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Attending to Attention: A Systematic Review of Attention and Reading

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Attending to Attention: A Systematic Review of Attention and Reading

Abstract

Background: Extensive research has conclusively linked inattention to poor reading performance. The process by which this relation occurs remains somewhat undefined, which makes it difficult for practitioners to identify key intervention targets. **Objectives:** This systematic review will synthesize current peer-reviewed research on the developmental relationship between inattention and reading. The primary aim of this review was to describe how inattention negatively relates to the development of literacy from preschool through middle childhood. A secondary aim of this review was to summarize recent research on the potential differential relationship between attention and literacy among students overrepresented in ratings of inattention, including boys and students of color. **Design and Methods:** PsycInfo, Education Full Text, ERIC, and ProQuest Education, and Dissertations and Theses were searched, using a broad search string. The initial search resulted in 1,262 potentially relevant studies published since the most recent authorization of the Every Child Succeeds Act (i.e., from December 2015-2019) for review. Out of 1,262 citations found, 70 empirical studies were screened and assessed for eligibility, and 16 met the specific inclusion criteria. A coding sheet was then used to synthesize data from the included studies. **Results:** Among preschool and elementary school children, inattention, whether measured through observer ratings or performance tasks, has a consistent, negative impact on reading skills as reported both by teachers, standardized instruments, and classroom performance outcomes. Results point to multiple pathways through which inattention may have a negative impact on reading outcomes. Evidence points to a negative and direct effect of inattention on the development of and performance in reading concurrently and over time. Inattention may have an additional, indirect, and negative effect on reading performance through its negative impact on early literacy and cognitive skills, including phonological awareness and processing, vocabulary, and working memory. There is a lack of research on potential differential processes by which attention relates to reading among subgroups of children who are at elevated risk for poor literacy outcomes. **Conclusions and Implications:** Assessing for and intervening in early attention problems in preschool and kindergarten is essential to promote optimal reading outcomes for all students. There is an urgent need for future research to investigate potential differential processes in the relation between attention and reading performance for children who are at an elevated risk for reading problems. School social workers are especially prepared and located to address the interaction of child and classroom factors within schools that impede student performance in early grades and set up challenges for later success.

Keywords

attention problems, reading development, early intervention, differential process

Authors

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Attending to Attention: A Systematic Review of Attention and Reading

Introduction

Reading is a building block of development, a foundation of individual and collective identity, and a critical tool for daily living. Students' ability to pay attention is one of the most stable and direct child-level predictors of academic performance (Trentacosta & Izzard, 2007), and on reading achievement in particular (Frick et al., 1991; Hinshaw; 1992; Rabiner & Coie, 2000). The ability of a child to pay attention, read, and succeed in school is influenced by micro-, mezzo-, and macro- factors. School social workers, trained from a systems perspective, are an integral link to these systems and are uniquely positioned to identify factors within schools that impede student performance in early grades and set up challenges for later success. With a thorough understanding of the relationship between attention and reading, school social workers can develop appropriate interventions to facilitate successful academic performance. As such, the purpose of this systematic review is to provide school social workers, educators, and other practitioners with a summary of the most current literature linking inattention to reading to inform intervention and instructional practices.

The field of cognitive science defines attention as a sensory and motor system of the brain that: (1) selects, prioritizes, and directs attention in response to stimuli (Hendry et al., 2016; Posner & Peterson 1990, 2012); (2) prepares the student to anticipate incoming stimuli (Posner & Peterson, 1990, 2012); and (3) enables planning, problem-solving, conflict resolution, and decision making (Posner & Rothbert, 1998; Shallice & Burgess, 1996; Wang, Liu & Fa, 2011). Both "top-down" and "bottom-up" processes can trigger attention. Top-down processes are initiated by one's desire to gain information about something in the environment, such as looking for a friend in the school cafeteria (Posner & Rothbert, 1998). On the other hand, bottom-up processes are driven by external stimuli, such as a flash of light or unexpected noise, and are relatively reflexive and automatic (Klein & Lawrence, 2012). There is considerable overlap between top-down and bottom-up processes, such that the salience of external stimuli will vary based on one's prior experiences, personal goals, and memory (Bornstein, 1990).

There are key areas of overlap in attention and other constructs such as executive function (Bornstein, 1990; Diamond, 2002; Klein & Lawrence, 2012; Kofler et al., 2011). Executive function has become an umbrella term for various top-down cognitive processes involved in deliberate control of emotion, thought, and action (Zelazo et al., 2013). However, there are key distinctions between executive function and attention. For one, attention and executive functioning are rooted, at least partially, in distinct neural nodes (i.e., dorsal vs. medial prefrontal cortex; rostral v. caudal anterior cingulate cortex), which provides objective evidence of their distinctiveness (Nigg, 2017). Attention and executive function are also conceptually distinct. For instance, the orienting system of attention is a largely

reflexive process that does not rely on the simple or complex cognitive processes of executive function. In addition, cognitive functions involved in situations with simple cognitive tasks such as solving mental math problems may not relate to attention. This differentiation helps illustrate that deficits in executive functioning can lead to diagnoses of specific learning disabilities that have nothing to do with attention (Klein & Lawrence, 2012).

Inattention manifests in observable behaviors such as wandering off tasks, being disorganized, having difficulty focusing, lacking persistence, and being forgetful (American Psychiatric Association, 2013). When inattention symptoms are persistent and impairing at school, home, and with peers, they constitute part of the attention deficit hyperactivity disorder (ADHD) diagnostic criteria (Groen-Blokhuis et al., 2014; Marcus and Barry, 2011).

Students with attention problems often perform below-expected levels and have worse grades relative to peers without attention problems (Barry, Lyman & Klinger, 2003; Duncan et al., 2007; Frazier et al., 2007). Attention problems have implications for reading achievement in particular (Frick et al., 1991; Hinshaw; 1992; Rabiner & Coie, 2000). Learning to read is cognitively demanding and requires sustained attention and on-task behavior over extended periods (Dittman 2016). Specific skills needed for reading achievement, such as letter-word identification and comprehension, have been linked to the ability to concentrate (Rabiner & Coie, 2000; Ghelani, Sidhu, Jain & Tannock, 2004).

