DEVELOPMENTAL RELATIONS BETWEEN READING SKILLS AND ATTENTION PROBLEMS AMONG ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

SARAH RABINER EISENSMITH: Developmental Relations Between Reading Skills and Attention Problems Among Elementary School Students

(Under the direction of David Ansong)

Since racial, socioeconomic, and gender-based gaps are observed both in reading performance and in ratings of attention problems, it follows that the study of the relationship between these constructs is warranted. However, such an investigation is mostly absent from the current literature. The three studies comprising this dissertation investigate the developmental relations between reading and attention, and whether these relations vary by subgroups of students who are at elevated risk for high ratings of attention problems and lower ratings of reading skills. The first paper systematically reviewed studies on the developmental relationship between inattention and reading. The second paper used a multiple-group path analysis design to test two competing explanations of how attention problems are related to reading skills, and the role moderation role of gender, race, and family poverty status, and their intersections. The third paper used a structural equation framework to empirically test whether growth in attention problems from kindergarten through third grade is associated with growth in reading skills over the same period. Both Paper 2 and 3 used data from the Early Child Longitudinal Study, Kindergarten Class of 2010-2011.

Results from Paper 1 indicate that inattention has a consistent and negative impact on reading skills through multiple pathways. Results from Paper 2 indicate that students' attention problems at kindergarten entry are negatively associated with third-grade reading skills directly

and through their impact on first-grade reading skills. Black students, boys, and students from low-income families had higher average ratings of attention problems and lower levels of average reading skills relative to White students, girls, and students from more affluent families. Results from Paper 3 indicate that attention problems and reading skills grow independently from kindergarten through third-grade. Initial levels of attention problems were negatively and significantly related to initial levels of reading skills, and rates of change in reading skills. All three subgroup measures—child race, poverty status, and gender—were statistically significantly related to average levels of attention problems at school entry and the rate of change in reading skills. Only gender statistically significantly moderated the rate of change in attention problems.

This research has strengthened the foundation for testing for intersectionality in the study of factors associated with student academic performance. Future studies can employ longitudinal designs and multidimensional measures to this area and others, as evidence of differential relations can be keys to unlocking the processes that perpetuate performance gaps.

To the children who fill school halls and brighten the world around them, and to the families and communities that support them.

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LIST OF ABBREVIATIONS

ADHD	Attention deficit hyperactivity disorder
AIC	Akaike information criterion
BIC	Bayesian information criterion
CFI	Confirmatory Fit Index
ECLS:K-2011	Early Childhood Longitudinal Study Kindergarten Cohort of 2011
ERIC	Education Resources Information Center
LRRC	Language and Reading Research Consortium
MLR	Maximum likelihood estimation with robust standard errors
NAEP	National Assessment of Educational Progress
NASW	National Association of Social Workers
NCES	National Center for Education Statistics
RMSEA	Root mean square error of approximation
TLI	Tucker-Lewis index

INTRODUCTION

DEVELOPMENTAL RELATIONS BETWEEN READING SKILLS AND ATTENTION PROBLEMS

Reading is a building block of development, a foundation of individual and collective identity, and a critical tool for daily living. Educators expect reading proficiency to vary across students because students arrive with differences in motivation, preparation, learning abilities, and educational experiences. However, other gaps in student reading performance have been associated with the entanglement of poverty and race since the 1960s when data about such gaps was first collected. Data from the National Assessment of Education Progress (NAEP), a long-running testing effort of the federal Education Department provides evidence of these gaps: as early as fourth-grade, Black students' reading ability is nearly one full grade level lower than that of White students (National Center for Education Statistics (NCES), 2018). Similarly, students who qualify for free and reduced lunch score one grade level behind their more affluent peers (NCES, 2018). Girls also outscore boys by half a year in reading (NCES, 2018). It is important to note that these gaps are not caused by a fundamental, inherent difference in the capacity of children along with gender, racial or socioeconomic lines (Ansong, Okumu, Albritton, Bahunk & Small, 2020; Hyde, 2005; Hyde & Mertz, 2009; Spearman & Watt, 2013). Rather, these associations are likely explained by an uneven distribution of resources, the concentration of poverty and its far-reaching effects, and the socialization of students in school (Hening, Hula, Orr & Pedescleux, 1999).

Improving students' reading skills to provide all students with access to educational opportunities is a pressing need for educators, researchers, and policymakers. Students'

attentional capacity is one of the most stable child-level predictors of academic performance, with lower levels of attention skills associated with poorer grades (Duncan et al., 2007; Frazier et al., 2007; Gray, Dueck & Tannock, 2017). In preschool and early school grades, attentional capacity is malleable and responds to environmental intervention (Jones, Aber & Brown 2011; van Lier, Muthen, van der Sar & Crijnen, 2004), and efforts to foster attention through interventions aimed at classrooms and students can serve to reduce performance gaps. Thus, exploring student attention can be critical to combat the risk of poor educational outcomes.

Attention Problems and Reading Performance: Current Evidence and Empirical Gaps

Attention problems can indicate severe impairment (i.e., Attention Deficit Hyperactivity Disorder, ADHD), or mild attention problems, both of which can contribute to poor academic outcomes and a widening performance gap if unaddressed. Attention problems have implications for reading achievement, in particular (Frick et al., 1991; Hinshaw, 1992; Rabiner & Coie, 2000). In fact, of children who meet criteria for ADHD, 25-40% also meet the criteria for reading disorders, and of students who meet criteria for reading disorders, 15-40% also meet the criteria for ADHD (Epstein, Shaywitz, Shaywitz, & Woolston, 1991). Evidence of a link between attentiveness and reading development is well established in the literature (Duncan et al., 2007; Frazier et al., 2007; Gray, Dueck & Tannock, 2017). In addition, many attention-supporting interventions aim to improve students' academic performance (Allan et al., 2018; LRRC, Jiang & Farquharson, 2018; Pham, 2016). Despite the robust evidence base on the association between attention problems and reading skills, there has been less study of *how* attention problems may be related to reading skills.

Just as there is evidence that students' reading skills vary as a function of race, gender, and socioeconomic status, there is emerging evidence that ratings of attention problems also vary

as a function of these characteristics both individually and through interactive effects. For instance, children in families of low socioeconomic status are more likely to be rated as inattentive relative to their more affluent peers (Georges, Brooks-Gunn & Malone, 2012). Results of one meta-analysis suggest that, on average, students from families of low socioeconomic status are 1.85-2.21 more likely to have a diagnosis of ADHD relative to their peers from families with high socioeconomic status (Russel, Ford, Williams & Russel, 2015). Boys are also generally more likely to be identified as having attention problems (DuPaul et al., 2014), with a male to female ratio of having a diagnosis of ADHD estimated at 2.28:1 (Ramtekkar, Reiersen, Todorov & Todd, 2010). Turning to race, in settings where Black and White students are primed to behave similarly, Black students are rated as more inattentive relative to White students (DuPaul et al., 1997; Epstein, March, Conners & Jackson, 1998; Lawson et al., 2017; Peters et al., 2014; Rabiner, Murray, Schmid, & Malone 2004). In other words, Black students may be overrepresented for ratings of attention problems, even when their behavior is the same as their White peers.

Because racial, socioeconomic, and gender-based gaps are observed both in reading performance and in ratings of attention problems, it follows that the study of the relationship between these constructs is warranted and emergent. Unfortunately, there has been little study of how variation in attention ratings may relate to variations in reading skills. This empirical gap is especially disappointing in light of the proliferation of evidence about differences in ratings of attention problems and reading skills by child race, gender, and socioeconomic status. One study exploring growth in student attention and reading reported that slower gains in reading among Black students were partially explained by higher ratings of attention problems among Black students relative to White students (Hooper et al., 2010). Eisensmith and Kainz (2019) similarly

reported that the impact of higher ratings of attention problems was associated with lower reading scores for Black students and boys relative to White students and girls. The authors explained the finding that differences in teacher ratings of attention problems by student race and gender are correlated with observed racial performance gaps by proposing that ratings of attention represent a social process.

Study Focus

This dissertation research builds on existing evidence and takes an exploratory approach to investigate the developmental relations between reading and attention, and whether these relations vary by subgroups of students who are at elevated risk for having high ratings of attention problems and lower ratings of reading skills. By exploring developmental trajectories of attention problems and reading skills, their relations with one another, and whether their trajectories vary as a function of child gender, race, and family poverty status, it is possible to gain insight for when and with whom to intervene to promote student success.

This three-paper dissertation addresses the following objectives:

(1) systematically identify, examine, and synthesize substantive findings from theoretical and empirical literature linking attention and reading development and provide suggestions for future research;

(2) test two competing explanations of how attention problems may be related to reading proficiency; and whether the relation between attention and reading proficiency holds for boys and girls, Black and White students, students whose families are poor and those whose families are not poor, and combinations of these characteristics;

(3) examine whether initial scores and rates of change for attention problems and reading performance vary by child race, gender, and socioeconomic status; and explore whether

growth in attention problems from kindergarten through third grade is associated with growth in reading skills over the same period of time.

Theoretical Underpinnings

This dissertation study seeks to meet the need to study further how variation in attention problems relates to variations in reading skills over time and for students of different sociodemographic backgrounds through a review of the theoretical and empirical literature and empirical testing. In so doing, this research draws from two contextual theories of development: the Integrative Model for the Study of Developmental Competencies in Minority Children (García-Coll et al., 1996), and the Transactional Model of Development (Sameroff, 1975, 2009). Together, these two theories allow for the nuanced study of the development of attention problems and reading skills among diverse subgroups of students.

