Published in final edited form as:

Sci Stud Read. 2020 ; 24(1): 14–22. doi:10.1080/10888438.2019.1593420.

Co-occurrence of Reading Disabilities and Math Disabilities: A Meta-Analysis

Rachel E. Joyner¹, Richard K. Wagner¹

¹Florida State University, Tallahassee, FL, USA

Abstract

Despite the importance of identifying individuals with reading disabilities, existing operational definitions of reading disability do not result in reliable identification. A large part of the problem arises from measurement error when a cut-point is imposed on a continuous distribution, especially for low base-rate conditions. One way to reduce measurement error is to include additional predictors in reading disability models. The present study examined co-occurring math disability as a possible additional criterion for predicting reading disability. Meta-analysis was used to examine the probability of individuals with reading disability also having a comorbid math disability. Possible moderators including age, severity of disability, and language were examined. The main result was an average weighted odds ratio of 2.12, 95% confidence interval [1.76, 2.55], indicating that students with a math disability are just over two times more likely to also have a reading disability than those without a math disability. Implications of the results are discussed.

Keywords

reading disabilities; math disabilities; comorbidity; meta-analysis

Existing operational definitions of reading disability do not result in reliable identification or diagnosis (Waesche, Schatschneider, Maner, Ahmed, & Wagner, 2011). This is true for both traditional definitions based on unexpected academic under-achievement (American Psychiatric Association, 2013) and for alternative proposed definitions based on response-to-intervention (RTI) or simple low achievement in reading. An important reason for poor reliability in diagnosis is that when a cut-point is imposed on a continuous distribution and the phenomenon is characterized by a relatively low base-rate, measurement error causes individuals who are near to the cut-point to end up on alternative sides upon repeated assessment, thereby resulting in unstable classification (Francis et al., 2005).

Given that measurement error is a cause of poor reliability of identification, efforts to reduce measurement error are a promising approach to improving reliability of identification. One approach to reduce measurement error is to incorporate multiple sources of information or criteria instead of relying primarily on a single criterion. The rationale is that multiple

Corresponding Author: Rachel E. Joyner, Florida State University, Department of Psychology, 1107 W Call St., Tallahassee, FL 32304, rjoyner@psy.fsu.edu.

Conflict of Interest: The authors declared no potential conflicts of interest while conducting this research.

correlated predictors are better able to predict a criterion compared to a single predictor. For the case of reading disability, there are several additional criteria that might be incorporated into diagnosis. For example, an individual who comes from a family with a history of reading problems has a roughly four times greater chance of having reading disability (Snowling, Gallagher, & Frith, 2003). Similarly, boys are two times more likely to have a severe reading disability than girls (Quinn, 2018).

One criterion that might be useful to consider as an additional predictor is co-occurring math disability. Previous studies suggest varying degrees of co-morbidity between math and reading disability (Badian, 1999; Barbaresi, Katusic, Colligan, Weaver, & Jacobsen, 2005; Branum-Martin et al., 2012; Dirks, Spyer, van Lieshout, & de Sonnevile, 2008; Lewis, Hitch & Walker, 1994; Light & DeFries, 1995). Possible reasons for the co-occurrence of reading and math disability include shared reliance on phonological processing, memory, or executive functioning, similarities between digits and letters for alphabetic writing systems, and the fact that much of math requires reading (de Smedt, Taylor, Archibald, & Ansaria, 2010; Hecht, Torgesen, Wagner, & Rashotte, 2001; Swanson & Jerman, 2006; Swanson, Jerman, & Zheng, 2009; Yeniad et al., 2013).

The usefulness of math disability as an indicator of reading depends upon the extent to which the presence of math disability is associated with increased risk of reading disability. Although a previous meta-analysis addressed the topic of shared potential causes of reading and math disabilities (Swanson, Jerman, & Zheng, 2009), no known research syntheses, literature reviews, or meta-analyses have examined the magnitude of the association between math and reading disability. Therefore, the purpose of the present study was to use meta-analysis to examine the extent to which the presence of math disability was associated with greater risk of reading disability.