The timing of attention-related interventions is critical as students in preschool and early elementary school years respond positively to environmental intervention (Jones, Aber & Brown, 2011; van Lier, Muthen, van der Sar & Crijnen, 2004); but by the time children are in first grade, their sustained attention abilities have developed with adult-like levels of stability (Deter-Deckard & Wang, 2014). At this age, attention problems can indicate severe impairment (i.e., Attention Deficit Hyperactivity Disorder, ADHD), or more mild attention problems, both of which can contribute to poor academic outcomes if unaddressed. Murray (2014) estimates that approximately 16 percent of students experience attention problems. Identifying children with attention problems early may be critical for school social workers to promote academic success for those students at risk of falling behind in their reading development.

Although there is a consensus among researchers, educators, and social workers that there is a relationship between attention and reading abilities, the process by which attention impacts reading remains somewhat elusive (O'Neill et al., 2016). Besides, much less is known about potential differential relationship between attention and reading development among students who are overrepresented in ratings of inattention, such as boys and students of color. Students of color are rated as having higher levels of attention problems relative to White peers, even in controlled settings where children are primed to behave identically to one another, which may be evidence of racial bias that disadvantages

non-White students (DuPaul et al., 1997; Epstein, March, Connors & Jackson, 1998; Rabiner, Murray, Schmid, & Malone 2004). This disparity merits additional attention and research, which school social workers are primed to provide given their function within the school system and their professional identity, including a commitment to social justice work.

The purpose of this article is to systematically review the contemporary literature on attention and reading. The primary goals of this review were to (1) describe how inattention and literacy develop both independently and concurrently from preschool through middle childhood, and (2) to summarize recent research on the potential differential relationship between attention and literacy among students of color and students experiencing poverty. In addition, this review aims to provide school social workers, educators, and other practitioners with a summary of the most current literature linking inattention to reading to inform intervention and instructional practices.

Methods

Best practices for the conduct of systematic reviews, as outlined by Litell, Corcoran, and Pillai (2008), were used to complete this review.

Inclusion Criteria

Inattention manifests as a dimensional trait in the general population (Gray, Dueck, Rogers & Tannock, 2017). This study aimed to capture the most current research on the natural development of the spectrum of inattention (or lack thereof) and its relationship with reading development that reflects a typical classroom, rather than focus on a subgroup of children whose severe attention problems cause clinical levels of impairment. Therefore, the following criteria were used to identify studies for inclusion in this systematic review. To be eligible for inclusion, studies had to (1) focus on reading skills, early literacy skills, or reading performance as an outcome; (2) include measures of attention or inattention; (3) use temporal data; (4) be published on or after December of 2015, so that the current study serves as an update to four previous reviews of the relationship between ADHD symptoms and academic outcomes (i.e., Arnold et al., 2015; Frazier et al., 2007; Gray, Dueck, Rogers & Tannock, 2017; Polderman et al., 2010); (5) include quantitative or qualitative data analyses (i.e., no narrative reviews, conceptual frameworks, book reviews, etc.); and (6) be published in English.

Search and Coding Strategy

Figure 1 illustrates the search strategy. A university social science reference librarian with systematic review experience consulted on the overall approach to the literature search. The same reference librarian, whose subject specialties include social work and psychology, also recommended relevant and available databases as well as search terms used. Using narrow and overly specific search terms could have omitted relevant studies from the search. Therefore, the final search string was inclusive and broad. It was as follows: attention AND inattention OR ADHD AND (read* development OR literacy OR pre-read* skills) AND elementary AND

student AND (achievement OR growth), limited from December 2015 and onward, and limited to English language and peer-reviewed only. Asterisks indicated that words beginning with that term, but with variant endings, would be included (e.g., read* would include search results containing the words reading and read). The search was conducted in September 2019 and updated in January 2020.