The Integrative Model for the Study of Developmental Competencies in Minority Children accounts for experiences of prejudice, racism, oppression, segregation, and discrimination in the development of competencies among non-White children. The Transactional Model of Development, on the other hand, holds that growth in any given year of schooling may depend on the child's experiences in previous years, as these experiences affect the reading skills that children bring to their new classroom (Sameroff, 1975, 2009). This dissertation tests these two theories to understand the developmental relations between reading skills and attention problems.

Relevance to Social Work Practice and Research

Social work is committed to improving well-being, particularly among those who are vulnerable and oppressed (National Association of Social Work, NASW, 2008). In the realm of social work practice, this dissertation may be most relevant to social workers practicing in

schools. The NASW Standards for School Social Workers states that school social workers must seek to ensure equitable educational opportunities for all students, with particular attention to students who struggle to fully benefit from the educational system (NASW, 2012). This inherently includes students who are at elevated risk for poor educational outcomes due to attention problems, as well as those who have historically had less access to educational opportunities.

Social workers employed in educational settings are well-positioned to contribute to solutions to observed racial, economic, and gender performance gaps in reading proficiency. Social work training enables these professionals to consider the interrelationship of social problems and academic outcomes in a broad context and to contribute to interventions aimed at reducing performance gaps. Typically, school social workers interested in addressing performance gaps in their schools are directed to provide social welfare and services solutions (Allen-Meares, 1994; Berzin et al., 2011; Kelly, 2008; Kelly et al., 2016). However, school social workers are specially 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.

School social workers are best positioned to not only facilitate better understandings of the social processes at play in school but also use their roles to contextualize teacher ratings of student attention. By increasing the awareness and understanding of the dynamics affecting students' attention, school social workers can make meaningful, well-informed proposals to implement interventions designed to improve reading proficiency and overall student success.

This dissertation also has implications for social work research. This dissertation study highlighted that there is a dearth of research on potential differences in ratings of attention

problems and reading skills by child race, gender, and family poverty status despite evidence that such gaps exist. This research has established the foundation for testing for intersectionality in the study of factors associated with student academic performance. Future studies can employ longitudinal designs and multidimensional measures to this area and others, as evidence of differential relations can be keys to unlocking the processes that perpetuate performance gaps.

Using this dissertation study as a foundation, social work researchers, in concert with: (1) scholars from education, policy, and psychology, (2) school social workers, teachers, and other school staff, and (3) families, children, and child-advocates, can foster a shared understanding of the problem of racial, socioeconomic and gender performance gaps in readings (Jensen & Kainz, 2019). Such work is in service of— and necessary for—making a real difference for children.

Organization of the Dissertation

This dissertation followed the three-paper format and focused on the developmental relations between attention problems and reading skills among subgroups of elementary school students. This introductory chapter presented a review of the current evidence on the relationship between attention and problems, the study focus, theoretical underpinnings of the study, and the relevance of the study for social work practice and research. Chapter 2 presents a systematic review of literature linking attention to reading development among all students and those who are at elevated risk for both attention problems and diminished reading performance. Chapter 3 presents results from a multiple-group path analysis design that tested two competing explanations of how attention problems are related to reading skills, and the role of gender, race, and family poverty status on this relation as moderators individually and through interactive effects. Chapter 4 presents results on whether growth in attention problems from kindergarten through third grade is associated with growth in reading skills over the same period of time.

Together, all three papers address important gaps in the literature and form cohesive yet distinct results that can be used to inform ongoing intervention development for children with attention problems and exploration into the mechanisms that drive persistent gender, race, and socioeconomic performance gaps. Following the presentation of each of the three papers, Chapter 5 integrates findings from the three papers, and implications for social work practice and research are discussed.

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PAPER 1

ATTENDING TO ATTENTION: A SYSTEMATIC REVIEW OF ATTENTION AND READING DEVELOPMENT FOR EDUCATORS AND PRACTITIONERS

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 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). Either "top-down" or "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. Bottom-up processes, on the other hand, are driven by external stimuli, such as a flash of light or unexpected noise, and are relatively reflexive and a

There are key areas of overlap in attention and other constructs such as executive function (Bornstein, 1990; Diamond, 2002; Klein & Lawrence, 2012; Kofler at al., 2011) Executive function has become an umbrella term for a variety of top-down cognitive processes that are 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 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).

Attention responds to environmental intervention during preschool and early elementary school years (Jones, Aber & Brown 2011; van Lier, Muthen, van der Sar, & Crijnen, 2004). However, 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 to promote reading development and performance for all children.

Although there is a consensus among researchers and educators 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 relations 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 their 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, Conners & Jackson, 1998; Rabiner, Murray, Schmid, & Malone 2004).

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. This review aims to

provide educators and practitioners with a summary of the most current literature linking inattention to reading to inform instructional and intervention practices.

Methods

Best practices for the conduct of systematic reviews, as outlined by Litell, Corcoran, and Pillai (2008), were used in the completion of 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 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 longitudinal data; (4) be published on or after December or 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 at 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 2.1 illustrates the search strategy. A university social science reference librarian with systematic review experience consulted on the overall search strategy and helped identify relevant databases. 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.

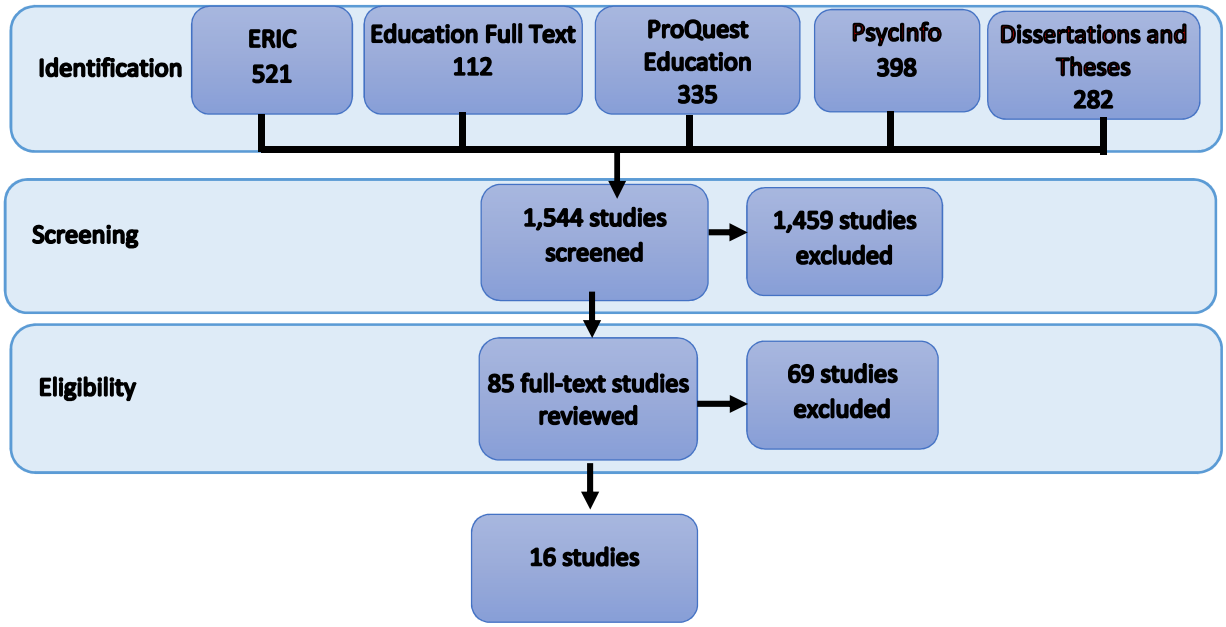

Figure 2. 1. Search strategy for identifying studies for inclusion

A search of ERIC, ProQuest Education, Education Full Text, PsycInfo, and Dissertations and Theses yielded 1,652 studies. I 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. After a review of titles, abstracts, and full text, if necessary, 85 studies were assessed for eligibility. Of these, 16 were included in the final review. 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 2.1.

Results

Study Characteristics

Table 2.1 displays descriptions and findings for each of the 16 studies reviewed. There was wide variation in terms of data collected, sample characteristics, and measured used. 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 2. 1. Study characteristics and findings for 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	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	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.	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	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.	Not explored.	Phonological awareness; Working memory; Rapid automatized naming	Recommended classroom-friendly screening and early intervention procedures.

Table 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	Implications for intervention
Leclercq & Sieroff (2016) Child Neuropsychology	Lab study in France	Experiment 1: 27 1st grade French children (18 girls), 27 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 students	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.	Not explored.	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	1,082 children;Mean age: 55mo, (SD=3.7mo); 45% girls; 47.8% White, 41.8% Black (Title 1 schools primarily served Black children, private schools primarily served White children)	Modified Conner's Teacher Rating Scale (Conners, 1997)	Preschool Comprehensive Test of Phonological and Print Processing; Oral LanguageReceptive and Language subtests of PCTOPP; Phonological AwarenessBlending and Elision subtest of PCTOPP; Print KnowledgePrint knowledge subtest of PCTOPPAlphabet, 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.	Not explored. 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 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	Implications for intervention
Westdal, J. N. (2018). *Family income, the home environment, sustained attention, genetic susceptibility, and children's reading outcomes: A structural equation modeling*	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	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.	Higher-income during early development was related to better reading in kindergarten, but not in 3rd 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.

