts for more boys than girls observed to have a reading disability is uncertain. More research is needed to clarify the relationship between motivation and reading.

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Conclusion

Throughout the literature it has been repeatedly demonstrated that girls outperform boys on measures of reading, and that there are more boys than girls who struggle with reading or have a reading disability. A number of theoretical explanations have been proposed to account for these reported gender differences in reading, including phonological awareness, auditory processing, behaviour, neurology, variability in cognitive ability scores, and motivation. From a review of empirically based evidence, it does not appear that any single explanation wholly accounts for gender differences in reading ability, and that gender, as a variable, is not a strong or consistent predictor of reading success.

Phonological awareness is one of the strongest predictors of reading ability, accounting for up to 54% of variability (Singleton et al., 1999), but there is minimal evidence suggesting that phonological awareness, or phonemic awareness, accounts for gender differences in reading. The majority of available research on phonemic awareness did not report gender at all, but based on the minimal evidence at hand, gender differences were evident depending on the nature and complexity of the task. These differences, however, did not consistently lead to gender differences in reading outcomes. Although significant gender differences in phonemic awareness have been reported across a number of studies, these same studies also conceded that differences were very small. Other studies found no differences in phonemic awareness between boys and girls. Likewise, evidence suggesting that auditory processing accounts for gender differences in reading is sparse. Studies that do report differences between boys and girls appear to rely on referred samples.

In terms of behaviour, there are consistently significant gender differences in problem behaviour, and although problem behaviour and poor reading are comorbid more often than chance (Knivsberg & Andreassen, 2008), this does not always translate to gender differences in reading ability. Similarly, it remains unclear whether the relationship between poor reading and problem behaviour are causal, correlational or reciprocal (Spira et al., 2005). Problem behaviour in itself, however, does contribute to the fact that significantly more boys than girls are referred for special education services.

In terms of neurological explanations, similar to the findings for phonemic awareness and auditory processing, the majority of studies do not report results by gender. Among those that did report gender, differences between boys and girls were found according to the complexity and nature of the task at hand, although this did not consistently affect reading outcomes. While some studies reported significant gender differences, others did not. According to neurological explanations for differences in reading, it does not appear that gender is a strong predictor of reading success. Boles (2005), for example, reported that gender only accounted for 0.09% to 1% of the variance.

In terms of cognitive variance, evidence suggests that boys have greater variability in scores than girls across a range of cognitive and educational domains, including reading. Greater male variability in reading scores, then, appears to be part of a larger phenomenon, and not necessarily a result of variability in cognitive ability. It is plausible that more boys are identified as poor readers as a result of their extreme scores, but because the majority of studies focus on means rather than variances, more research is needed in order to establish the validity of this explanation.

Finally, motivation is a factor that has been shown to be significantly correlated to reading success (Mucherah & Yoder, 2008), but the evidence suggesting that motivation accounted for gender differences in reading success was mixed. A number of studies demonstrated that girls have an overall higher level of reading motivation, and that boys

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

and girls have different strengths and weaknesses in aspects of motivation. It was not clear, however, whether gender differences in reading were due to gender differences in motivation, or vice versa. More research on the nature of the relationship between reading and motivation is clearly needed in order to draw substantive conclusions.

Based on the findings in this review, two key conclusions can be drawn. First, it does not appear that any single explanation accounts for the observed preponderance of boys identified as having a reading disability. Each explanation clearly has some merit and plays a role in successful reading. All students, for instance, would benefit from a sound knowledge of phonemic awareness, positive behaviour and attention, and an intrinsic motivation for reading. Although these factors are related to successful reading outcomes, they do not consistently explain gender differences in reading outcomes, particularly when evidence supporting gender differences is sparse. Additionally, while there are studies to support the validity of each argument, there are also studies that provide evidence to the contrary.