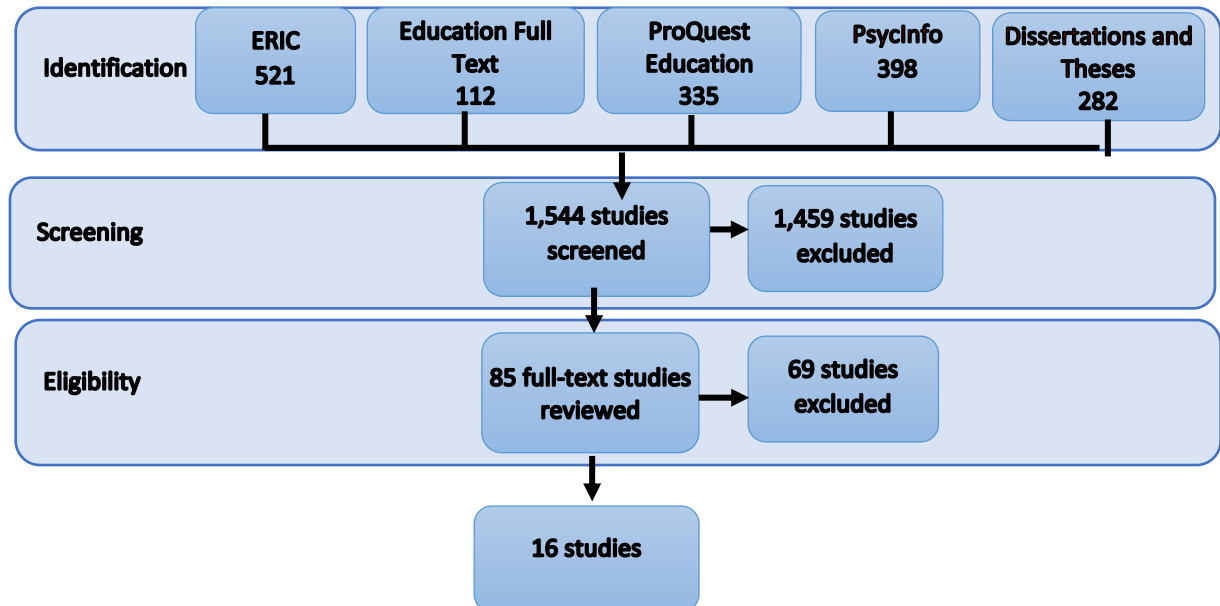


Figure 1. Search strategy for identifying studies for inclusion

A search of ERIC, ProQuest Education, Education Full Text, PsycInfo, and Dissertations and Theses yielded 1,652 studies. We then imported all identified studies into *Covidence* (i.e., online software for systematic review management), and duplicate references were omitted. A total of 1,544 studies were identified for initial screening. Two primary raters reviewed all studies, while a third reviewer resolved any conflicts. After reviewing titles, abstracts, and full text, 85 studies were assessed for eligibility if necessary. Of these, 16 were included in the final review. Inter-rater reliability was 97 percent for the title and abstract reviews and 92 percent for full-text reviews. Twenty-two studies were excluded for their inclusion of a sample of children with ADHD. Ten intervention research studies were screened out because this review focused on the natural development of inattention and reading; eight were eliminated because they focused on executive function and self-regulation, which are related to but separate from attention. An additional ten studies were removed because their focus was too broad. Two studies were duplicates and were also excluded.

Coding sheets were used to abstract relevant data from all studies, including author information, research questions, sample information, participant characteristics, and study conclusions. Completed coding sheets were used to generate Table 1.

Results

Study characteristics

Table 1 displays descriptions and findings for each of the 16 studies reviewed. These studies varied in data collection techniques, including measurement tools, and further varied on sample characteristics. Three studies used large, nationally representative datasets; five employed primary, non-probability samples; and seven conducted secondary data analysis of existing data. Seven studies included data from children living outside of the United States.

Table 1. Study characteristics and findings of articles reporting a direct, negative relationship between attention problems and reading outcomes.

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Allan et al. (2018) Learning and Individual Difference	Preschools serving low-income children in the United States followed across one school year	Sampling method: not specified, non-probability 284 children; 128 girls; Mean age: 57.57mo, (SD=5.97mo); 81% Black, 15% White	Modified Conner's Teacher Rating Scale (Conners, 1997)	Vocabulary: Expressive One-Word Picture Vocabulary Test-Revised (Gardner, 1990); Clinical Evaluation of Language Fundamentals-Preschool (Wiig, Secord & Semel, 1992); Phonological awareness: Study-specific tasks; Letter knowledge; Study-specific task	Inattention is concurrently and longitudinally related to children's reading skills, regardless of who rated children's attention. There was a weak association among ratings from three different raters.	No Sample limited to children from low-income families, but otherwise, these characteristics or were not addressed.	Working memory; Nonverbal cognitive skills; Age; Rater of attention	Recommended interventions included small group reading and one-on-one reading training for children with inattention problems.
Dittman (2016) Journal of Attention Disorders	One elementary school in a "middle-income suburb" in Queensland Australia followed from across two school years	Sampling method: not specified, non-probability 136 children; 69 girls; Mean age: 67.77 mo; (SD=3.81mo)	Modified inattention subscale of the Conners' Teacher Rating Scale-Revised: Short Form	Word-reading ability: Clay Ready to Read (Duncan & McNaughton, 2001); Word-reading skills: Woodcock Reading Mastery Test (Form H: Woodcock, 1998); Modified Test of Word Reading Efficiency (Torgesen, Wagner & Rashotte, 1999); Verbal ability: Peabody Picture Vocabulary Test—Third Edition (Dunn & Dunn, 1997)	Inattention at school entry uniquely predicted word reading and word-reading efficiency at the end of 1st and 2nd grades. Inattention at the end of 1st grade also uniquely predicted word reading and reading efficiency at the end of 2nd grade.	No.	Phonological awareness; Working memory; Rapid automatized naming	Recommended classroom-friendly screening and early intervention procedures.

Table 1. Study characteristics and findings of articles reporting a direct, negative relationship between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Leclercq & Sieroff (2016) Child Neuropsychology	Lab study in France	Sampling method: not specified, non-probability Experiment 1: 27 1st grade French children (18 girls), 2nd grade French children (10 girls), and 27 4th grade French children (19 girls); Experiment 2: 26 1st grade French children & 23 3rd grade French student	Computer task (Posner, 1980)	Standardized Reading Test (Lefavrais, 1963)	Orienting one's attention to the beginning of a letter string and determining whether a string of letters is a word or non-word are skills that develop through the second and fourth year of schooling, respectively. Students who have difficulty orienting their attention to the beginning of a letter string have problems with reading acquisition.	No.	Direction of letter string presented to children.	None mentioned.
Lonigan, Allan & Phillips (2017) Developmental Psychology	Children attending Title 1 and private preschools in the United States assessed multiple times over one school year	Sampling method: not specified, non-probability 1,082 children; Mean age: 55mo, (SD=3.7mo); 45% girls; 47.8% White, 41.8% Black	Modified Conner's Teacher Rating Scale (Conners, 1997)	Preschool Comprehensive Test of Phonological and Print Processing; Oral Language subtests of PCTOPP; Phonological Awareness Blending and Elision subtest of PCTOPP; Print Knowledge Print knowledge subtest of PCTOPP Alphabet, conventions and meanings subtests of the Tests of Early Reading Ability (Reid, Hresko & Hammil, 2001)	Attention was consistently and uniquely related to children's early literacy skills at preschool entry. Attention was significantly or marginally associated with growth in all early literacy skills over time. Children rated as more inattentive had slower growth on three of the four language measures as compared to children with lower ratings of inattention.	No. These characteristics were included as a robustness check for the main findings. Results of the robustness check were not reported in the article.	Overall cognitive ability; Executive Function	None mentioned.