Table 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	Implications for intervention
Pham (2016) Journal of Attention Disorders	Children from three elementary schools in the United States who were followed across two school years	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.	Differential relations by gender explored. 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.
Rabiner, Carrig & Dodge (2016) Journal of Attention Disorders	Secondary data analysis from non-intervention participants, which include children attending elementary school in the US followed from 1st grade through 5th grade	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	Not explored.Race and gender were included as control variables and did not significantly predict achievement.	Intelligence	Early and intensive intervention for children with identified attention problems.

Table 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	Implications for intervention
Rabiner, Goodwin & Dodge (2016) School Psychology Review	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	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.	Not explored. 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. Attention-training interventions include computerized training programs, working memory training, and mindfulness-based training
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.	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.	Not explored. 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 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	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	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.	Not explored. 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 come from a US-based longitudinal study of reading comprehension that followed children from first through third grade	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.	Not explored. Gender and family income were included in analyses 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 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	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	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.	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.
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	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	Not explored. 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

Table 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	Implications for intervention
O'Neill, Marks, Thornton, Rajendran & Halpern (2016) Neuropsychology	United States; children assessed in preschool and at age 8	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 Intex	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.	Not explored 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
Plourde et al. (2018) Developmental Neuropsychology	Canada; twin children followed from birth through age 7. Analyses presented are based on data from two years.	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.	Not explored.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.

Table 2.1. Study characteristics and findings for articles reporting 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	Potential differential relations by race, ethnicity, SES, or gender	Other explanatory factors that predict reading outcome	Implications for intervention
van de Sande, Segers & Verhoeven (2017) Written Language & Literacy	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.	Not explored. 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.

Measures of reading and pre-reading skills and reading proficiency were diverse across the 15 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). Attention and inattention were measured using observer rating scales completed by teachers (*n*=7), teachers, and another rater (*n*=4), as well as task performance on observable measures (*n*=4).

Substantive Findings

Effect of inattention on concurrent and long-term reading skills.

Direct effects. Results from nine of the sixteen studies suggest that inattention has a direct impact on 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, Leclerq and colleagues (2016) created two experiments to examine the unique role of the orienting subsystem of attention on reading abilities and 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 has a direct impact on the development of early literacy skills are presented. Pham (2016) first presents that attention 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 Leclerq and colleagues (2016) suggest that the development of efficient attentional processes involved in reading—specifically, the dominant orientation of attention—is necessary for both reading a word correctly and for 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.

There was virtually no meaningful study of potential differential processes in the relation between attention 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 students have significantly higher ratings of attention problems, even in a controlled setting where children are primed to behave identically to one another difficulties (DuPaul et al., 1997; Epstein, March, Conners & 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. Eisensmith and Kainz (2019) similarly reported that although attention is an important predictor of reading ability for all students, attention has a more robust impact on the reading abilities of students of color relative to white students. The authors found that among students with low levels of teacher-rated

attention, Black students scored lower on second-grade reading assessments relative to their White peers. At higher levels of teacher-rated attention, the gap in reading score remains significant but is reduced by half to 10% of a standard deviation (approximately one point). In addition, steeper slopes representing the relationship between teacher-rated attention and spring second-grade reading score among Black and Hispanic relative to White students indicates that ratings of attention matter more for non-White students in terms of their reading proficiency. Unfortunately, it is not yet possible to make any recommendations for a nuanced intervention strategy to target children at elevated risk for academic failure.

Importance of early identification of and intervention 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 who are at risk for poorer performance caused by attention problems. These findings are in line with previous research that reported that 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).

Conclusion

This systematic review synthesized current research on the developmental relations 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 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.

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 that there are multiple pathways through which an increase in attention problems has negative direct effects(Allan et al., 2018; Dittman 2016; Leclercq et al. 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; Leclerq et al., 2016); genetic underpinnings (Willcutt et al., 2001; Wilcutt 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). There is additional evidence supporting 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.

Limitations

Identification of all possibly relevant studies was likely not fully attainable for this—or any—systematic review. It is thus possible that 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 (American Psychiatric Association; Groen-Blokhuis et al., 2014; Marcus and 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.

Summary

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. In fact, "few constructs have had a more direct impact on children's academic achievement than their ability to pay attention in the classroom" (Trentacosta & Izzard, 2007, p. 78). Identifying attention problems and subsequently intervening to promote attention skills before 1st grade is critical to facilitate the development of literacy for all students. This systematic review helped highlight that there is a need for future research to explore the potential of differential processes in the relation between attention and reading among subgroups of students who are at an elevated risk for reading problems. This lack of study renders it impossible to make recommendations for nuanced intervention strategy 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 sixteen studies upon which this systematic review is based.*

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PAPER 2

PATH TO PROFICIENCY: THE ROLE OF ATTENTION, RACE, GENDER, AND POVERTY STATUS ON READING SKILLS

Reading proficiency is a building block of development, a foundation of individual and collective identity, and a critical tool for daily living. Educators expect reading proficiency to vary across students because students arrive with differences in motivation and preparation, educational aspirations, learning abilities, and work ethic. However, other gaps in student reading performance have been associated with the entanglement of poverty and race, which had persisted since the 1960s when data about such gaps were first collected. Data from the National Assessment of Education Progress (NAEP), a long-running testing effort of the federal Education Department provides evidence of these gaps: by fourth grade, Black students' reading ability is nearly one full grade level lower than that of White students (National Center for Education Statistics [NCES], 2018). Similarly, students who qualify for free and reduced lunch score one grade level behind their more affluent peers (NCES, 2018). These gaps are not caused by a fundamental, inherent difference in child capability. Rather, this association is likely explained by an uneven distribution of resources, and the concentration of poverty and its far-reaching effects (Hening, Hula, Orr & Pedescleux, 2001S). These observed performance gaps suggest the circumstances into which a child is born is a critical factor in students' ultimate achievement.

It is challenging—and perhaps illogical—to separate socioeconomic status and race in the context of U.S. public education. Black students are six times more likely than are their White

peers to attend high-poverty schools with the highest rates of delinquency, suspensions, expulsions, and school drop out (Bevans et al., 2007; Birnbaum et al., 2003; Bradshaw et al., 2009; Elliott et al., 1996; Haycock, Jerald, & Huang, 2001; NCES, 2015; Stewart 2003). As compared with students of color in schools with low concentrations of minority students, students of color attending low-resourced schools with high concentrations of minority students make less progress during the academic year (Kainz, 2019). These early gaps in performance are compounded by school disadvantage and ultimately contribute to persistently wide gaps that jeopardize student advancement, high school graduation, employment outcomes, and long-term quality of life.

An especially promising area to promote the success of all students is to focus on students' attention in class, one of the most stable child-level predictors of academic performance (Duncan et al., 2007; Frazier et al., 2007). In fact, "few constructs have had a more direct impact on children's academic achievement than their ability to pay attention in the classroom" (Trentacosta & Izzard, 2007, p. 78). 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 (Allan et al., 2018; Eisensmith & Kainz, 2019; Isbell, Calkins, Swingler & Leerkes, 2018; Rabiner & Coie, 2000). Many students experience attention problems; in fact, attention-deficit/hyperactivity disorder (ADHD) is the most commonly diagnosed mental health disorder among children in the United States (Froelich et al., 2007; Pastor & Reuben, 2005; Sciutto & Eisenberg, 2007).

The present study uses a multiple-group path analysis design to test two competing explanations of how attention problems may be related to reading skills among third-grade students. The present study then employs a moderated mediation design to examine the role of

gender, race, and socioeconomic status as potential moderators individually as well as through interactive effects.

The Construct of Attention

Attention is 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) alerts and prepares the student to anticipate incoming stimuli (Posner & Peterson, 1990, 2012); and (3) supervises and enables planning, problem-solving, conflict resolution and decision making (Posner & Rothbert, 1998; Shallice & Burgess, 1996; Wang, Liu & Fa, 2011). Either "top-down" or "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. Bottom-up processes, on the other hand, are driven by external stimuli, such as a flash of light or unexpected noise, and are relatively reflexive and automatic (Klein & Lawrence, 2012).

Theorists interested in attention have primarily focused on the alerting and supervisory attention subsystems, often considered to be voluntary (James, 1992). Piaget (1964), Luria (1966), and Vygotsky (1997) first postulated a sequence of stages during which neurophysical functions for intelligence and learning are developed and interact with environmental stimuli. This interactive development informs neurobiological structures associated with higher-level mental abilities such as memory, abstraction, and attention. This view that neuroanatomy interacts with environmental stimuli to inform attention is consistent with the present theory that phenotypes are shaped by experience (Goldstein, Naglieri, Princiotta & Otero, 2014).

Attention may initiate the passage of incoming information through the cognitive system to result in memory storage or an emotional or physiological response (Bornstein, 1990; Languis

& Miller, 1992). One's capacity to process information is finite, and attention may act as a filter to permit a limited amount of information to be processed while blocking out the infinite rest (Broadbent, 1958). How one filters, processes, and reacts to information is, at least in part, interpersonal and dynamic: behavior is learned from attending to and subsequently watching a model (Bandura, 1986). An individual's attention to the model varies by their past experiences, preferences, the model's relation to the individual, behavior complexity, prevalence, and effectiveness.

The transactional and interactional way that attention and these broader factors relate with one another in social learning theory overlaps with the Transactional Model of Development, which stresses the dynamic nature of child development (Sameroff, 1975, 2009). Like with other developmental theories, voluntary attention in this context reflects a change from viewing attentive behavior as a simple reaction to environmental contingencies and instead views voluntary attention from a constructivist perspective in which children are actively engaged in the structuring and organization of their world (Sameroff, 1975, 2009).