Method

Literature Search

Studies were found using both ProQuest and EBSCO search engines, specifically using the PsycINFO, ERIC, Linguistics and Language Behavior Abstracts, Dissertations and Theses-Global, and Dissertations and Theses @FSU-FCLA databases from ProQuest, and the ERIC and Academic Search Complete Databases from EBSCO. Search terms for these databases consisted of both reading and math disabilities, skills, development, difficulties, achievement, or abilities. Search terms were shortened with an asterisk to broaden the search based on variations of terms (e.g., disab* to search for disabilities, disability, disabled, etc.). Terms typically found in the abstract of an empirical article such as depend*, predict*, or associat* were also included in the search to ensure that the studies found were empirical in nature. Exclusionary search terms pertained to brain or head injuries, motor control deficits, deafness or blindness, neurological disorders, or intellectual development disorders.

A comprehensive search of the databases above resulted in 705 studies. Ten neurological studies were disqualified from analyses and 464 studies were excluded based on title relevancy. Another 145 studies were excluded based on abstract content. The remaining 86 studies were then screened for the inclusionary criteria listed below. Based on these criteria,

61 studies were excluded leaving 25 studies to be included in the current meta-analysis. Manually searching the reference lists of included studies turned up an additional 13 additional studies that were included, resulting in a total of 36 studies included in the meta-analysis.

Inclusionary Criteria

The following inclusion criteria were used for study identification:

1. Studies must be written in, or translated into, English.
2. Studies must include participants who are typically developing, reading disabled, math disabled, and both reading and math disabled.
3. Studies must contain relevant statistical information for the present meta-analysis. The effect sizes for each study were calculated using an odds ratio. To calculate this statistic, it was necessary to record the sample size of participants in each subgroup of disability (see above).

Coding Procedures

Studies were coded for sample size of each disability subgroup along with the following potential moderator variables: Overall sample size, year of publication, mean age and/or grade of participants, language spoken by sample, and severity of disability. Severity of disability was quantified by the percentile or standard deviation cut-off of standardized assessments used to classify reading or math disabilities. Four studies failed to report classification criteria but were still included in analyses as missing data in moderator analyses of severity of disability.

When coding for language spoken, languages were sorted into four separate categories: English, other Germanic languages (e.g., German, Swedish, Dutch, and Norwegian), Uralic languages (e.g., Finnish), and Latin languages (e.g., Spanish, French, or Italian). Categorizing languages as such not only groups languages based on complexity, but also eliminates bias in analyses for languages only used in one study compared to languages used in multiple studies.

Few studies had longitudinal or cross-sectional designs, and when they did, only a single odds ratio was included from each study to eliminate dependent effect sizes. In these cases, the odds ratio was calculated from the first time point. Reliability of coding was examined for moderator variables by double-coding 20 percent of the studies. Reliability was perfect for each of the moderators with Kappa = 1.0, which reflects the obvious and objective nature of the moderator variables that were coded.

Statistical Analyses

To quantify relations between reading and math disability, an odds ratio was calculated for each included study. To calculate the odds ratio, the product of individuals with reading disability only and math disability only was divided by the product of individuals with both disabilities and neither disability. Three outlying odds ratios, defined in the present study as being outside the range median plus or minus 2.5 interquartile ranges, were identified and,

thus, excluded from analyses. As is standard procedure in meta-analysis, odds ratios were transformed to log odds ratio for analyses (Cooper, Hedges, & Valentine, 2009, p.244). Once analyses were completed, log odds ratios were transformed back to odds ratios for easy interpretation.

After the average weighted log odds ratio was calculated, a Q statistic was used to assess heterogeneity of effect sizes (i.e., whether variability in effect sizes across studies was greater than would be expected on the basis of sampling error). A Q statistic indicates significant heterogeneity if effect sizes across studies (Cooper, Hedges, & Valentine, 2009). To test the magnitude of effect size heterogeneity, the I^2 statistic was also calculated. The I^2 statistic complements the Q in that it represents the proportion of variance not due to chance in effect sizes across studies. The Q statistic for the present study was significant, $Q = 81.81$, $p < .001$, indicating that effect sizes across studies varied more than would be expected based on sampling error alone. The I^2 value of 63.32% indicated that more than half of the variability across effect sizes could not be attributed to sampling error, warranting moderator analyses.