Table 1. Study characteristics and findings for articles reporting a direct, negative relationship between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Westdal, J. N. (2018). Dissertation and Theses.	Secondary data analysis of data from the Fragile Families and Child Well-being study involving two subsamples of students followed from birth through age nine	Sampling method: non-probability 2,062 children; 49% girls; Mean age at kindergarten entry=68.15 mo, SD=14.76mo); 19% White, 54% Black, 23% Hispanic, 3% other race	Leiter-International Performance Scale-Revised (Leiter-R), Attention Sustained Subtest (Roid & Miller, 1997)	Letter-word identification subtest of the Woodcock-Johnson Revised Test of Achievement (WJ-R, Woodcock & Johnson, 1990) Passage comprehension subtest of the Woodcock-Johnson Test of Achievement Third Edition (WJ-III; Woodcock, McGrew & Mather, 2001)	Sustained attention skills in kindergarten were directly related to reading skills in kindergarten and third grade.	Yes—socioeconomic status (income). Higher-income during early development was related to better reading in kindergarten, but not in 3 rd grade.	Maternal depression, home literacy environment, DRD4 gene presentation	There is a critical period of early development whereby children would benefit from exposure to early literacy experiences.
Pham (2016) Journal of Attention Disorders	Children from three elementary schools in the United States who were followed across two school years	Sampling method: not specified, non-probability 131 children; 66 girls; Mean age=109.56mo; 80% White, 6% Black, 6% Hispanic/Latinx	Hyperactivity, Inattention, and Impulsivity subscales from the Swan, Nolan and Pellam-Version IV (Swanson et al., 2001)	Oral reading comprehension and reading fluency subtests of the Gray Oral Reading Test—4th Edition (Wiederholt & Bryant, 2001)	Ratings of inattention significantly predicted reading fluency and reading comprehension concurrently and over time.	Yes. Boys who demonstrated inattentive behaviors performed more poorly than did girls with inattentive behaviors. Family income was included as a control variable.	None mentioned.	Literacy and speech-related interventions may be helpful for children with attention problems, perhaps especially so for boys.

Table 1. Study characteristics and findings of articles reporting a direct, negative relationship between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Rabiner, Carrig & Dodge (2016) <i>Journal of Attention Disorders</i>	Secondary data analysis from non-intervention participants, which include children attending elementary school in the US followed from 1st grade through 5th grade	Sampling method: non-probability 386 children; Mean age at 1st-grade entry: 78.24 mo (SD=5.28 mo); 49% girls; 51% White, 43% Black	Inattentive symptoms from the ADHD Rating Scale (DuPaul, 1999)	Word-letter identification and passage subtests from Woodcock-Johnson (Woodcock & Johnson, 1989)	Attention problems in 1st grade were strongly and significantly related to poor reading performance concurrently and longitudinally, even among children for whom attention problems dissipated by 2nd grade. These children performed worse in 5th grade than what would have been predicted by prior performance. Attention problems that emerged in 2nd grade were not significantly related to reading	Yes. Race and gender were included as control variables and did not significantly predict achievement.	Intelligence. Notably, parts of the sample, including students identified as inattentive, on average had borderline IQ scores.	Early and intensive intervention for children with identified attention problems.
Rabiner, Goodwin & Dodge (2016) <i>School Psychology Review</i>	Secondary data analysis from non-intervention participants, which include children attending elementary school in the US followed from 1st grade through 5th grade, with follow up in middle school and at age 24-25	Sampling method: non-probability 386 children; Mean age at 1st grade entry: 78.24 mo (SD=5.28 mo); 49% girls; 51% White, 43% Black	Inattentive symptoms from the ADHD Rating Scale (DuPaul, 1999)	Word-letter identification and passage subtests from Woodcock-Johnson (Woodcock & Johnson, 1989); Middle school grades; Education Information Questionnaire (Howe & Frazis, 1992)	Grades in 5th grade, but not in middle school, were uniquely predicted by inattention. Inattention in 1st grade reduced the probability of high school graduation and years of education obtained by age 25.	Yes. Race and SES were included as control variables.	Early academic skills; Social competence; Intelligence; Environmental setting (i.e., urban, rural, suburban)	Early intervention for inattention is critical to promote long-term educational success.

Table 1. Study characteristics and findings for articles reporting a direct, negative relationship between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Salla et al. (2016) European Journal of Child and Adolescent Psychiatry	Secondary data analysis of Quebec Longitudinal Study of Child Development; this study included data from birth through age 12.	Sampling method: non-probability 2,120 children; 48% girls	Child Behavior Checklist (Statistics Canada, 1995; Child Behavior Questionnaire (Tremblay, Desmarais-Gervais, Gagnon & Charlebois, 1987); Ontario Child Health Study Scales (Achenbach, 1991)	Quebec reading examTeacher-rated academic performance using study-specific measures	The researchers identified three trajectories linking attention problems to reading abilities. Low, moderate, and high levels of inattention were all significantly negatively associated with teacher ratings of academic averages. Students who were rated as highly inattentive also scored lower on the government exam score relative to students with less severe inattention problems.	Yes. Gender and parental sociodemographic indicators were used as control variables. Both were significantly related to reading averages.	Internalizing and externalizing behavior problems.Early literacy skills (i.e., vocabulary, number knowledge)	Early (i.e., preschool) prevention and intervention strategies are recommended.