A second conclusion to be drawn is that gender does not appear to be a strong or consistent predictor of reading outcomes. Across the six explanations discussed, gender has been shown to account for a very small percentage of variance in reading, compared to other factors such as socioeconomic status (Fluss et al., 2009; Strand et al., 2006). Indeed, it has been previously reported that there is sometimes greater variance evident within sex groups, than between sex groups (Boles, 2005; Strand et al., 2006). It may be beneficial, then, for future interventions to be based on aspects of reading which are known to correlate highly with successful reading, focusing on reading outcomes for all students regardless of gender. For example, phonological awareness is one of the strongest predictors of reading ability and accounts for a significant proportion of variance in reading ability (Singleton et al., 1999). Similarly, it has been demonstrated to be a domain of gender-equivalence rather than gender-difference (Savage & Carless, 2004), and therefore separate interventions for boys and girls are not warranted. Research has shown that boys and girls are equally responsive to intervention (Linklater et al., 2009). In addition, because problem behaviour is often comorbid with poor reading, it may also be feasible for future interventions to address issues of behaviour management. While it is not known whether the relationship between problem behaviour and poor reading is causal, correlational or reciprocal, it is generally agreed that intervention should target both behaviour and reading. Successful behaviour strategies may not only benefit poor reading, but may also assist in reducing boys' more frequent referral to special education services, subsequently dispelling the myth that poor reading is a predominantly male phenomenon (Smart et al., 2001). Furthermore, if boys' externalising problem behaviour is reduced, then girls who are struggling readers may have a greater chance of being properly identified. Increasing reading motivation may also be beneficial, particularly in self-efficacy and reading more challenging material. Finally, from a neurological point of view, emerging evidence suggests that although behaviour and reading problems are distinctly different disorders, they access similar regions of the brain and therefore may benefit from similar interventions.

The findings in this review are confounded by a number of variables. Sample selection and bias, for example, may have affected the outcomes of studies reviewed across explanations. As indicated by Smart et al. (2001), in recent decades a considerable number of studies have employed referred samples, where there are up to four times as many boys as girls (Shaywitz et al., 1990). The use of referred samples rather than population samples has resulted in the assumption that poor reading is more a male phenomenon (Smart et al., 2001). Others have reached similar conclusions (Shaywitz et al., 1990). Second,

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

publication bias and non-reporting of nonsignificant results (Wallentin, 2009) should also be considered when drawing conclusions. The majority of studies on phonemic awareness, auditory processing and neurological processing, for example, do not report results by gender, raising the question of whether gender differences are not evident and therefore not reported, or whether there is an alternative explanation. It further demonstrates that the belief that reading disability is more likely to be a male phenomenon might be based on assumption rather than empirical evidence. Additionally, of the few studies that do report gender, it remains questionable whether the results are representative enough, or significant enough, to draw realistic conclusions.

A final point to consider is that although a number of explanations have been proposed to account for gender differences in reading, the jury is still out as to whether there actually are gender differences in reading. As indicated earlier, some studies have reported little or no differences in reading between boys and girls, where others have reported gender ratios for poor reading up to 4.51:1 (Miles et al., 1998), as a result of differences across studies in assessments, severity of selection, and samples. Wheldall and Limbrick (2010) addressed these inconsistencies by analysing the performance of Years 3 and 5 students on a large-scale assessment over a 10-year period, with a sample of more than one million students. They concluded that although there were more boys than girls who were poor readers, the difference was not as dire as previously thought. Others have reached similar conclusions (Limbrick, Wheldall, & Madelaine, 2010; Siegel & Smythe, 2005). Such findings are also complementary to Hyde's (2005) gender similarities hypothesis. Based on a review of 46 meta-analyses, Hyde concluded that boys and girls are more alike than different in a range of educational and psychological variables, and gender differences have previously been over-inflated. Based on findings in this review, then, it may be that there are differences between boys and girls on various aspects of reading and reading-related factors, but these differences are not as large as previously thought, and do not consistently affect reading outcomes.

References

Aarnoutse, C., & Schellings, G. (2003). Learning reading strategies by triggering reading motivation. *Educational Studies, 29*, 387–409. doi:10.1080/0305569032000159688

Amitay, S., Ben-Yehudah, G., Banai, K., & Ahissar, M. (2002). Disabled readers suffer from visual and auditory impairments but not from a specific magnocellular deficit. *Brain, 125*, 2272–2285. doi:10.1093/brain/awf231

Baker, L., & Wigfield, A. (1999). Dimensions of children's motivation for reading and their relations to reading activity and reading achievement. *Reading Research Quarterly, 34*, 452–477.