Moderator analyses were conducted using meta-regression to better understand the roles of year of publication, age, language spoken, sample size, and severity of disability status of participants as moderators in predicting the average log odds ratio and accounting for heterogeneous variance across studies. Although the construct used for assessing and classifying a math disorder may be a potential moderator, there was a lack in variability of screening measures in the included studies. Therefore, mathematical constructs were not included in the moderator analyses. Publication bias was tested by the creation of a funnel plot (Cooper, Hedges, & Valentine, 2009) and Egger's test of asymmetry (Egger, Smith, Schneider, & Minder, 1997).

Results

Pooled Effect Size Calculations

Log odds ratios were transformed back to odds ratios after analyses so that results could be interpreted easily. A forest plot of odds ratios from the 33 studies included in analyses is shown in Figure 1. The average odds ratio for these studies was significant, $OR = 2.12$, 95% confidence interval, $CI [1.76, 2.55]$, $p < .001$. This ratio suggests that individuals are just over two times more likely to have a reading disability if they also have a math disability than are individuals who do not have a math disability. The results of moderator analyses show that none of the predicted moderators accounted for significant variance in effect sizes across studies: $B = -.13$, $p = .17$ for year, $B = -.04$, $p > .5$ for age, $B = -.04$, $p > .5$ for language, $B = .07$, $p = .44$ for sample size, and $B = -.03$, $p > .5$ for severity of disability¹.

¹In response to a reviewer comment, alternative measures of severity of the reading and math disability were tested as possible moderators. A Cohen's d value representing the difference in reading and math skills between control and disabled groups within each study was calculated, resulting in six possible moderators (reading Control vs. RD only, math Control vs. RD only, reading Control vs. MD only, math Control vs. MD only, reading Control vs. RD+MD, and math Control vs. RD+MD). Although doing a moderator analysis using these values would contribute a more continuous visualization of the difference between control and disability groups, results were not significant.

With 33 effect sizes, sensitivity to detect significant moderators is limited; however, even the magnitude of the regression coefficients was small.

A funnel plot of the effect size was produced to better visualize the potential for publication bias in studies chosen for analysis (Figure 2). The large number of studies with smaller effect sizes is expected, and the balanced presence of studies on either side of the distribution suggests an unbiased sample of studies in the present analysis. Egger's test for funnel plot asymmetry was not significant, $p > .5$, further suggesting no evidence for publication bias.

Sensitivity Analyses

Multiple statistical decisions were made to maximize integrity of results in the present study; namely, three possible dependent odds ratios and three outlying odds ratios were excluded from analyses. When including these six data points, however, results did not change significantly, with average weighted OR = 2.42, 95% CI [.87, 6.72], $p < .001$, $Q = 139.13$, $I^2 = 73.14\%$. Similarly, moderator analyses did not change significantly when dependent effect sizes were included: $B = -.11$, $p = .33$ for year, $B = -.11$, $p = .29$ for age, $B = -.04$, $p > .5$ for language, $B = .13$, $p = .18$ for sample size, and $B = -.16$, $p = .15$ for severity of disability. No evidence of publication bias was apparent when including dependent effect sizes in analyses, as seen by an insignificant Egger's test of asymmetry, $p > .5$.

When dependent effect sizes are included in analyses but three outliers remain excluded, the average odds ratio did not change significantly, OR = 2.21, 95% CI [.94, 5.19], $p < .001$, $Q = 100.55$, $I^2 = 65.56\%$. Similarly, moderator analyses did not change significantly when dependent effect sizes were included: $B = -.09$, $p = .33$ for year, $B = -.06$, $p > .5$ for age, $B = -.10$, $p > .5$ for language, $B = .07$, $p = .44$ for sample size, and $B = -.07$, $p > .5$ for severity of disability. No evidence of publication bias was apparent when including dependent effect sizes in analyses, as seen by an insignificant Egger's test of asymmetry, $p = .44$.