Table 1. Study characteristics and findings of articles reporting a negative, indirect relationship between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Isbell et al. (2017) Journal of Experimental Child Psychology	One southeastern state in the United States followed from preschool through 1st grade	Sampling method: not specified, non-probability 250 students; 137 girls; Mean age=56 mo, SD=5mo; 61% White, 28% Black, 2% Asian, 2% Multiracial	Response time variability: Go/No-Go task (Lahat, Todd, Mahy, Lau & Zelazo, 2010)	Woodcock-Johnson III Tests of Achievement: Applied Problems and Letter-Word Identification (Woodcock, McGrew & Mather, 2001); Mock Report Card (Pierce, Hamm & Vandell, 1999)	Attention fluctuations had a significant and direct impact on preschool reading and math readiness and cognitive flexibility, each of which in turn predicted lower teacher ratings of academic performance in 1st grade. Attention fluctuations had a significant and direct negative effect on cognitive flexibility.	Yes. Minority status, gender, and income-to-needs ratio were included as control variables.	Cognitive flexibility	Programs to promote cognitive abilities, particularly attentional control, in preschoolers
Language and Reading Research Consortium et al. (2018) Reading and Writing	Data came from a US-based longitudinal study of reading comprehension that followed children from first through third grade	Sampling method: non-probability 125 children; Mean age=79.8mo (SD=4.08mo); Family income 19.1% <=\$40k 28% \$41k-\$80k 53% >\$81k; 81% White, 10% Hispanic	Inattention subscale of the Strengths and Weakness of ADHD-Symptoms and Normal Behavior (Swanson et al., 2006)	Reading comprehension: Qualitative Reading Inventory (Leslie & Caldwell, 2011), Study-specific measures; Word reading: Word Identification and Word Attach subtests of the Woodcock Reading Mastery Test-Revised: Normative Sample (Woodcock, 1998)	Inattention in 1st grade was not directly related to 3rd-grade reading comprehension. Inattention in 1st grade did predict 1st-grade word reading, which in turn predicted 3rd-grade reading comprehension.	Yes. Gender and family income were included as control variables. Family income was a predictor of 1st-grade word reading.	Early literacy; Working memory	Individualized, one-on-one intervention delivered early in the school year is needed for children who show inattention problems.

Table 1. Study characteristics and findings of articles reporting negative, indirect relationship between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Ten Braak, Kleemans, Storsken, Verhoeven & Segers (2018) Learning and Individual Differences	Children living in the Netherlands who were followed from kindergarten through 2nd grade	Sampling method: non-probability 90 children; 41 girls	Flanker Fish (Diamond et al., 2007)	Phonological awareness: Screening Instrument for Emerging Literacy (Vloedgraven, Keuning & Verhoeven, 2009); Word decoding: Three Minute Reading Test (Verhoeven, 1995)	Attentional control in kindergarten was statistically significantly associated with phonological processing in kindergarten, which in turn predicted 1st-grade reading skills.	Yes. Socioeconomic status was included as a control.	Previous performance	Assessing for inattention as early as kindergarten (or before) will allow for optimal support of children's academic development.

Table 1. Study characteristics and findings of articles reporting mixed relationships between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Ogg, Volpe & Rogers (2016) School Psychology Quarterly	Children in preschool living in the United States and Canada measured in fall and spring of one academic year	Sampling method: non-probability 181 children Mean age: 69.22 mo. (SD=4.08 mo); 82 girls; 62% White, 13% Hispanic/Latino, 11% Multiracial, 6% Black; Parental education as SES proxy: 45.7% HS/GED, 21% Master's, 13% Doctoral, 12% some graduate work.	ADHD Symptom Checklist-IV (Gadow & Sprafkin, 2008)	AIMSweb Tests of Early Literacy: Letter Naming and Letter Sound Fluency (Shinn & Shinn, 2012)	Inattention had a direct and negative relationship with early literacy levels at school entry, and in the rate of change of early literacy skills. Inattention also had an indirect, negative impact on early literacy skills through motivation and interpersonal skills	No. The sample was described in terms of child gender, ethnicity, and parental education. However, these do not appear to have been explored in relation to attention and reading.	Academic Competence	Intervention targets: impulsive behavior, academic enabling skills such as engagement, motivation and interpersonal skills
O'Neill, Marks, Thornton, Rajendran & Halpern (2016) Neuropsychology	United States; children assessed in preschool and at age 8	Sampling method: non-probability 150 preschool students; Mean age at study start=50.88mo (SD=5.88mo); 26 Girls; 60% White, 10% Black, 12.7% Asian, 17.3% multiracial; 29% Hispanic; Mean SES=64.13 (SD=17.96) on the Nakao-Treas Socioeconomic Prestige Index	ADHD Rating Scale-IV (DuPaul et al., 1998)	Early language: A Developmental Neuropsychological Assessment (Korkman, Kirk, & Kemp, 1998); Academic Achievement: Wechsler Individual Achievement Test (Wechsler, 2001); The National Institute for Children's Health Quality Vanderbilt Assessment Scale-Teacher Informant (Wolraich, Feurer, Hannah, Baumgaertel, & Pinnock, 1998)	Preschool inattention directly predicted reading comprehension and teacher-rated written expression at eight years of age. Preschool inattention also indirectly impacted reading comprehension and teacher-rated written expression at eight years of age through early literacy skills.	No. The sample was described in terms of child gender, race, ethnicity, language ability, and SES. However, these do not appear to have been explored in relation to attention and reading.	Affective (mood) disorders Intelligence Medication	Early reading skills

Table 1. Study characteristics and findings of articles reporting mixed relationships between attention problems and reading outcomes (cont'd).