Bauermeister, J.J., Shrout, P.E., Chávez, L., Rubio-Stipec, M., Ramirez, R., Padilla, L., … Canino, G. (2007). ADHD and gender: Are risks and sequela of ADHD the same for boys and girls? *Journal of Child Psychology and Psychiatry, 48*, 831–839. doi:10.1111/j.1469-7610.2007.01750.x

Beaman, R., Wheldall, K., & Kemp, C. (2007). Recent research on troublesome classroom behaviour: A review. *Australasian Journal of Special Education, 31*, 45–60. doi:10.1080/10300110701189014

Bennett, K.J., Brown, K.S., Boyle, M., Racine, Y., & Offord, D. (2003). Does low reading achievement at school entry cause conduct problems? *Social Science & Medicine, 56*, 2443–2448. doi:10.1016/S0277-9536(02)00247-2

Biederman, J., Kwon, A., Aleardi, M., Chouinard, V.-A., Marino, T., Cole, H., … Faraone, S. V. (2005). Absence of gender effects on Attention Deficit Hyperactivity Disorder: Findings in nonreferred subjects. *American Journal of Psychiatry, 162*, 1083–1089.

Boles, D.B. (2005). A large-sample study of sex differences in functional cerebral lateralization. *Journal of Clinical and Experimental Neuropsychology, 27*, 759–768. doi:10.1080/13803390590954263

Burman, D.D., Bitan, T., & Booth, J.R. (2008). Sex differences in neural processing of language among children. *Neuropsychologia, 46*, 1349–1362. doi:10.1016/j.neuropsychologia.2007.12.021

Burt, L., Holm, A., & Dodd, B. (1999). Phonological awareness skills of 4-year-old British children: An assessment and developmental data. *International Journal of Language & Communication Disorders, 34,* 311–335. doi:10.1080/136828299247432

Catts, H.W., Fey, M.E., Zhang, X., & Tomblin, J.B. (1999). Language basis of reading and reading disabilities: Evidence from a longitudinal investigation. *Scientific Studies of Reading, 3*, 331–361. **doi:**10.1207/s1532799xssr0304_2

Chan, D.W., Ho, C.S.-H., Tsang, S.-M., Lee, S.-H., & Chung, K.H.H. (2007). Prevalence, gender ratio and gender differences in reading-related cognitive abilities among Chinese children with dyslexia in Hong Kong. *Educational Studies, 33,* 249–265. doi:10.1080/03055690601068535

Chermak, G.D., & Musiek, F.E. (1997). *Central auditory processing disorders: New perspectives.* San Diego: Singular Publishing Group.

Clements, A.M., Rimrodt, S.L., Abel, J.R., Blankner, J.G., Mostofsky, S.H., Pekar, J.J., … Cutting, L.E. (2006). Sex differences in cerebral laterality of language and visuospatial processing. *Brain and Language, 98*, 150–158. doi:10.1016/j.bandl.2006.04.007

Coddington, C.S., & Guthrie, J.T. (2009). Teacher and student perceptions of boys' and girls' reading motivation. *Reading Psychology, 30,* 225–249. doi:10.1080/02702710802275371

Colom, R., Juan-Espinosa, M., Abad, F., & García, L.F. (2000). Negligible sex differences in general intelligence. *Intelligence, 28*, 57–68.

Coney, J. (2002). Lateral asymmetry in phonological processing: Relating behavioral measures to neuroimaged structures. *Brain and Language, 80,* 355–365. doi:10.1006/brln.2001.2596

Dawes, P., & Bishop, D. (2009). Auditory processing disorder in relation to developmental disorders of language, communication and attention: A review and critique. *International Journal of Language & Communication Disorders, 44*, 440–465. doi:10.1080/13682820902929073

Deary, I.J., Thorpe, G., Wilson, V., Starr, J.M., & Whalley, L.J. (2003). Population sex differences in IQ at age 11: The Scottish mental survey 1932. *Intelligence, 31*, 533–542.

de Jong, C.G.W., Oosterlaan, J., & Sergeant, J.A. (2006). The role of double dissociation studies in the search for candidate endophenotypes for the comorbidity of attention deficit hyperactivity disorder and reading disability. *International Journal of Disability, Development and Education, 53,* 177–193. doi:10.1080/10349120600716158

Dlouha, O., Novak, A., & Vokral, J. (2007). Central auditory processing disorder (CAPD) in children with specific language impairment (SLI) central auditory tests. *International Journal of Pediatric Otorhinolaryngology, 71,* 903–907. doi:10.1016/j.ijporl.2007.02.012