When including the outliers previously excluded from analyses but excluding dependent effect sizes, the average weighted odds ratio did not change significantly, OR = 2.34, 95% CI [1.91, 2.89], $p < .001$, $Q = 123.99$, $I^2 = 73.26\%$. Similarly, moderator analyses did not change significantly when outliers were included: $B = -.11$, $p = .33$ for year, $B = -.11$, $p = .29$ for age, $B = -.04$, $p > .5$ for language, $B = .13$, $p = .18$ for sample size, and $B = -.16$, $p = .15$ for severity of disability. Including the outliers resulted in an insignificant Egger's test of asymmetry, $p > .5$, which suggests no publication bias.

Discussion

Identification of possible criteria that could contribute to more reliable identification of individuals with reading disabilities is important to researchers and clinicians alike. The purpose of the current meta-analysis was to calculate the increased chances of having reading disability if co-occurring math disability was present. The results suggest a substantial and practically useful criterion to be considered in that individuals with math disability were found to have a just over a two times greater chance of having reading disability. Considerable variability in effect sizes across studies not due to chance was

present based on the Q and I^2 statistics. However, the moderators we examined did not account for this observed variability in effect sizes. Publication bias was not apparent, suggesting that the sample of studies included in the present analyses was representative of the population. When conducting sensitivity analyses, results remained stable despite the reintroduction of dependent effect sizes and outliers that were excluded from the analyses.

There are several implications of the present findings. First, co-occurring math disability is a potentially important predictor to be considered in future studies that examine combinations of predictors that might predict reading disability with greater reliability. Second, individuals identified as having a math disability should be screened for possible problems in reading and, conversely, individuals with reading disability should be screened for possible problems in math.

Limitations and Future Research

One limitation of this meta-analysis was that we had to exclude some studies because they did not have all of the groups that we needed to calculate our effect size (e.g., studies that included participants with reading disabilities and comorbid reading and math disabilities, but not participants with only math disabilities). Another potential limitation is that studies included had imposed cut-points on continuous distributions to create distinct groups. We agree with the view that dichotomizing a continuous variable such as reading or math disability is not an ideal practice under most circumstances. It was necessary for us to restrict our meta-analysis to studies that did this, however, to be able to use an effect size that represented co-occurrence of reading and math disability as opposed to an effect size that represented the correlation between reading and math performance in general. We see these as different meta-analyses that might have been done but that address different topics. Given our purpose of using the presence of math disability to improve accuracy of predicting reading disability, we needed to use the effect size that dichotomization made possible to determine whether the presence of math disability increased the chances of the presence of reading disability. Finally, despite variability in effect sizes across studies that was greater than expected on the basis of sampling error, we were not able to identify moderators that accounted for this variability.

The present meta-analysis cannot explain the underlying reasons for the substantial comorbidity between reading and math disability. It is possible that it arises because of characteristics within learners themselves, similarities between reading and math, or both. For example, it is possible that an underlying deficit exists that affects both reading and math, such as a deficit in working memory (De Weerd, Desoete, & Roeyers, 2013; Peng & Fuchs, 2016; Schuchardt, Maehler, & Hasselhorn, 2008; Swanson & Jerman, 2006), phonological processing (de Smedt, Taylor, Archibald, & Ansari, 2010; Hecht et al., 2011; Jordan, Wylie, & Mulhern, 2015), or visuospatial skills (Helland & Asbjørnsen, 2004). For an example of similarities between math and reading, letters and digits are both examples of symbols that appear in writing systems and doing math often involves a considerable amount of reading as in directions appearing on worksheets or in math books or when the math problems are presented as word problems (Fuchs & Fuchs, 2002). There is a clear need for

additional research that tests alternative explanations for the observed degree of comorbidity.

Acknowledgments

Funding: Support for this research was provided by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Grant P50 HD052120.