Study author(s) & journal title	Study Location	Sample characteristics	Attention measure	Reading outcome measure	Relationship between attention and reading	Does study look at attention considering race, ethnicity, gender, or SES?	What other factors that may predict reading outcome are considered?	Implications for intervention
Plourde et al. (2018) <i>Developmental Neuropsychology</i>	Canada; twin children followed from birth through age 7. Analyses presented are based on data from two years.	Sampling method: non-probability 660 children (sample characteristics not provided in the article).	Social Behavior Questionnaire—Inattention subscale (Tremblay, Desmaris-Gervais, Gagnon & Charlebois, 1987)	Reading Abilities Test Phonetic Decoding subtest and reading comprehension subtest (Pepin & Loranger, 1999)	Inattention had a significant, direct, and negative impact on decoding skills. Inattention had a non-significant negative impact on reading comprehension. Inattention had a significant indirect effect on both decoding and reading comprehension through its impact on early literacy skills.	No. The researchers describe children who participated in terms of their average household income and gender. These were not included in analyses, however.	Early literacy skills (e.g., phonological awareness, rapid automatized naming, rapid bimodal processing, rapid auditory processing, vocabulary skills) Nonverbal abilities.	Targeting early literacy skills may bolster reading achievement for children with attention problems.
van de Sande, Segers & Verhoeven (2017) <i>Written Language & Literacy</i>	Children living in the Netherlands who were followed from kindergarten through 2nd grade	94 children; Mean age=73 mo, SD=4mo; All children “middle-upper class.”	Flanker Fish (Diamond et al., 2007)	Phonological awareness: Screening Instrument for Emerging Literacy (Vloedgraven, Keuning & Verhoeven, 2009); Word decoding: Three Minute Reading Test (Verhoeven, 1995); Reading comprehension: Reading Comprehension Grade 2 (Krom, Jongen, Verhelst, Kamphuis & Kleintjes, 2006)	Attention control had a direct effect on reading skills and an indirect effect on reading skills through early reading skills. Attention control was only indirectly related to reading comprehension through its impact on early literacy skills.	No. Background characteristics, including gender, were excluded from analyses.	Executive Action	Interventions that explicitly engage attentional control during phonological awareness interventions may be especially salient for children in preschool, kindergarten, and first grade.

Methods used across studies

Sampling

Notably, no study included in the present review described the use of randomization in sample selection, and just six named their sampling strategy or provided a reference for a discussion of the study methodology (i.e., Language and Reading Research Consortium (LRRC), Jiang & Farquharson, 2018; Rabiner, Carrig & Dodge, 2016; Rabiner, Goodwin & Dodge, 2016; Salla et al., 2016; Wesdal, 2018). All studies reviewed would be strengthened by the inclusion of the following evidence (Guo & Hussey, 2014): that their sample provides adequate statistical power for hypothesis testing, that they performed diagnostic tests to investigate any departure of data from statistical assumptions. In addition, all studies reviewed would be improved by a careful reminder to readers that their findings are limited in their generalizability.

Instruments Used

Measures of reading and pre-reading skills and reading proficiency were diverse across the 16 studies reviewed. Reading outcomes were assessed with the following measures: phonological awareness and knowledge ($n=6$), word reading ($n=5$), reading comprehension ($n=3$), letter knowledge ($n=3$), teacher ratings of reading performance ($n=4$), and objective performance measures (i.e., grades, standardized test scores) ($n=2$). Notably, all but one study reviewed (Leclercq & Sieroff, 2016) operationalized reading skills using more than one measure. Subtests of the Woodcock Johnson Test of Achievement were most commonly used across studies (Woodcock, 1998).

Attention and inattention were measured using observer rating scales completed by teachers ($n=7$), teachers with another rater ($n=4$), as well as task performance on observable measures ($n=4$). All measures used to assess attention skills appear to be established and validated tools, with common tools cited including the ADHD Rating Scale (DuPaul 1999), Conner's Rating Scale (Conners, 1997), and the Flanker Fish computer task (Diamond et al., 2007). However, no study employed multiple methods of assessing attention, and just four included multiple raters. Comprehensive diagnostic assessment of attention is time and resource-intensive and includes data sourced from multiple respondents across multiple methods (DuPaul, Reid, Anastopoulos & Power, 2014). Unfortunately, ratings from individual observers—particularly teachers—have been found to be unstable (DuPaul, Reid, Anastopoulos & Power, 2014; Rabiner et al. 2010.) This

instability raises questions about the validity of using teacher ratings of attention as the unitary measure of attention.

Substantive findings

Effect of Inattention on Concurrent and Long-term Reading Skills.

Direct Effects. Nine of the 16 studies suggest that inattention directly impacts children's reading and early literacy skills, both concurrently and longitudinally. Among preschool student samples, higher levels of inattention were directly and significantly related to early literacy skills, including vocabulary, phonological awareness, and letter knowledge (Allan et al., 2018; Lonigan, Allan & Phillips, 2017). Among elementary student samples, higher levels of inattention significantly predicted lower performance on standardized reading assessments (Pham, 2016; Rabiner, Carrig & Dodge, 2016; Rabiner, Goodwin & Dodge, 2016; Salla et al., 2016; Wesdal, 2018) and school grades (Rabiner, Goodwin & Dodge, 2016). In addition, Leclercq and colleagues (2016) created two experiments to examine the unique role of the orienting subsystem of attention on reading abilities. They found that children who have difficulty orienting their attention to the beginning of a letter string have more problems reading relative to children without orienting issues.

Results from longitudinal studies indicated that inattention was directly linked to long-term academic consequences. For instance, Rabiner, Goodwin, and Dodge (2016) found that a one standard deviation increase in 1st-grade inattention skills was associated with a .16 standard deviation decrease in reading performance on standardized measures and a .25 standard deviation decrease in average grades. These authors also reported that students whose attention problems in 1st grade were one standard deviation above average were 40% less likely to graduate from high school relative to children with average levels of attention problems. Taken together, the results of the studies reviewed provide consistent and compelling evidence that attention problems are directly linked to poor reading outcomes for children concurrently and over time.