Dodd, B., Holm, A., Hua, Z., & Crosbie, S. (2003). Phonological development: A normative study of British English-speaking children. *Clinical Linguistics & Phonetics, 17,* 617–643. doi:10.1080/0269920031000111348

Domitz, D.M., & Schow, R.L. (2000). A new CAPD battery — multiple auditory processing assessment: Factor analysis and comparisons with SCAN. *American Journal of Audiology, 9*, 1–11. doi:10.1044/1059-0889(2000/012)

Dykiert, D., Gale, C.R., & Deary, I.J. (2009). Are apparent sex differences in mean IQ scores created in part by sample restriction and increased male variance? *Intelligence, 37*, 42–47.

Ellis, H. (1894). *Man and woman.* London: Walter Scott.

Fleming, C.B., Harachi, T.W., Cortes, R.C., Abbott, R.D., & Catalano, R.F. (2004). Level and change in reading scores and attention problems during Elementary school as predictors of problem behavior in Middle school. *Journal of Emotional and Behavioral Disorders, 12,* 130–144.

Fluss, J., Ziegler, J.C., Warszawski, J., Ducot, B., Richard, G., & Billard, C. (2009). Poor reading in French elementary school: The interplay of cognitive, behavioural, and socioeconomic factors. *Journal of Developmental & Behavioral Pediatrics, 30*, 206–216. doi:10.1097/DBP.0b013e3181a7ed6c

Galsworthy, M.J., Dionne, G., Dale, P.S., & Plomin, R. (2000). Sex differences in early verbal and non-verbal cognitive development. *Developmental Science, 3*, 206–215.

Gernand, K.L., & Morgan, M.J. (2007). Phonological awareness abilities of 6-year-old children with mild to moderate phonological impairments. *Communication Disorders Quarterly, 28*, 206–215.

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Ghanizadeh, A. (2009). Screening signs of auditory processing problem: Does it distinguish attention deficit hyperactivity disorder subtypes in a clinical sample of children? *International Journal of Pediatric Otorhinolaryngology, 73*, 81–87. doi:10.1016/j.ijporl.2008.09.020

Gur, R.C., Alsop, D., Glahn, D., Petty, R., Swanson, C.L., Maldjian, J.A., … Gur, R.E. (2000). An fMRI study of sex differences in regional activation to a verbal and a spatial task. *Brain and Language, 74,* 157–170. doi:10.1006/brln.2000.2325

Guthrie, J.T., & Davis, M.H. (2003). Motivating struggling readers in middle school through an engagement model of classroom practice. *Reading & Writing Quarterly, 19*, 59–85.

Halpern, D.F., & LaMay, M.I. (2000). The smarter sex: A critical review of sex differences in intelligence. *Educational Psychology Review, 12*, 229–246.

Hawke, J.L., Olson, R.K., Willcutt, E.G., Wadsworth, S.J., & DeFries, J.C. (2009). Gender ratios for reading difficulties. *Dyslexia, 15*, 239–242. doi:10.1002/dys.389

Hawke, J.L., Wadsworth, S.J., Olson, R.K., & DeFries, J.C. (2007). Etiology of reading difficulties as a function of gender and severity. *Reading and Writing, 20*, 13–25. doi:10.1007/s11145-006-9016-z

Heim, S., Tschierse, J., Amunts, K., Wilms, M., Vossel, S., Willmes, K., … Huber, W. (2008). Cognitive subtypes of dyslexia. *Acta Neurobiologiae Experimentalis, 68*, 73–82.

Hinshaw, S.P. (1992). Externalizing behavior problems and academic underachievement in childhood and adolescence: Causal relationships and underlying mechanisms. *Psychological Bulletin, 111*, 127–135.

Hudson, R.F., High, L., & Al Otaiba, S. (2007). Dyslexia and the brain: What does current research tell us? *The Reading Teacher, 60*, 506–515.

Hyde, J.S. (2005). The gender similarities hypothesis. *American Psychologist, 60*, 581–592.

Hyde, J.S., & Lynn, M.C. (1988). Gender differences verbal ability: A meta-analysis. *Psychological Bulletin, 104*, 53–69.