References

Note: * indicated studies included in the present meta-analysis

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC.
- * Andersson U (2008). Mathematical competencies in children with different types of learning difficulties. *Journal of Educational Psychology*, 100(1), 48–66.
- * Andersson U (2010). Skill development in different components of arithmetic and basic cognitive functions: Findings from a 3-year longitudinal study of children with different types of learning difficulties. *Journal of Educational Psychology*, 102(1), 115–134.
- * Archibald LMD, Oram Cardy J, Joanisse MF, & Ansari D (2013). Language, reading, and math learning profiles in an epidemiological sample of school age children. *PLoS ONE*, 8(10), 1.
- * Badian NA (1999). Persistent arithmetic, reading, or arithmetic and reading disability. *Annals of Dyslexia*, 49(1), 43–70.
- Barbareis W, Katusic S, Colligan R, Weaver A, & Jacobsen S (2005). Math learning disorder: Incidence in a population-based birth cohort, 1976–1982, Rochester, Minn. *Ambulatory Pediatrics*, 5, 281–289. [PubMed: 16167851]
- Branum-Martin L, Fletcher JM, & Stuebing KK (2012). Classification and identification of reading and math disabilities: The special case of comorbidity. *Journal of Learning Disabilities*, 46(6), 490–499. [PubMed: 23232442]
- * Cirino PT, Fletcher JM, Ewing-Cobbs L, Barnes MA, & Fuchs LS (2007). Cognitive arithmetic differences in learning difficulty groups and the role of behavioral inattention. *Learning Disabilities Research & Practice* (Wiley-Blackwell), 22(1), 25–35.
- * Cirino PT, Fuchs LS, Elias JT, Powell SR, & Schumacher RF (2015). Cognitive and mathematical profiles for different forms of learning difficulties. *Journal of Learning Disabilities*, 48(2), 156–175. [PubMed: 23851137]
- Cooper H, Hedges LV, & Valentine J, C. (2009). *The handbook of research synthesis and meta-analysis*. New York, NY: Russell Sage Foundation
- de Smedt B, Taylor J, Archibald L, Ansari D, (2010). How is phonological processing related to individual differences in children's arithmetic skills? *Developmental Science*, 13(3), 508–520. [PubMed: 20443971]
- * de Weerd F, Desoete A, & Roeyers H (2013). Working memory in children with reading disabilities and/or mathematical disabilities. *Journal of Learning Disabilities*, 46(5), 461–472. [PubMed: 22941463]
- * Dirks E, Spyer G, Van Lieshout ECDM, & De Sonneville L (2008). Prevalence of combined reading and arithmetic disabilities. *Journal of Learning Disabilities*, 41(5), 460–473. [PubMed: 18768777]
- * Donker M, Kroesbergen E, Slot E, Van Viersen S, & De Bree E (2016). Alphanumeric and non-alphanumeric Rapid Automatized Naming in children with reading and/or spelling difficulties and mathematical difficulties. *Learning and Individual Differences*, 47, 80–87.
- Egger M, Smith GD, Schneider M, & Minder C (1997). Bias in meta-analysis detected by a simple, graphical test. *The British Medical Journal*, 315, 629–634. [PubMed: 9310563]
- * Forsyth SR, & Powell SR (2017). Differences in the mathematics-vocabulary knowledge of fifth-grade students with and without learning difficulties. *Learning Disabilities Research & Practice* (Wiley-Blackwell), 32(4), 231–245.