Conceptual Framework for the Relations Between Attention and Reading Skills

The process by which attention impacts reading remains somewhat elusive (O'Neill et al., 2016). It has been suggested that the co-occurrence between children's reading ability and attention can be explained by a reciprocal, transactional relationship between early attention and reading problems (Hinshaw, 1992).

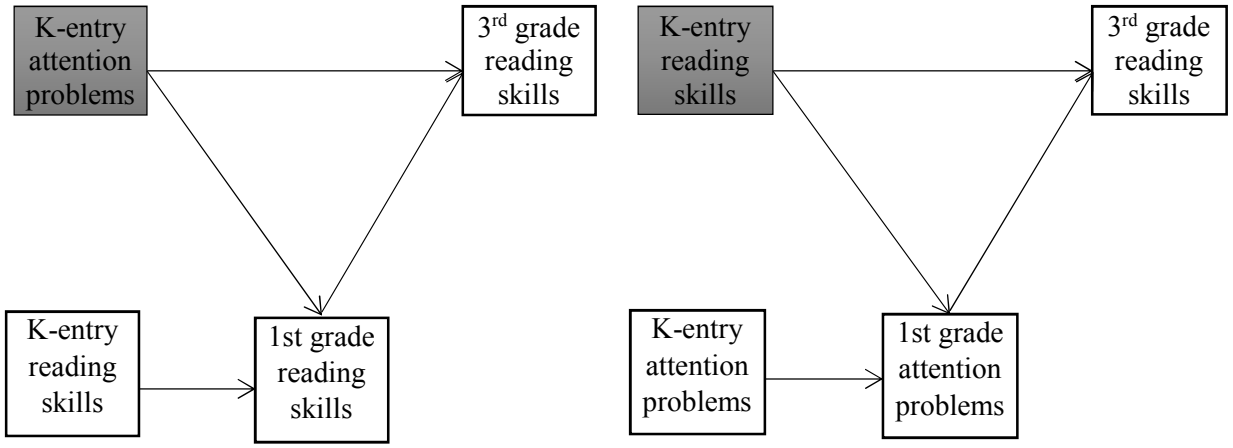
The relation between attention and reading skills may be initiated by a lack of planning and initiation, two problems often associated with attention problems (American Psychiatric Association, 2013). Attention problems in preschool and early grades have been found to have a direct impact on children's early literacy skills and reading skills, both concurrently and

longitudinally (i.e., Allan et al., 2018; Lonigan, Allan & Phillips, 2017; Rabiner, Goodwin & Dodge). Attention problems have also been negatively linked indirectly to later reading ability through their adverse impact on the acquisition of early literacy skills that are required to read, (i.e., Isbell et al., 2017; Language and Research Reading Consortium, Jiang & Farquharson, 2018; ten Braak, Kleemans, Storsken, Verhoeven & Segers, 2018). In turn, these problems in early literacy and cognitive skills harm later reading abilities. In other words, early attention problems may, directly and indirectly, predict students' reading performance through its impact on the development of early reading skills.

Alternatively, the relation between attention and reading may be initiated by a lack of early reading skills. Some experience early reading failure at school entry due to phonological processing issues, lack of practice, or poor decoding skills (Stanovich, 1986). In turn, this early reading failure can lead to students feeling bored, anxious, avoidant, and frustrated with academic activities (Aunola, Leskinen, Onatsu-Arvilommi & Nurmi, 2002; Chapman, Tunmer & Prochnow, 2000). Behaviors associated with boredom, avoidance confusion, and frustration, such as lack of eye contact, fidgeting, gazing out the window, or off-task behavior, are also signs of inattention and may be interpreted by teachers as such. In other words, poor reading skills at school entry may be related to poor reading skills in third grade directly, and also indirectly through their impact on students' attention problems.

As illustrated in the conceptual models in Figure 3.1, this study tested competing hypotheses regarding the relation between attention skills, early reading skills, and third-grade reading performance. Model 1 proposes that attention problems at kindergarten entry predict third-grade reading skills directly and through their impact on the acquisition of early reading

skills. Model 2 explores whether reading skills at kindergarten entry predict third-grade reading skills directly and through their impact on attention problems in first grade.



(a) Model 1 where K-entry attention problems is hypothesized as the main antecedent.

(b) Model 2 where K-entry reading skills is hypothesized as the main antecedent.

Figure 3. 1. Testable "competing" models of attention problems and reading skills

The Relations Between Attention and Reading in Subgroups Groups of Students

Little extant literature has explored the relationship between attention and reading development among students who are overrepresented in ratings of attention problems and poorer academic performance, such as boys, students from poor families, and students of color, despite evidence that differences may exist. For instance, children in families of low socioeconomic status are, on average, 1.85-2.21 more likely to have a diagnosis of ADHD relative to their peers from families with high socioeconomic status (Russel, Ford, Williams & Russel, 2015). Boys are also generally more likely to be identified as having attention problems, with a male to female ratio estimated at 2.28:1 (Ramtekkar, Reiersen, Todorov & Todd, 2010). In addition, in settings where Black and White students are primed to behave similarly, Black students are rated as more inattentive relative to White students (DuPaul et al., 1997; Epstein, March, Conners & Jackson, 1998). In other words, Black students may be overrepresented for

ratings of attention problems, even when their behavior is the same as their White peers. In a study exploring growth in student attention and reading, Hooper and colleagues (2010) reported that slower gains in reading among Black students were partially explained by higher ratings of attention problems. Eisensmith and Kainz (2019) similarly reported that the impact of higher ratings of attention problems were associated with lower reading scores for Black students and boys relative to White students and girls. The authors explained the finding that differences in teacher ratings of attention problems by student race and gender are correlated with observed racial performance gaps by proposing that ratings of attention represent a social process. The literature points to a need for further study of whether the relationship between attention and reading is the same for subgroups of students who are an elevated risk both for more attention problems and lower reading skills. Evidence of differential relations between ratings of attentional capacity and student academic performance could be instrumental in unlocking the processes that perpetuate racial performance gaps.

Present Study

The present study has two aims: (1) to test two competing models about the relation between attention problems and reading skills; (2) to test whether the relation between attention and reading is moderated by child race, gender, and poverty status individually as well as through interactive effects. Testing moderation by these characteristics allows for a more nuanced study of how attention problems and reading skills are related and may aid in the identification of students who would most benefit from intervention. I use a moderated-mediation design to test the direct and indirect relations between attention problems and reading skills among children participating in the ECLS-K:2011.

First, I fit a mediation model that explored whether attention problems at kindergarten entry predict third-grade reading skills directly and through their impact on early reading skills (see Model 1 in Figure 3.1). Next, I fit an alternative mediation model that explored whether reading skills at kindergarten entry predict third-grade reading skills directly and through its impact on attention problems in first grade (see Model 2 in Figure 3.1). Based on the model fit statistics for the proposed models, I then identified a final model of best fit between attention problems and reading skills at the end of third grade. Finally, using a discovery approach to address a gap in the literature, I tested moderating variables, specifically, whether the relations between attention problems and reading skills at the end of third grade differed between: (1) boys and girls, (2) Black and White students, (3) students who are from poor families and those who are not, (4) poor boys and poor girls, (5) poor Black and poor White students, (5) Black boys and White boys, and (6) Black girls, and White girls.

Methods

Data and Sample Selection

Analyses are based on data from the ECLS-K: 2011, a nationally representative sample of approximately 20,000 children enrolled in 1,319 schools beginning the 2010-11 school year and followed through elementary school (Tourangeau, Nord, et al., 2018). Direct assessments of children, parents, teachers, and administrators from Fall 2010 through Spring 2014 were used in analyses. Data from public schools in kindergarten, first, and third grades were incorporated. Approximately half of the sample is male. Roughly half of the students are from households at or above 200% of the federal poverty level. Nearly half of the sample is White, and 13% percent of the sample is Black. Because White students were overrepresented in the overall sample, a random sample of White students were obtained for analyses. Analyses for the present study reflect 3,129 White students and 2,210 Black students who participated in the ECLS-K:2011.

Variables

The outcome variable was children's reading skills in third grade. Trained assessors administered reading performance tests in the Fall and Spring of each school year. Staff from the ECLS-K:2011 converted students' raw scores to scale scores appropriate for cross-sectional and longitudinal analyses. Reading scale scores range from 0-155 and represent children's overall reading knowledge, with higher scores indicating greater reading knowledge.

The analysis included five child-level predictors: attention problems in kindergarten and first grade, reading skills in kindergarten and first grade, family poverty status, gender, and race.

Attention problems. Teacher ratings of children's attention were measured at school entry and Spring first grade. Six items from the Children's Behavior Questionnaire (Putnam & Rothbart, 2006, subscale α=.87) prompted teachers to report on students' attentional focus. Using a seven-option response scale, teachers indicated how "true" or "untrue" statements were about students' reactions to situations in the past six months using a seven-point scale. Higher scores indicate that the child exhibited more behaviors that demonstrate the ability to focus attention on cues in the environment. Teacher ratings were reverse coded so that higher scores indicate that the child exhibited greater levels of attention problems.

Reading skills. As with reading skills in third grade, trained assessors administered reading performance tests to students in the Fall of kindergarten and Spring of first grade. Staff from the ECLS-K:2011 converted students' raw scores to scale scores appropriate for cross-sectional and longitudinal analyses. Reading scale scores range from 0-155 and represent children's overall reading knowledge, with higher scores indicating greater reading knowledge.