Jaeger, J.J., Lockwood, A.H., Van Valin, R.D., Kemmerer, D.L., Murphy, B.W., & Wack, D.S. (1998). Sex differences in brain regions activated by grammatical and reading tasks. *NeuroReport, 9*, 2803–2807.

Johnson, W., & Bouchard, T.J. (2007). Sex differences in mental abilities: *g* masks the dimensions on which they lie. *Intelligence, 35*, 23–39.

Jutras, B., Loubert, M., Dupuis, J.-L., Marcoux, C., Dumont, V., & Baril, M. (2007). Applicability of central auditory processing disorder models. *American Journal of Audiology, 16*, 100–106. doi:10.1044/1059-0889(2007/014)

Kaiser, A., Haller, S., Schmitz, S., & Nitsch, C. (2009). On sex/gender related similarities and differences in fMRI language research. *Brain Research Reviews, 61*, 49–59. doi:10.1016/j.brainresrev.2009.03.005

Kansaku, K., Yamaura, A., & Kitazawa, S. (2000). Sex differences in lateralization revealed in the posterior language areas. *Cerebral Cortex, 10,* 866–872. doi:10.1093/cercor/10.9.866

Kelley, M.J., & Decker, E.O. (2009). The current state of motivation to read among middle school students. *Reading Psychology, 30,* 466–485. doi:10.1080/02702710902733535

Lepola, J. (2004). The role of gender and reading competence in the development of motivational orientations from Kindergarten to Grade 1. *Early Education & Development, 15,* 215–240.

Levy, F., Hay, D.A., Bennett, K.S., & McStephen, M. (2005). Gender differences in ADHD subtype comorbidity. *Journal of the American Academy of Child Adolescent Psychiatry, 44*, 368–376. doi:10.1097/01.chi.0000153232.64968.c1

Liederman, J., Kantrowitz, L., & Flannery, K. (2005). Male vulnerability to reading disability is not likely to be a myth: A call for new data. *Journal of Learning Disabilities, 38*, 109–129.

Limbrick, L., Wheldall, K., & Madelaine, A. (2008). Gender ratios for reading disability: Are there really more boys than girls who are low-progress readers? *Australian Journal of Learning Difficulties, 13*, 161–179.

Limbrick, L., Wheldall, K., & Madelaine, A. (2010). Estimating gender ratios of poor reading using large-scale assessments. *Australian Journal of Education, 54*, 190–222.

Linklater, D.L., O'Connor, R.E., & Palardy, G.J. (2009). Kindergarten literacy assessment of English only and English language learner students: An examination of the predictive validity of three phonemic awareness measures. *Journal of School Psychology, 47,* 369–394. doi:10.1016/j.jsp.2009.08.001

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Lohman, D.F., & Lakin, J.M. (2009). Consistencies in sex differences on the Cognitive Abilities Test across countries, grades, test forms, and cohorts. *British Journal of Educational Psychology, 79*, 389–407. doi:10.1348/000709908X354609

Lynn, R., & Mikk, J. (2009). Sex differences in reading achievement. *Trames, 13*, 3–13. doi:10.3176/tr.2009.1.01

Machin, S., & Pekkarinen, T. (2008). Global sex differences in test score variability. *Science, 322*, 1331–1332. doi:10.1126/science.1162573

Majeres, R.L. (2006). Sex differences in phonological coding: Alphabet transformation speed. *Intelligence, 35*, 335–346. doi:10.1016/j.intell.2006.08.005

Martin, A.J. (2003). Boys and motivation. *The Australian Educational Researcher, 30*, 43–65.

Martin, A.J. (2004). School motivation of boys and girls: Differences of degree, differences of kind, or both? *Australian Journal of Psychology, 56*, 133–146. doi:10.1080/00049530412331283363

Matthews, J.S., Ponitz, C.C., & Morrison, F.J. (2009). Early gender differences in self-regulation and academic achievement. *Journal of Educational Psychology, 101*, 689–704. doi:10.1037/a0014240

McCormack, P., & Knighton, T. (1996). Gender differences in the speech development of 2.5-year-old children. In P. McCormack & A. Russell (Eds.), *Proceedings of the Sixth Australian International Conference on Speech Science and Technology* (pp. 217–222). The Australian Speech Sciences and Technology Association, Adelaide, Australia.

McIntosh, K., Horner, R.H., Chard, D.J., Dickey, C.R., & Braun, D.H. (2008). Reading skills and function of problem behavior in typical school settings. *The Journal of Special Education, 42*, 131–147.