- Francis DJ, Fletcher JM, Stuebing KK, Lyon GR, Shaywitz BA, & Shaywitz SE (2005). Psychometric approaches to the identification of LD: IQ and achievement scores are not sufficient. *Journal of Learning Disabilities*, 38, 98–108. [PubMed: 15813593]
- Fuchs LS, Fuchs D (2002). Mathematical problem-solving profiles of students with mathematics disabilities with and without comorbid reading disabilities. *Journal of Learning Disabilities*, 35(6), 564–574.
- * Fuchs LS, Fuchs D, & Compton DL (2013). Intervention effects for students with comorbid forms of learning disability: Understanding the needs of nonresponders. *Journal of Learning Disabilities*, 46(6-), 534–548. [PubMed: 23232441]
- * Fuchs LS, Fuchs D, & Prentice K (2004). Responsiveness to mathematical problem-solving instruction: Comparing students at risk of mathematics disability with and without risk of reading disability. *Journal of Learning Disabilities*, 37(4), 293–306. [PubMed: 15493402]
- * Geary DC, Hamson CO, & Hoard MK (2000). Numerical and arithmetical cognition: A longitudinal study of process and concept deficits in children with learning disability. *Journal of Experimental Child Psychology*, 77(3), 236–263. [PubMed: 11023658]
- * Geary DC, Hoard MK, & Hamson CO (1999). Numerical and arithmetical cognition: patterns of functions and deficits in children at risk for a mathematical disability. *Journal of Experimental Child Psychology*, 74(3), 213–239. [PubMed: 10527555]
- Hecht SA, Torgesen JK, Wagner RK, & Rashotte CA, (2001). The relations between phonological processing abilities and emerging individual differences in mathematical computation skills: A longitudinal study from second to fifth grades. *Journal of Experimental Child Psychology*, 79(2), 192–227. [PubMed: 11343408]
- * Helland T, & Asbjørnsen A (2003). Visual-sequential and visuo-spatial skills in dyslexia: variations according to language comprehension and mathematics skills. *Child Neuropsychology*, 9(3), 208–220. [PubMed: 13680410]
- * Holopainen L, Taipale A, & Savolainen H (2017). Implications of overlapping difficulties in mathematics and reading on self-concept and academic achievement. *International Journal of Disability, Development and Education*, 64(1), 88–103.
- * Jordan JA, Wylie J, & Mulhern G (2015). Mathematics and reading difficulty subtypes: Minor phonological influences on mathematics for 5–7-years-old. *Frontiers in Psychology*, 6(MAR), 1–12. [PubMed: 25688217]
- * Jordan NC, & Hanich LB (2000). Mathematical Thinking in second-grade children with different forms of LD. *Journal of Learning Disabilities*, 33(6), 567–578. [PubMed: 15495398]
- * Jordan NC, Hanich LB, & Kaplan D (2003). A longitudinal study of mathematical competencies in children with specific mathematics difficulties versus children with comorbid mathematics and reading difficulties. *Child Development*, 74(3), 834–850. [PubMed: 12795393]
- * Jordan NC, Kaplan D, & Hanich LB (2002). Achievement growth in children with learning difficulties in mathematics: Findings of a two-year longitudinal study. *Journal of Educational Psychology*, 94(3), 586–597.
- * Klorman R, Thatcher JE, Shaywitz SE, Fletcher JM, Marchione KE, Holahan JM, ... Shaywitz BA (2002). Effects of event probability and sequence on children with attention-deficit/hyperactivity, reading, and math disorder. *Biological Psychiatry*, 52(8), 795. [PubMed: 12372651]
- * Landerl K, Bevan A, & Butterworth B (2004). Developmental dyscalculia and basic numerical capacities: a study of 8–9-year-old students. *Cognition*, 93(2), 99–125. [PubMed: 15147931]
- * Landerl K, Fussenegger B, Moll K, & Willburger E (2009). Dyslexia and dyscalculia: Two learning disorders with different cognitive profiles. *Journal of Experimental Child Psychology*, 103(3), 309–324. [PubMed: 19398112]
- Lewis C, Hitch G, & Walker P (1994). The prevalence of specific arithmetic difficulties and specific reading difficulties in 9- to 10-year-old boys and girls. *Journal of Child Psychology and Psychiatry*, 35, 283–292. [PubMed: 8188799]
- Light JG & DeFries JC (1995). Comorbidity of reading and mathematics disabilities: Genetic and environmental etiologies. *Journal of Learning Disabilities*, 28(2), 96–106. [PubMed: 7884303]