Poverty status. The ECLS-K: 2011 defined poverty level using the U.S. census definition of a poverty threshold based on parents' reports of multiple income sources adjusted

for household size. In the present analysis, *Poor* is defined as household income-to-needs ratio up to 200% of the poverty threshold. Approximately 46% of the sample are identified as poor.

Child gender. The ECLS-K:2011 dataset identifies whether children are boys or girls. Child gender was determined by researchers at the school-based assessment and confirmed via the initial parent interview. Forty-eight percent of the sample were girls.

Child race. Child race is provided in the ECLS-K:2011 dataset. Parents provided information on child race in the parent interview. The ECLS-K:2011 accounts for six categories of race (i.e., Black, White, Hispanic, Asian, Native Hawaiian/Pacific Islander, American Indian/Native Alaskan, and Two or more races). In total, 3,129 White students (58% of the sample) and 2,210 Black students (42% of the sample) comprise the sample.

Data Analysis

Path analysis. Path models were first estimated in Mplus Version 8.1 (Muthen & Muthen, 2019). The (MLR) estimator in Mplus was used because it is robust to non-normality and non-independence of observations for complete and incomplete data (Schreiber, 2017). Also, because the sample was drawn from different schools, the cluster option in Mplus was used to correct for potential clustering in the standard errors and chi-square estimation.

The first path model tested the causal chain from kindergarten entry reading skills through first-grade attention problems to third-grade reading performance (Model 1). The second path mode presented a causal chain from attention problems and kindergarten entry through first-grade reading skills to third-grade reading performance (Model 2).

Model fit assessment of path models and selection of the final model. The fit between the two hypothesized path models and observed data were assessed using six recommended fit criteria (Eveland, Hayes, Shah & Kwak, 2005). The following fit criteria were used: the Akaike

Information Criterion (AIC) and the Bayesian Information Criterion (BIC) (smaller values indicate a model is more likely to be the true model (Kass and Raftery 1995; Raftery, 1995); $\chi 2$/df ratio (good if > 1, lower values indicate better fit (Eveland, Hayes, Shah & Kwak, 2005)); root mean square error of approximation (RMSEA; mediocre fit if between .08 and .10, good if ≤.05); comparative fit index (CFI; acceptable if > .90, good if > .95); and the Tucker-Lewis index (TLI; acceptable if > .90, good if > .95) (Hu & Bentler, 1999; Kline, 2005). The model with a superior fit based on the recommended fit criteria was retained for invariance analyses. Table 3.1 presents the covariance matrixes used to estimate the path models for the full sample.

Table 3. 1. Correlation Matrix

	3rd-grade reading	1st-grade reading	K-entry reading
1st-grade reading	0.648		
K-entry reading	0.589	0.725	
K-entry attention	0.553	0.68	0.851

Invariance analysis. After confirming that which path model has the best fit with the observed data, a multi-group framework was used to test whether the final path model was invariant across the following groups: (1) boys and girls, (2) Black and White students, (3) students who are from poor families and those who are not, (4) poor boys and poor girls, (5) poor Black and poor White students, (5) Black boys and White boys, and (6) Black girls, and White girls. A five-step process was used to assess the path invariance (van de Schoot, Lutgig & Hox, 2012). First, I tested the overall model and then separately examined the model fit for each subgroup. The third step involved the configural invariance model (baseline model). If the baseline model fit the data well, I proceeded to the path invariance model, where I constrained all the path coefficients to be equal for both subgroups. I used a Satorra-Bentler scaled chi-square

difference test (see Equations 1 and 2 below) to compare the configural and path invariance models to determine whether the coefficients (paths) were different between different subgroups. In the Equation 1 and 2 below, "*cd"* represents the test scaling correction; *c0* indicates the scaling correction factor for the nested model; *d0* signifies the degrees of freedom in the nested model while *d1* signifies the degrees of freedom in the comparison model; and *T0* and *T1* are the MLR chi-square values for the nested and comparison models, respectively.

$$cd = (d0 \times c1) \div (d0 - d1) \quad (1)$$

$$TRd = (T0 \times c0 - T1 \times c1) \div cd \quad (2)$$

If the paths were the same across groups, I constrained the intercepts to be equal for both groups to test for scalar invariance. Once again, I used a Satorra-Bentler scaled chi-square difference test to compare the scalar and path invariance models to determine whether the intercepts were different between subgroups.

Results

Descriptive Statistics

Descriptive statistics for the analytical sample can be found in Table 3.2. On average, Black students have higher ratings of attention problems (kindergarten entry: *M*=3.52*, SD*= 1.31, first grade: *M*=3.58*, SD*= 1.39*)* relative to White students (kindergarten entry: *M*=3.12*, SD*= 1.29, first grade: *M*=3.25*, SD*= 1.33*).* Boys have higher levels of attention problems than do girls at kindergarten entry and in first grade (boys—kindergarten entry: *M*=3.52*, SD*= 1.31, first grade: *M*=3.58*, SD*= 1.39*;* girls—kindergarten entry: *M*=2.99*, SD*= 1.25, first grade: *M*=3.09*, SD*= 1.28*)*. Students whose families are poor have higher levels of attention problems than do children whose families are not poor at kindergarten entry and in first grade (students whose families are poor—kindergarten entry: *M*=3.46*, SD*= 1.31, first grade: *M*=3.58*, SD*= 1.38*;*

students whose families are not poor—kindergarten entry: *M*=2.98*, SD*= 1.25, first grade: *M*=3.06*, SD*= 1.27*)*. On average, Black students' third-grade reading skills is approximately 10 points lower than that of White students, while students from low-income families scored on average 11-points behind students whose families are not low-income on third-grade reading skills.

Table 3. 2. Descriptive characteristics of the analytical sample

	Overall n=5,249	Boys n=2,726	Girls n=2,512	Black n=2,210	White n=3,139	Poor n=1,375	Not poor n=1,625
3rd grade reading	114.75(15.20)	112.91(15.95)	116.82(14.01)	108.48(14.18)	118.54(14.52)	109.75(15.61)	120.83(13.00)
1st grade reading	91.27(17.85)	89.245(18.24)	93.52(17.11)	86.16(16.88)	94.68(17.68)	86.37(17.87)	97.98(16.65)
K-entry reading	54.41(10.89)	51.54(10.91)	53.33(10.78)	50.37(9.70)	53.90(11.45)	50.13(9.73)	56.54(12.20)
1st grade attention	3.28(1.3)	3.55(1.31)	2.99(1.25)	3.52(1.31)	3.12(1.29)	3.46(1.31)	2.98(1.25)
K-entry attention	3.39(1.36)	3.67(1.38)	3.09(1.28)	3.58(1.39)	3.25(1.33)	3.58(1.38)	3.06(1.27)

Results from Final Model

Model fit indices for the path models are presented in Table 3.3. The model with the best fit to the data was the model with attention at kindergarten entry, directly and indirectly, predicting third-grade reading skills, through first-grade reading skills. Figure 3.2 presents standardized solutions for the final model. The results offer support to the claim that higher levels of attention problems at kindergarten entry contribute to poor reading skills in first grade, which, in turn, predicts lower levels of reading skills in third grade.

Invariance Testing Between Subgroups of Children

Model fit indices for the invariance tests are presented in Table 3.3. Figures 3.2a-3.2g present the standardized solution for the model among different subgroups of students.

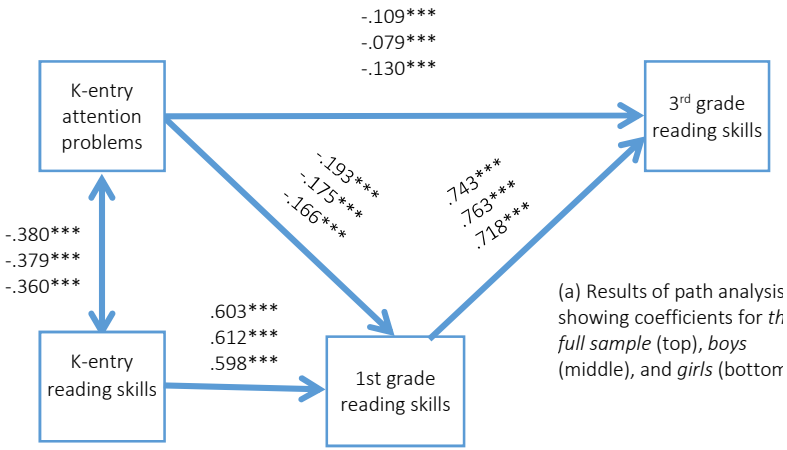
Boys and girls. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model, boys-only model, and girls-only model all exhibited acceptable to good fit. Similarly, the configural invariance ($\chi2(2) = 16.185$, $p<.05$, RMSEA =

.052, 90% CI [.031 – .077], CFI = .998, TLI = .988) and the path invariance model ($\chi 2(7)$ = 37.237, $p<.05$, RMSEA = .041, 90% CI [.028 – .054], CFI = .995, TLI = .993) fit the data well. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models was statistically significant ($\Delta\chi 2 = 21.68$, $\Delta df = 5$, $p<.001$).