Several hypotheses as to why inattention directly impacts the development of early literacy skills are presented. Pham (2016) first presents that inattention and reading difficulties share small but significant genetic underpinnings (i.e., Willcutt et al., 2001; Willcutt et al., 2005). He also proposes a neuropsychological perspective, whereby atypical behavior inhibition can alter one's ability to process visual or auditory information while simultaneously refraining from reacting to a stimulus too quickly. In the context of reading, children with impaired behavioral inhibition may impulsively read a word incorrectly, which can lead them to misinterpret or miscomprehend the text. Interestingly, others have suggested that

impulsivity *can also* be positively associated with reading attainment, as it signals engagement in the learning. Related to inattentive symptoms, a neuropsychological perspective holds that students with impaired attentional processes may become easily distracted, and are more likely to experience difficulty in sustained or selective attention when reading for long periods. Finally, both Pham (2018) and Leclercq and colleagues (2016) suggest that the development of efficient attentional processes involved in reading—specifically, the dominant orientation of attention—is necessary for reading a word correctly and reading fluency.

Indirect Effects. Evidence from three studies indicates that inattention is only indirectly related to reading ability through its bearing on cognitive skills that are required for reading. These three studies reported similar findings, which collectively suggest that among children followed from preschool through elementary school, inattention has a direct impact on the development and acquisition of early literacy and cognitive skills (e.g., phonological awareness and processing, rapid automatized naming, word decoding,) and that these skills, in turn, have a direct impact on later reading abilities (Isbell et al., 2017; Language and Reading Research Consortium (LRRC), Jiang & Farquharson, 2018; ten Braak, Kleemans, Storsken, Verhoeven & Segers, 2018).

Mixed-Effects. Four studies reported evidence that inattention has both a direct impact on reading *and* an indirect impact on reading skills through its impact on other cognitive skills (Ogg, Volpe & Rogers, 2016; O’Neill, Thornton, Marks, Rajendran & Halperin, 2016; Plourde et al., 2018; van de Sande, Segers & Verhoeven, 2017).

Summary of Findings. Although the results of the 16 studies included in this systematic review do not definitively suggest one pathway through which attention relates to reading, there is a consensus that higher levels of attention problems are associated with greater reading difficulties and slower reading development. The lack of clarity regarding the pathway by which attention and reading are related suggests that these competencies are complex and dynamic. It is also important to note that the study setting, participant characteristics, and measurement approaches varied widely across studies. These study design factors likely explain, at least in part, the multiple pathways linking inattention and reading that emerged from the articles included in this review.

Potential Differential Processes

Although eight studies included race, ethnicity, gender, or socioeconomic status as control variables, there was virtually no meaningful study of potential differential processes in the relationship between attention and reading

performance among students who are overrepresented in ratings of attention problems. Pham (2016) explored attention by gender interactions and found that boys who demonstrated inattentive behaviors performed more poorly on measures of oral reading comprehension and reading fluency than did girls with inattentive behaviors, though the author did not test for similar findings related to student race or socioeconomic status. Just half ($n=8$) of studies reviewed even accounted for any variation in student reading performance due to race, gender, and socioeconomic status.

That the most current literature on the relationship between attention problems and reading failed to explore potential differential processes by which attention relates to reading among students who are at an elevated risk for being labeled with attention problems is disappointing. This gap in the literature is especially discouraging in light of longstanding evidence indicating that relative to their White peers, Black grade school students have significantly higher ratings of attention problems, even in a controlled setting where children are primed to behave identically to one another (DuPaul et al., 1997; Epstein, March, Connors & Jackson, 1998). These ratings of attention problems are subsequently strongly associated with academic achievement (Rabiner, Murray, Schmid & Malone, 2004). Hooper and colleagues (2010) similarly reported that African-American and Hispanic students had lower levels of reading performance relative to White students, and that slower gains in reading among African American students are explained in part by attention ratings. Unfortunately, a lack of meaningful study of potential differential processes in the relationship between attention and reading performance among students who are overrepresented in ratings of attention problem limits the ability to make recommendations for a nuanced intervention strategy to target children at elevated risk for academic failure.

Importance of Early Identification of and Interventions Targeting Inattention.

Evidence from nearly all studies ($n=12$) indicates that identifying inattention in preschool and kindergarten, and engaging in individualized intervention activities is critical to promote academic success among children at risk for poorer performance caused by attention problems. These findings align with previous research that reported children's sustained attention ability levels in 1st grade remain stable across the lifespan (Deter-Deckard & Wang, 2014).

Attention skills, reading skills, and academic enabling skills (i.e., engagement, motivation, etc.) emerged as key intervention targets to promote academic success among children with attention problems. Recommended

classroom-based interventions include small group reading (Allan et al., 2018), one-on-one reading training (Allan et al., 2016; LRRC, Jiang & Farquharson, 2018), and literacy and speech interventions (Pham, 2016). Other recommended interventions include computerized attention and working memory training (Rabiner, Goodwin & Dodge, 2016), and targeting attentional control during phonological awareness intervention (ten Braak, Kleemans, Storsken, Verhoeven & Segers, 2018). Mindfulness-based interventions may also promote attention and sustained attention (Rabiner, Goodwin & Dodge, 2016).

Discussion

The primary aim of this review was provide school social workers, educators, and other practitioners with a description of how inattention negatively relates to the development of literacy from preschool through middle childhood. A secondary aim of this study was to summarize potential differences in ratings of attention problems and reading skills by child race, gender, and family poverty status and over time. To achieve these aims, this systematic review synthesized current research on the developmental relations between inattention and reading by reviewing 16 articles obtained from five databases.

The results of this study support the evidence pointing to a negative relationship between attention problems and performance in academic skills, with a focus on reading. The results suggest there are multiple pathways through which an increase in attention problems has negative direct effects (Allan et al., 2018; Dittman 2016; Leclercq & Sieroff, 2016; Lonigan, Allan & Phillips, 2017; Pham, 2016; Rabiner, Carrig & Dodge, 2016; Rabiner, Goodwin & Dodge, 2016 Salla et al., 2016; Wesdal, 2018) on reading skills across measures of attention and measures of reading performance. Shared neuroanatomy (Pham, 2018; Leclercq et al., 2016); genetic underpinnings (Willcutt et al., 2001; Willcutt et al., 2005), neuropsychological explanations (i.e., atypical attention processes can contribute to atypical information processing, and misinterpretations and miscomprehensions of text) may, at least in part, explain the direct impact of attention problems on the acquisition of early literacy. The impact of early attention problems on later reading achievement is also indirectly linked through early cognitive skills, such as processing speed, rapid automatized naming, and word decoding (Isbell et al., 2017; LRRC, Jiang & Farquharson, 2018; ten Braak, Kleemans, Storsken, Verhoeven & Segers, 2018). Additional evidence supports a mix of direct and indirect effects of attention problems on reading skills (Ogg, Volpe & Rogers, 2016; O'Neill, Thorton, Marks, Rajendran & Halperin, 2016; Plourde et al., 2018).