- * Moll K, Göbel SM, & Snowling MJ (2015). Basic number processing in children with specific learning disorders: Comorbidity of reading and mathematics disorders. *Child Neuropsychology*, 21(3), 399–417. [PubMed: 24697279]
- * Pauly H, Linkersdörfer J, Lindberg S, Woerner W, Hasselhorn M, & Lonnemann J (2011). Domain-specific Rapid Automatized Naming deficits in children at risk for learning disabilities. *Journal of Neurolinguistics*, 24(5), 602–610.
- * Peake C, Jiménez JE, Rodríguez C, Bisschop E, & Villarroel R (2015). Syntactic awareness and arithmetic word problem solving in children with and without learning disabilities. *Journal of Learning Disabilities*, 48(6-), 593–601. [PubMed: 24509567]
- Peng P, & Fuchs D (2016). A meta-analysis of working memory deficits in children with learning difficulties. *Journal of Learning Disabilities*, 49(1), 3–20. [PubMed: 24548914]
- Quinn JM (2018). Differential identification of females and males with reading difficulties: A meta-analysis. *Reading and Writing*, 31(5), 1039–1061 [PubMed: 29962661]
- * Raddatz J, Kuhn JT, Holling H, Moll K, & Dobel C (2017). Comorbidity of arithmetic and reading disorder: Basic number processing and calculation in children with learning impairments. *Journal of Learning Disabilities*, 50(3), 298–308. [PubMed: 26772796]
- * Schuchardt K, Maehler C, & Hasselhorn M (2008). Working memory deficits in children with specific learning disorders. *Journal of Learning Disabilities*, 41(6), 514–523. [PubMed: 18625783]
- * Schwenck C, Dummert F, Endlich D, & Schneider W (2015). Cognitive functioning in children with learning problems. *European Journal of Psychology of Education - EJPE* (Springer Science & Business Media B.V.), 30(3), 349–367.
- * Shafir U, & Siegel LS (1994). Subtypes of Learning. *Journal of Learning Disabilities*, (2), 123–134. [PubMed: 8195688]
- * Slot EM, Viersen S van, de Bree EH, & Kroesbergen EH (2016). Shared and unique risk factors underlying mathematical disability and reading and spelling disability. *Frontiers in Psychology*, 7(JUN).
- Snowling MJ, Gallagher A, & Frith U (2003). Family risk of dyslexia is continuous: Individual differences in the precursors of reading skill. *Child Development*, 74, 358–373. [PubMed: 12705560]
- * Swanson HL (2012). Cognitive profile of adolescents with math disabilities: Are the profiles different from those with reading disabilities? *Child Neuropsychology*, 18(2), 125–143. [PubMed: 21967554]
- Swanson HL & Jerman O (2006). Math disabilities: A selective meta-analysis of the literature. *Review of Educational Research*, 76(2), 249–274.
- Swanson HL, Jerman O, & Zheng X (2009). Math disabilities and reading disabilities: Can they be separated? *Journal of Psychoeducational Assessment*, 27(3), 175–196.
- * van Daal V, van der Leij A, & Adèr H (2013). Specificity and overlap in skills underpinning reading and arithmetical fluency. *Reading and Writing*, 26(6), 1009–1030.
- Waesche JSB, Schatschneider C, Maner JK, Ahmed Y, & Wagner RK (2011). Examining agreement and longitudinal stability among traditional and RTI-based definitions of reading disability using the affected-status agreement statistic. *Journal of Learning Disabilities*, 44(3), 296–307. [PubMed: 21252372]
- * Willburger E, Fussenegger B, Moll K, Wood G, Landerl K (2008). Naming speed in dyslexia and dyscalculia. *Learning and Individual Differences*, 18, 224–236.
- * Willcutt EG, Petrill SA, Wu S, Boada R, DeFries JC, Olson RK, & Pennington BF (2013). Comorbidity between reading disability and math disability: concurrent psychopathology, functional impairment, and neuropsychological functioning. *Journal of Learning Disabilities*, 46(6-), 500–516. [PubMed: 23449727]
- * Wilson AJ, Andrewes SG, Struthers H, Rowe VM, Bogdanovic R, & Waldie KE (2015). Dyscalculia and dyslexia in adults: Cognitive bases of comorbidity. *Learning and Individual Differences*, 37, 118–132.
- Yeniad N, Malda M, Mesman J, van Ijzendoorn MH, & Piper S (2013). Shifting ability predicts math and reading performance in children: A meta-analytical study. *Learning and Individual Differences*, 23, 1–9.

Figure 1.

A forest plot of all odds ratio effect sizes included in the meta-analysis, $k = 33$. The diamond indicates the average odds ratio, $OR = 2.12$ [1.76, 2.55].

Figure 2.

A funnel plot examining publication bias in studies used in the meta-analysis. Concurrent Egger's test of asymmetry is not significant, $p > .5$, suggesting symmetry and, therefore, no publication bias.