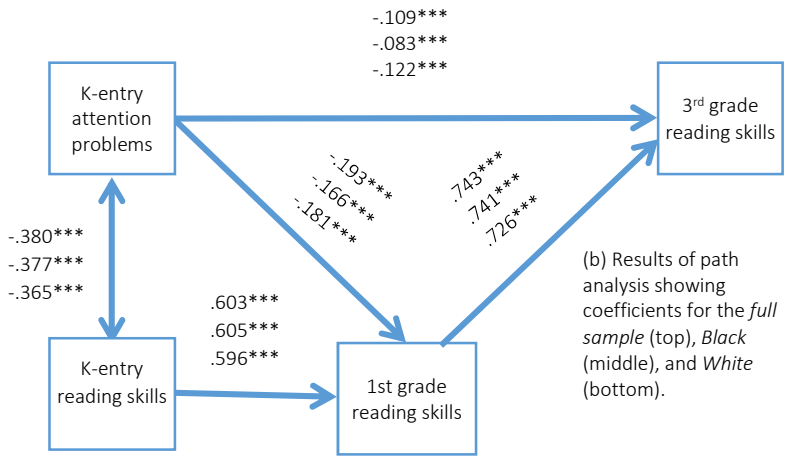
Table 3.3. Model fit indices for invariance tests.

	Model	χ2(df)	RMSEA [90% CI]	CFI	TLI	Δχ2(Δdf)
Testable Models	Model 1	-	.049 [.029, .074]	0.998	0.991	
	Model 2	-	.098 [.077, .122]	0.978	0.89	
Girls and Boys	Boys	5.656	.041 [.014, .077]	0.999	0.993	
	Girls	10.456	.061 [.032, .097]	0.996	0.982	
	Configural	16.185(2)	.052 [.031, .077]	0.998	0.988	
	Path	37.238(7)*	.041 [.028, .054]	0.995	0.993	21.68(5)***
	Scalar	54.423(9)*	.044 [.033, .055]	0.993	0.992	-
Poverty Status	Poor	4.250(1)*	.049 [.009, .110]	0.998	0.991	
	Not poor	4.546(1)*	.047 [.011, .094]	0.998	0.992	
	Configural	8.803(2)*	.048 [.019, .082]	0.998	0.991	
	Path	66.108(7)*	.075 [.059, .092]	0.985	0.979	54.47(5)***
	Scalar	229.382(9)*	.128 [.114, .143]	0.945	0.939	-
Race	Black	9.938(1)*	.043 [.000, .118]	0.999	0.994	
	White	6.013(1)*	.048 [.000, .126]	0.998	0.991	
	Configural	15.609(2)*	.045 [.000, .099]	0.999	0.993	
	Path	26.895(7)*	.025 [.000, .057]	0.998	0.998	10.67(5), *p=.06*
	Scalar	277.098(9)*	.028 [.000, .056]	0.997	0.997	-
Poverty x Gender	Girls	2.293(1), *p*=.130	.043 [.000, .118]	0.999	0.994	
	Boys	2.491(1), *p*=.130	.048 [.000, .126]	0.998	0.991	
	Configural	4.791(2), *p*=.091	.045 [.000, .099]	0.999	0.993	
	Path	9.898(7), *p*=.194	.025 [.000, .057]	0.998	0.998	5.654(5), *p*=.341
	Scalar	13.892(9), *p*=.126	.028 [.000, .056]	0.997	0.997	4.020(2) *p*=.134
Poverty x Race	Black	2.390(1), *p*=.093	.054 [.000, .133]	0.998	0.992	
	White	2.547(1), *p*=.108	.046 [.000, .119]	0.998	0.989	
	Configural	5.396(2), *p*=.067	.050 [.000, .103]	0.998	0.991	
	Path	9.737(7), *p*=.204	.024 [.000, .056]	0.999	0.998	5.160(5), *p*=.398
	Scalar	73.966(9)*	.103 [.082, .125]	0.966	0.962	83.10(2)***
Gender x Race (boy)	Black	8.156(1)*	.070 [.032, .118)	0.999	0.995	
	White	2.854(1), *p*=.09	.034 [.000, .0844]	0.995	0.976	
	Configural	10.908(2)*	.054 [.026, .088]	0.997	0.987	
	Path	31.637(7)*	.048 [.032, .066]	0.993	0.99	21.07(5)***
	Scalar	41.408(9)*	.049 [.034, .064]	0.991	0.99	-
Gender x Race (girl)	Black	1.84(1)*	.028 [.000, .092]	0.999	0.996	
	White	5.564(1)*	.063 [.021, .110]	0.996	0.979	
	Configural	7.243(2)*	.049 [.014, .089]	0.998	0.988	
	Path	11.025(7), *p*=.138	.023 [.000, .047]	0.998	0.997	4.45(5), *p*=.487
	Scalar	26.749(9)*	.054 [.024, .061]	0.992	0.991	17.624(2)***

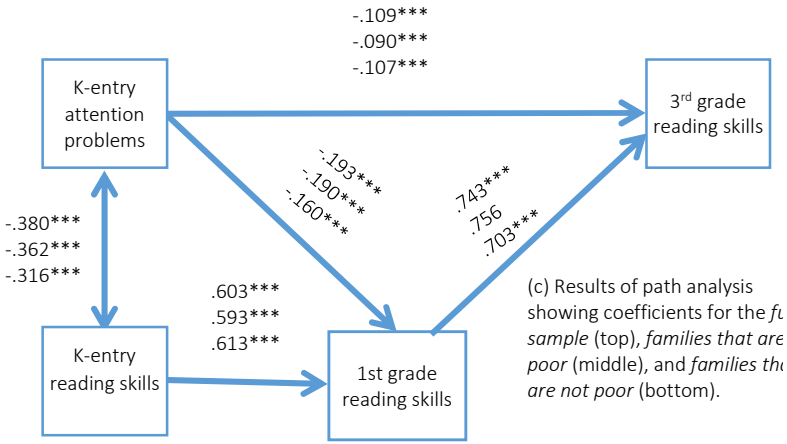
*$p < .05$, **$p < .01$, ***$p < .001$; Δχ2: change in chi-square statistic; Δdf: change in degress of freedom



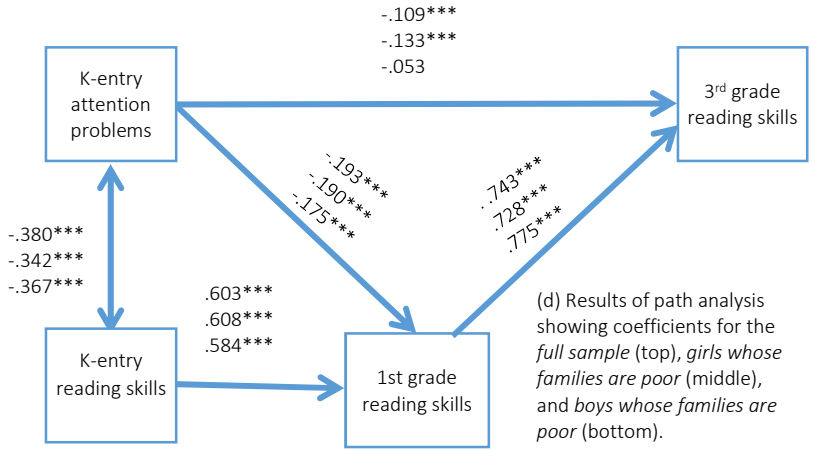
(a) Results of path analysis showing coefficients for *th full sample* (top), *boys* (middle), and *girls* (bottom



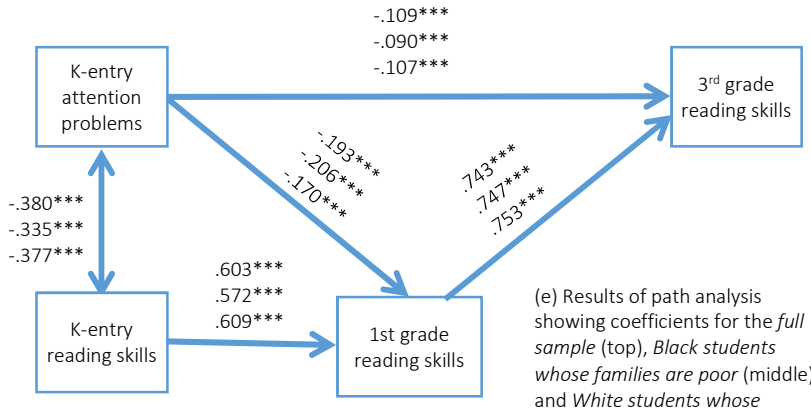
(b) Results of path analysis showing coefficients for the *full sample* (top), *Black* (middle), and *White* (bottom).



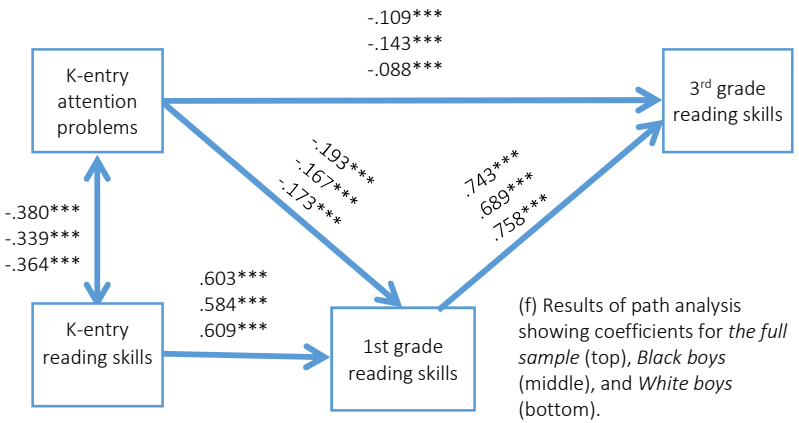
(c) Results of path analysis showing coefficients for the *fu sample* (top), *families that are poor* (middle), and *families tha are not poor* (bottom).