Meece, J.L., Bower Glienke, B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology, 44*, 351–373. doi:10.1016/j.jsp.2006.04.004

Meece, J.L., & Miller, S.D. (2001). A longitudinal analysis of elementary school students' achievement goals in literacy activities. *Contemporary Educational Psychology, 26*, 454–480. doi:10.1006/ceps.2000.1071

Miles, T.R., Haslum, M.N., & Wheeler, T.J. (1998). Gender ratio in dyslexia. *Annals of Dyslexia, 48*, 27–55. doi:10.1007/s11881-998-0003-8

Molfese, D.L., Fonaryova Key, A., Kelly, S., Cunningham, N., Terrell, S., Ferguson, M., … Bonebright, T. (2006). Below-average, average, and above-average readers engage different and similar regions while reading. *Journal of Learning Disabilities, 39*, 352–363.

Moore, D.R. (2007). Auditory processing disorders: Acquisition and treatment. *Journal of Communication Disorders, 40*, 295–304. doi:10.1016/j.jcomdis.2007.03.005

Morgan, P.L., Farkas, G., Tufis, P.A., & Sperling, R.A. (2008). Are reading and behavior problems risk factors for each other? *Journal of Learning Disabilities, 41*, 417–436.

Moura, S.R., Mezzomo, C.L., & Cielo, C.A. (2008). Phonemic awareness stimulation and its effects regarding the variable gender. *Pró-Fono Revista de Atualização Científica, 21*, 51–56.

Mucherah, W., & Yoder, A. (2008). Motivation for reading and middle school students' performance on standardized testing in reading. *Reading Psychology, 29*, 214–235. doi:10.1080/02702710801982159

National Institute on Deafness and Other Communication Disorders (NIDCP). (2009). *Auditory processing disorders in children*. Retrieved September 1, 2009, from http://www.nidcd.nih.gov/health/voice/auditory.asp

Nowell, A., & Hedges, L.V. (1998). Trends in gender differences in academic achievement from 1960 to 1994: An analysis of differences in mean, variance, and extreme scores. *Sex Roles, 39*, 21–43. doi:10.1023/A:1018873615316

O'Malley, K.J., Francis, D.J., Foorman, B.R., Fletcher, J.M., & Swank, P.R. (2002). Growth in precursor and reading-related skills: Do low-achieving and IQ-discrepant readers develop differently? *Learning Disabilities Research & Practice, 17*, 19–34. doi:10.1111/1540-5826.00029

Papadopoulos, T.C., Spanoudis, G., & Kendeou, P. (2009). The dimensionality of phonological abilities in Greek. *Reading Research Quarterly, 44*, 127–143.

Phillips, M.D., Lowe, M.J., Lurito, J.T., Dzemidzic, M., & Mathews, V.P. (2001). Temporal lobe activation demonstrates sex-based differences during passive listening. *Radiology, 220*, 202–207.

Phillips, L.M., Norris, S.P., & Steffler, D.J. (2007). Potential risks to reading posed by high-dose phonics. *Journal of Applied Research on Learning, 1*, 1–18.

https://doi.org/10.1375/ajse.35.1.1 Published online by Cambridge University Press

Pugh, K.R., Shaywitz, B.A., Shaywitz, S.E., Constable, R.T., Skudlarksi, P., Fulbright, R.K., … Gore, J.C. (1996). Cerebral organization of component processes in reading. *Brain*, 119, 1221–1238.

Puolakanaho, A., Ahonen, T., Aro, M., Eklund, K., Leppänen, P.H.T., Poikkeus, A.-M., … Lyytinen, H. (2007). Very early phonological and language skills: Estimating individual risk of reading disability. *Journal of Child Psychology and Psychiatry, 48*, 923–931. doi:10.1111/j.1469-7610.2007.01763.x

Reynolds, C.A., Hewitt, J.K., Erickson, M.T., Silberg, J.L., Rutter, M., Simonoff, E., … Eaves, L.J. (1996). The genetics of children's oral reading performance. *Journal of Child Psychology and Psychiatry, 37*, 425–434. doi:10.1111/j.1469-7610.1996.tb01423.x

Rowe, K., & Rowe, K. (2006, April). *BIG issues in boys' education: Auditory processing capacity, literacy and behaviour.* Paper presented at the Second New Zealand Boys in Education Conference, Massey University, Auckland, New Zealand.