There was virtually no meaningful study of variation in the development of attention problems and reading skills as a function of child gender, race, and

socioeconomically individually or through interactive effects across the 16 studies reviewed. This gap in the literature is especially discouraging in light of the strong evidence base pointing to variations in both ratings of attention problems (i.e., DuPaul et al., 2014; Peters et al., 2014; Rabiner, Murray, Schmid & Malone, 2004; Ramtekkar, Reirsen, Todorov & Todd, 2010) and reading skills (NCES, 2018) by child race, gender, and socioeconomic status.

Implications for School Social Workers and Social Work Research.

School social workers may be especially prepared and located to address the interaction of child and classroom factors within schools that impede student performance in early grades and set up challenges for later success. Specifically, school social workers can better understand the social processes at play in school and can leverage their roles to contextualize teacher ratings of student attention in a broader context. School social workers can advocate against the over-reliance of symptom counts in reporting inattentive behavior, and for the use of multiple raters when completing behavioral assessments of attention. In addition, school social workers can also raise awareness about the relationship between perceived attention problems and reading scores for students who are at an elevated risk for poor academic outcomes. Finally, school social workers can also collaborate with other school staff to explore factors that lead to student inattention, and propose and implement interventions that improve student success.

The findings of this review also have implications for the role of school social workers in multitiered systems of support (MTSS). As a data-driven framework, MTSS considers students' academic and social/behavioral needs in holistic decision-making processes by offering educational supports of increasing intensity and individualization (Hoover, Méndez Barletta & Klingner, 2016). Systematic reading interventions can increase literacy when designed and applied for specific support needs. More school social work-focused research is needed to identify the role of attention in implementing tiered reading supports, and school social workers and researchers can play a leadership role in this line of research. Results from a national survey of school social workers indicated that the majority (86.4%) of respondents felt that their time spent performing universal support versus selective support for students with additional needs, and expressed that their activities should be more balanced (Kelly et al., 2010). Finally, there is an important distinction between learning disabilities and language acquisition among English learners (Hoover et al., 2016). School social workers can work with linguistically diverse families and teachers to develop plans for addressing attention challenges for students who are not eligible for special education services but would benefit from educationally related services.

It is evident that assessing for and intervening in early attention problems in preschool and kindergarten is essential to promote optimal reading outcomes for all students. Unfortunately, it is not yet possible to make any recommendations for a nuanced intervention strategy to target children at elevated risk for academic failure. Thus, there is an urgent need for future social work research to investigate potential differential processes in the relationship between attention and reading performance for children at increased risk for reading problems. In the literature reviewed for the present study, gender, race, and socioeconomic status were key factors associated with suboptimal reading outcomes. There is a need to include these and other factors not explored in the present study in future research on the relationship between attention and reading. This is especially true for research that occurs in national and cultural contexts not represented in this review.

In addition, scholars pursuing future studies on the relationship between attention and reading would benefit from the inclusion of comprehensive measures of attention and reading performance, including performative, observational, and self-report rating scales completed by multiple raters. The tools employed by studies reviewed serve as viable options, provided that they have been validated for use in the target population. Future research would similarly benefit from recruiting diverse and representative samples.

Limitations

The results of this study must be considered in light of its limitations. Identification of all possibly relevant studies was likely not fully attainable for this—or any—systematic review. Thus, relevant studies exist that were not identified within the search strategy employed for this review. For instance, a different conceptualization of attention could have resulted in the inclusion of different and more studies for review. However, the formulation of attention employed by the present study reflects current views of mental health diagnoses. In the present study, attention is conceptualized as a brain system that interacts with the environment to produce dimensional symptoms that are defined by observable behaviors (Groen-Blokhuis et al., 2014; Marcus & Barry, 2011). Notably, articles not published in English were not represented in this review. Consequently, this review fails to reduce the risk of publication bias (Rothstein & Hopewell, 2009).

Despite this notable limitation, best practices outlined by methodological experts were followed in the conduct of this review (e.g., Littell et al., 2008). In addition, the search involved many databases, manual searches of relevant journals, and was conducted in consultation with a professional reference librarian. Finally, and importantly, the findings of this study point also to a need for future researchers

to: (1) be more transparent in describing their sampling strategy and diagnostic testing prior to hypothesis testing, and (2) investigate the potential for differential processes in the relation between attention and reading performance among students at elevated risk for poor reading outcomes. These findings are relevant for all scholars, regardless of country of origin.

Conclusions

In sum, this systematic review contributes to a broader understanding of the relationship between student inattention and student reading skills. Inattention is directly and indirectly associated with reading skills, such that higher levels of attention problems result in poorer reading performance and academic success more broadly. Identifying attention problems and subsequently intervening to promote attention skills before 1st grade is critical to facilitate the development of literacy for all students. School social workers can work with linguistically diverse families and teachers to develop plans for addressing attention challenges for students who are not eligible for special education services but would benefit from educationally related services. Finally, this systematic review helped highlight a need for future research to explore the potential of differential processes in the relationship between attention and reading among subgroups of students at an elevated risk for reading problems. This lack of studies renders it impossible to make recommendations for nuanced intervention strategies or practice recommendations for students at elevated risk for academic challenges due to attention problems.

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*Note: * indicates that a given citation was one of 16 studies upon which this systematic review is based.*

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