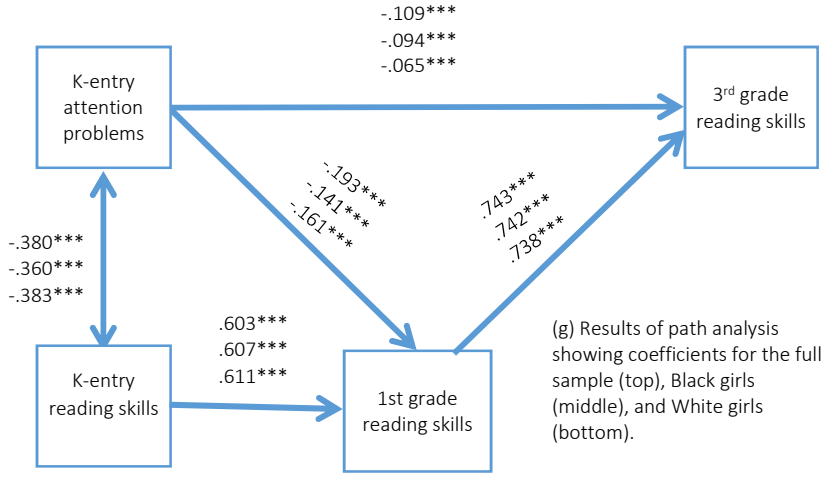
(d) Results of path analysis showing coefficients for the *full sample* (top), *girls whose families are poor* (middle), and *boys whose families are poor* (bottom).



(e) Results of path analysis showing coefficients for the *full sample* (top), *Black students whose families are poor* (middle), and *White students whose families are poor* (bottom).



(f) Results of path analysis showing coefficients for *the full sample* (top), *Black boys* (middle), and *White boys* (bottom).



(g) Results of path analysis showing coefficients for the full sample (top), Black girls (middle), and White girls (bottom).

Figure 3. 2. Results of multi-group invariance tests showing the extent to which the final path model is variant and invariant across the following groups: (a) boys and girls, (b) Black and White students, (c) students who are from poor families and those who are not, (d) poor boys and poor girls, (e) poor Black and poor White students, (f) Black boys and White boys, and (g) Black girls and White girls.

The statistically significant results of the Satorra-Bentler scaled chi-square difference test implies that path coefficients are significantly different for boys and girls. In other words, gender moderates the direct and indirect associations between early attention problems, first-grade reading skills, and third-grade reading skills. The significant standardized coefficient for the path from early attention problems to first-grade reading was higher in the boys-only sample (β = -.175, p < .001) than in the girls-only sample (β = -.166, p < .001). The path from first-grade reading skills to third grade reading skills was also larger for boys than for girls (boys: β = .763, p < .001; girls: β = .718, p < .001). The Sobel test for the indirect effect confirmed that the indirect causal chain from early attention problems to third-grade reading skills was stronger for boys (β = -.134, p<.001) than girls (β = -.119, p< .001). In other words, while a one standard deviation increase in early attention problems is associated with decreases in third-grade reading skills for boys and girls, the same one standard deviation increase in early attention problems produces greater decreases in boys' third-grade reading skills relative to girls.

Black and White students. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model, Black students-only model, and White students-only models all exhibited acceptable to good fit. Similarly, the configural invariance model (χ2(2) = 15.609, p<.05, RMSEA = .051, 90% CI [.029 – .076], CFI = .998, TLI = .988) and the path invariance model (χ2(7) = 26.895, p<.05, RMSEA = .033, 90% CI [.020 – .047], CFI = .997, TLI = .995) fit the data well. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models were statistically significant ($\Delta\chi$2 = 10.57, Δdf = 5, p=.058). The statistically non-significant results of the Satorra-Bentler scaled chi-square difference test implies that path coefficients are not significantly different for Black and

White students, and thus that race moderates the associations between early attention problems, first-grade reading skills, and third-grade reading skills.

Students whose families are poor and those whose families are not poor. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model, students whose families are poor-only model, and students whose families are not poor-only model all exhibited acceptable to good fit. Similarly, the configural invariance ($\chi2(2) = 8.803$, $p<.05$, RMSEA = .048, 90% CI [.019 – .082], CFI = .998, TLI = .991 and the path invariance model ($\chi2(7) = 66.108$, $p<.05$, RMSEA = .075, 90% CI [.059– .092], CFI = .985, TLI = .979) had acceptable fit with the data. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models were not statistically significant ($\Delta\chi2 = 54.47$, $\Delta df = 5$, $p<.001$). This implies that path coefficients are significantly different for students who are poor and students who are not poor, and thus that family poverty status moderates the associations between early attention problems, first-grade reading skills, and third-grade reading skills.

The significant standardized coefficient for the path from early attention problems to first-grade reading was higher in the sample of students who are poor ($\beta = -.190$, $p < .001$) than in the sample of students who are not poor ($\beta = -.160$, $p < .001$). The path from first-grade reading skills to third-grade reading skills was also stronger for students who are poor than for students who are not (students who are poor: $\beta = .756$, $p<.001$; students who are not poor: $\beta = .703$, $p < .001$). The Sobel test for the indirect effect confirmed that the indirect causal chain from early attention problems to third-grade reading skills was stronger for students whose families are poor ($\beta = -.144$, $p<.001$) than students whose families are not poor ($\beta = -.120$, $p< .001$). In other words, while a one standard deviation increase in early attention problems is

associated with decreases in third-grade reading skills for students from families are and are not poor, the same one standard deviation increase in early attention problems produces greater decreases in the third-grade reading skills of students whose families are poor relative to students whose families are not poor.

Among students whose families are poor: Girls and boys. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model of students whose families are poor, girls-only, and boys-only all exhibited acceptable to good fit. Similarly, the configural invariance ($\chi2(2) = 4.791$, p=.091, RMSEA = .045, 90% CI [.000 – .099], CFI = .999, TLI = .9883 and the path invariance model ($\chi2(7) = 9.898$, p=.194, RMSEA = .025, 90% CI [.000 – .057], CFI = .998, TLI = .998) fit the data well. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models were not statistically significant ($\Delta\chi2 = 5.654$, $\Delta df = 5$, p=.341). This implies that path coefficients are not significantly different for girls who are poor and boys who are poor. The scalar invariant model also had a good fit to the data ($\chi2(9) = 13.892$, p=.126, RMSEA = .025, 90% CI [.000 – .056], CFI = .997, TLI = .997). Results of the Satorra-Bentler scaled chi-square difference test that compared the path, and scalar invariance models were not statistically significant ($\Delta\chi2 = 4.02$, $\Delta df = 5$, p=.134), suggesting that among students whose families are poor, gender does not moderate the relation between early attention problems and third-grade reading skills.

Among students whose families are poor: Black and White children. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model of students whose families are poor, Black students, and White students models all exhibited acceptable to good fit. Similarly, the configural invariance model ($\chi2(2) = 5.396$, p=.067, RMSEA = .050, 90% CI [.000 – .103], CFI = .998, TLI = .991 and the path invariance model

($\chi2(7) = 9.737$, p=.204, RMSEA = .024, 90% CI [.000 – .056], CFI = .998, TLI = .998) fit the data well. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models were not statistically significant ($\Delta\chi2 = 5.160$, $\Delta df = 5$, p=.398). This implies that path coefficients are not significantly different for Black students who are poor and White students who are poor. The scalar invariant model did not have a good fit to the data ($\chi2(9) = 73.966$, p<.001, RMSEA = .103, 90% CI [.082 – .125], CFI = .966, TLI = .962). Results of the Satorra-Bentler scaled chi-square difference test that compared the path, and scalar invariance models were statistically significant ($\Delta\chi2 = 83.10$, $\Delta df = 5$, p<.001), suggesting that among students whose families are poor, there are differences in students' early attention and reading skills as a function of race. In other words, there is a difference in the level of skills of Black and White students whose families are poor at school entry, but there is not a difference in the impact of early skills on later skills.

Black girls and White girls. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model, Black girls-only, and White girls-only models all exhibited acceptable to good fit. Similarly, the configural invariance model ($\chi2(2) = 7.234$, p<.05, RMSEA = .049, 90% CI [.014– .089], CFI = .998, TLI = .997 and the path invariance model ($\chi2(7) = 11.025$, p=.138, RMSEA = .023, 90% CI [.000 – .047], CFI = .998, TLI = .997) fit the data well. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models were not statistically significant ($\Delta\chi2 = 4.45$, $\Delta df = 5$, p=.487). This implies that path coefficients are not significantly different for Black girls and White girls. The scalar invariant model had a good fit to the data ($\chi2(9) = 26.749$, p<.05, RMSEA = .054, 90% CI [.082 – .125], CFI = .992, TLI = .991). Results of the Satorra-Bentler scaled chi-square difference test that compared the path, and scalar invariance models were

statistically significant ($\Delta\chi2 = 17.624$, $\Delta df = 2$, $p<.001$), suggesting that among girls, race impacts students' early attention and reading skills at kindergarten entry. In other words, there is a difference in the reading skills among Black and White girls at school entry, but there is not a difference in the impact of early skills on skills in third grade.