Rowe, K.J., & Rowe, K.S. (1999). Investigating the relationship between students' attentive-inattentive behaviors in the classroom and their literacy progress. *International Journal of Educational Research, 31*, 1–138.

Rowe, K.S., & Rowe, K.J. (2006a). Careful, he may not hear you: Or, more accurately, may not process auditory information. *Teacher: The National Education Magazine,* May, 60–63.

Rowe, K., Rowe, K., & Pollard, J. (2004, October). *Literacy, behaviour and auditory processing: Building 'fences' at the top of the 'cliff' in preference to 'ambulance services' at the bottom.* Paper presented at the ACER Research Conference, Adelaide, Australia.

Sanson, A., Prior, M., & Smart, D. (1996). Reading disabilities with and without behaviour problems at 7–8 years: Prediction from longitudinal data from infancy to 6 years. *Journal of Child Psychology and Psychiatry, 37,* 529–541. doi:10.1111/j.1469-7610.1996.tb01439.x

Savage, R., & Carless, S. (2004). Predicting curriculum and test performance at age 7 years from pupil background, baseline skills and phonological awareness at age 5. *British Journal of Educational Psychology, 74*, 155–171.

Savage, R., Carless, S., & Ferraro, V. (2007). Predicting curriculum and test performance at age 11 years from pupil background, baseline skills and phonological awareness at age 5 years. *Journal of Child Psychology and Psychiatry, 48*, 732–739. doi:10.1111/j.1469-7610.2007.01746.x

Schminky, M.M., & Baron, J.A. (2000). *Central auditory processing disorders: An overview of assessment and management practices.* Retrieved October 26, 2009, from http://www.tsbvi.edu/Outreach/seehear/spring00/centralauditory.htm

Sharma, M., Purdy, S.C., & Kelly, A.S. (2009). Comorbidity of auditory processing, language, and reading disorders. *Journal of Speech, Language, and Hearing Research, 52*, 706–722.

Sharma, M., Purdy, S.C., Newall, P., Wheldall, K., Beaman, R., & Dillon, H. (2006). Electrophysiological and behavioral evidence of auditory processing deficits in children with reading disorder. *Clinical Neurophysiology, 117*, 1130–1144. doi:10.1016/j.clinph.2006.02.001

Shaywitz, S.E., & Shaywitz, B.A. (2007). What neuroscience really tells us about reading instruction: A response to Judy Willis. *Educational Leadership, 64,* 74–76.

Shaywitz, S.E., & Shaywitz, B.A. (2008). Paying attention to reading: The neurobiology of reading and dyslexia. *Development and Psychopathology, 20*, 1329–1349. doi:10.1017/S0954579408000631

Shaywitz, B.A., Shaywitz, S.E., Blachman, B.A., Pugh, K.R., Fulbright, R.K., Skudlarski, P., … Gore, J.C. (2004). Development of left occipitotemporal systems for skilled reading in children after a phonologically-based intervention. *Biological Psychiatry, 55*, 926–933. doi:10.1016/j.biopsych.2003.12.019

Shaywitz, S.E., Shaywitz, B.A., Fletcher, J.M., & Escobar, M.D. (1990). Prevalence of reading disability in boys and girls: Results of the Connecticut Longitudinal Study. *The Journal of the American Medical Association, 22*, 998–1002.

Shaywitz, B.A., Shaywitz, S.E., Pugh, K.R., Constable, R.T., Skudlarski, P., Fulbright, R.K., … Gore, J.C. (1995). Sex differences in the functional organization of the brain for language. *Nature, 373,* 607–609.

Siegel, L.S., & Smythe, I.S. (2005). Reflections on research on reading disability with special attention to gender issues. *Journal of Learning Disabilities, 38,* 473–477. doi:10.1177/00222194050380050901

Singleton, C., Horne, J., & Thomas, K. (1999). Computerised baseline assessment of literacy. *Journal of Research in Reading, 22*, 67–80.

Skårbrevik, K.J. (2002). Gender differences among students found eligible for special education. *European Journal of Special Needs Education, 17,* 97–107. doi:10.1080/08856250210129038

Smart, D., Prior, M., Sanson, A., & Oberklaid, F. (2001). Children with reading difficulties: A six-year follow-up from early primary school to secondary school. *Australian Journal of Psychology, 53,* 45–53. doi:10.1080/00049530108255121

Sommer, I.E., Aleman, A., Somers, M., Boks, M.P., & Kahn, R.S. (2008). Sex differences in handedness, asymmetry of the Planum Temporale and functional language lateralization. *Brain Research, 1206,* 76–88. doi:10.1016/j.brainres.2008.01.003

Spira, E.G., Bracken, S.S., & Fischel, J.E. (2005). Predicting improvement after first-grade reading difficulties: The effects of oral language, emergent literacy, and behaviour skills. *Developmental Psychology, 41,* 225–234. doi:10.1037/0012-1649.41.1.225

Stanovich, K.E. (1999). The sociopsychometrics of learning disabilities. *Journal of Learning Disabilities, 32*, 350–361. doi:10.1177/002221949903200408

Strand, S., Deary, I.J., & Smith, P. (2006). Sex differences in Cognitive Abilities Test scores: A UK national picture. *British Journal of Educational Psychology, 76,* 463–480. doi:10.1348/000709905X50906

Thorndike, E.L. (1914). *The psychology of learning*. New York: Teachers College.

Topping, K.J., Samuels, J., & Paul, T. (2008). Independent reading: The relationship of challenge, non-fiction and gender to achievement. *British Educational Research Journal, 34*, 505–524. doi:10.1080/01411920701609380

Treutlein, A., Zöller, I., Roos, J., & Schöler, H. (2008). Effects of phonological awareness training on reading achievement. *Written Language & Literacy, 11,* 147–166. doi:10.1075/wll.11.2.03tre

Trzesniewski, K.H., Moffitt, T.E., Caspi, A., Taylor, A., & Maughan, B. (2006). Revisiting the association between reading achievement and antisocial behavior: New evidence of an environmental explanation from a twin study. *Child Development, 77*, 72–88. doi:10.1111/j.1467-8624.2006.00857.x

Van Kesteren, M.T.R., & Wiersinga-Post, E.C. (2007). Auditory temporal-order thresholds show no gender differences. *Restorative Neurology and Neuroscience, 25*, 119–122.

Veuillet, E., Magnan, A., Ecalle, J., Thai-Van, H., & Collet, L. (2007). Auditory processing disorder in children with reading disabilities: Effect of audiovisual training. *Brain, 130*, 2915–2928. doi:10.1093/brain/awm235

Vogel, S.A. (1990). Gender differences in intelligence, language, visual-motor abilities, and academic achievement in students with learning disabilities: A review of the literature. *Journal of Learning Disabilities, 23*, 44–52. doi:10.1177/002221949002300111

Voyer, D., Voyer, S., & Bryden, M.P. (1995). Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin, 117*, 250–270. doi:10.1037/0033-2909.117.2.250

Wallentin, M. (2009). Putative sex differences in verbal abilities and language cortex: A critical review. *Brain & Language, 108*, 175–183. doi:10.1016/j.bandl.2008.07.001

Walker, M.M., Shinn, J.B., Cranford, J.L., Givens, G.D., & Holbert, D. (2002). Auditory temporal processing performance of young adults with reading disorders. *Journal of Speech, Language, and Hearing Research, 45,* 598–605. doi:10.1044/1092-4388(2002/048)

Wheldall, K., & Limbrick, L. (2010). Do more boys than girls have reading problems? *Journal of Learning Disabilities, 43*, 418–429. doi:10.1177/0022219409355477

Wigfield, A. (1997). Reading motivation: A domain-specific approach to motivation. *Educational Psychologist, 32*, 59–68. doi:10.1207/s15326985ep3202_1

Wigfield, A., & Guthrie, J.T. (1995). *Dimensions of children's motivations for reading: An initial study* (Research Rep. No. 34). Athens, GA: National Reading Research Center.

Wigfield, A., & Guthrie, J.T. (1997). Relations of children's motivation for reading to the amount and breadth of their reading. *Journal of Educational Psychology, 89,* 420–432.

Willcutt, E.G., & Pennington, B.F. (2000). Comorbidity of reading disability and attention-deficit/hyperactivity disorder: Differences by gender and subtype. *Journal of Learning Disabilities, 33,* 179–191. doi:10.1177/002221940003300206