Black boys and White boys. As shown in Table 3.3, the results from the first three steps in the invariance test showed the overall model, Black boys, and White boys models all exhibited acceptable to good fit. Similarly, the configural invariance model ($\chi2(2) = 10.908$, $p<.05$, RMSEA = .054, 90% CI [.026 – .088], CFI = .997, TLI = .987 and the path invariance model ($\chi2(7) = 31.637$, $p<.05$, RMSEA = .048, 90% CI [.032 – .066], CFI = .993, TLI = .990) fit the data well. Results of the Satorra-Bentler scaled chi-square difference test that compared the configural and path invariance models were statistically significant ($\Delta\chi2 = 21.07$, $\Delta df = 5$, $p=.398$), which implies that path coefficients are significantly different for Black boys and White boys.

The significant standardized coefficient for the path from early attention problems to first-grade reading scores/skills was stronger for White boys ($\beta = -.173$, $p < .001$) than for Black boys ($\beta = -.167$, $p < .001$). The path from first-grade reading skills to third-grade reading skills was also larger for White boys than for Black boys (White boys: $\beta = .758$, $p<.001$; Black boys: $\beta = .689$, $p < .001$). The Sobel test for the indirect effect confirmed that the indirect causal chain from early attention problems to third-grade reading skills was stronger for White boys ($\beta = -.131$, $p<.001$) than Black boys ($\beta = -.115$, $p< .001$). In other words, while a one standard deviation increase in early attention problems is associated with decreases in third-grade reading skills for students, the same one standard deviation increase in early attention problems produces greater decreases in the third-grade reading skills of White boys relative to Black boys.

Interestingly, however, the statistically significant direct effect of attention problems at kindergarten entry on third-grade reading skills was higher for Black boys β = -.115, p<.001) than for White boys (β = -.088, p< .001).

Discussion

The present study aimed to test two competing mediating models about the relation between attention problems and reading skills, to explore whether the relation between attention and reading is moderated by child race, gender, and poverty status, and combinations of these factors. A multiple-group path analysis design was used to test the direct and indirect relations between attention problems and reading skills among children participating in the ECLS-K:2011. First models that present competing hypotheses about the relation between early attention and reading skills with third-grade attention and reading skills were tested. After identifying the best fitting model, the model was tested for invariance across child race, gender, poverty status, and combinations of these factors.

Related to this study's first aim, it was found that the model reflecting that attention problems at kindergarten entry predicted third-grade reading skills directly and through its impact on early reading skills had a good fit to the data. This finding suggests that teacher ratings of students' attention problems are negatively associated with students' third grade reading scores. As teacher ratings of attention problems increase, children's reading scores decrease. This finding is consistent with prior research on the relationship between attention problems and reading skills, which report that early attention problems have a negative effect on early literacy skills, such as phonological awareness and word decoding (Allen et al., 2018; Plourde et al., 2018; van de Sande, Segers & Verhoeven, 2017). Thus, it appears that the relationship between attention and reading is driven by students' early attention problems. That attention is such a

stable and salient factor associated with student achievement demands that school staff remain vigilant about factors that impede student attention.

Related to this study's second aim, race, gender, and family poverty status were found to moderate the relationship between attention problems and third-grade reading skills. Black students had higher ratings of average attention problems, which is consistent with the results of prior literature comparing ratings of attention between Black and White students (DuPaul et al., 1997; Epstein, March, Conners & Jackson, 1998; Rabiner et al., 2003). The results of this study also indicated that Black students had lower levels of reading skills in kindergarten, first grade, and third grade relative to White students. Racial performance gaps have been observed since performance data have been collected. Evidence from NAEP indicates that by fourth grade, Black students' reading ability is nearly one full grade level lower than that of White students (NCES, 2018). That persistent performance gaps have remained stable should be a concern for education stakeholders and must be remedied.

The results also revealed that boys have higher levels of attention problems and lower levels of third-grade reading skills relative to do girls. These findings are consistent with published research indicating that boys are overrepresented for identified attention problems (Ramtekkar, Reiersen, Todorov & Todd, 2010) and reading difficulties (Mano, Mano et al., 2017) relative to girls. Students whose families are poor have higher levels of attention problems and lower levels of reading skills when compared to students whose families are not poor. These patterns, too, have been reported previously (NCES, 2018).

The negative direct and indirect effects of early attention problems on third-grade reading was stronger for girls and students whose families are poor than for boys and students whose families are not poor. Among students whose families are poor, the negative direct and indirect

effect of early attention problems on third-grade reading remains strong for girls. The finding that attention problems have a greater impact on reading scores for girls is consistent with existing literature indicating that when compared with boys with attention problems, girls display greater intellectual impairment (Gaub & Carlson, 1997; Gershon, 2002). In gender-specific samples, the effect of early attention problems on third-grade reading was stronger for Black students than for White students.

The results of this study should be considered in light of several limitations. Reading skills were assessed through performance tests administered by ECLS: K-2011 staff, and no other measure of reading performance was available. In addition, teacher ratings of student attention were the sole measure of attention. The inclusion of ratings from parents and ECLS: K-2011 staff observers would perhaps improve our confidence that students' attentional capacity was adequately captured. Finally, results are limited to data from kindergarten, first, and third grades. Expanding analyses to include other grades would allow for exploration of whether there are differences in teacher ratings of attention problems into later school years, and if so, whether such differences are associated with differences in student performance. Future studies that allow for the inclusion of greater racial and ethnic diversity would better reflect the true population.

Despite these limitations, this research contributes to the broader understanding of the relationship between attention problems and student reading skills, and implications for practice can be derived from this work. The results of this study suggest a pressing need for better systems of identifying girls with attention problems and subsequently engaging them in intervention to mitigate the impact of attention problems on their reading skills. Findings from this study also indicate that there is an interactive relationship between race and family poverty status in the relation between attention problems and reading skills, which suggests a need for a

nuanced approach for identification and intervention for students of diverse backgrounds. Finally, results from this study provide further evidence that racial and economic performance gaps in reading skills grow from kindergarten through third grade. At kindergarten entry, Black students score 3.5 points behind their White peers in terms of reading skills. By third grade, this gap widens to 10 points. In addition, there is no observed gap between students whose families are poor and those whose families are not poor at kindergarten entry. However, by third grade, students from families who are poor score 5 points behind their more affluent peers. We have yet to create and sustain school environments that promote equitable opportunities for an increasingly racially diverse student population to learn and develop.

Public education is at a crossroads. The majority of students enrolled in public schools are poor (Suitts, 2015). The U.S. population is shifting such that the majority of students attending public school are those that our schools struggle to serve: by 2050, more than half of the U.S. population will be non-White (U.S. Census Bureau, 2006). If we continue to ignore the reality that current methods are failing to teach non-White and poor students to read proficiently, we risk compromising the knowledge, advancement, and future of the majority of public school students.

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PAPER 3

EXAMINING DEVELOPMENTAL RELATIONS BETWEEN ATTENTION PROBLEMS AND READING SKILLS IN ELEMENTARY SCHOOL

Reading skills are the cornerstone of obtaining content knowledge in and out of school (Lonigan, 2006). Cumulative, historical trajectories of inequality are reflected in reading performance gaps that have persisted since the 1960s when data about racial and economic performance gaps were first collected (Downey & Condron, 2016). Imagine the long-term implications of a 24-26-point gap in reading proficiency, reflecting a difference of more than one year of expected growth, favoring White fourth grade students compared to Black and Hispanic students (National Center for Education Statistics, NCES, 2018).

Improving students' reading skills with the goal of providing all students with access to educational opportunities is a pressing need among educators, researchers, and policymakers. Research suggests that improving students' attention skills is one avenue to pursue to promote stronger academic achievement. Students' attentional skills are one of the most stable child-level predictors of academic performance, with lower levels of attention associated with poorer grades (Duncan et al., 2007; Frazier et al., 2007; Gray, Dueck & Tannock, 2017). In preschool and early school grades, attentional capacity is malleable and responds to environmental intervention (Jones, Aber & Brown 2011; van Lier, Muthen, van der Sar & Crijnen, 2004). Efforts to foster attention through interventions aimed at classrooms and students can serve to reduce

performance gaps. Thus, enhancing students' attention can be critical to combat the risk of poor educational outcomes.

Attention problems have implications for reading achievement, in particular (Frick et al., 1991; Hinshaw, 1992; Rabiner & Coie, 2000). In fact, of children who meet criteria for Attention Deficit Hyperactivity Disorder (ADHD), 25-40% also meet criteria for reading disorders, and of students who meet criteria for reading disorders, 15-40% also meet criteria for ADHD (Epstein, Shaywitz, Shaywitz, & Woolston, 1991). Evidence of a link between attentiveness and reading development is well established in the literature (Duncan et al., 2007; Frazier et al., 2007; Gray, Dueck & Tannock, 2017). In addition, many attention-supporting interventions aim to improve students' academic performance (Allan et al., 2016; LRRC, Jiang & Farquharson, 2018 Pham, 2016)

Because attention skills are critical to academic achievement, accurate measures of attention are necessary for identifying students who may need early intervention. Comprehensive diagnostic assessment of attention problems is time and resource-intensive and requires data sourced from multiple respondents across multiple methods (DuPaul, Reid, Anastopoulos & Power, 2014). Schools may be left to choose from among brief teacher-reported ratings of attention, especially for students whose attention problems do not reach clinical significance but may benefit from intervention. Unfortunately, there is low cross-grade stability of teacher ratings of students' inattentive symptoms (Rabiner et al., 2010). There are numerous reasons that this might be possible, such as student maturation, student-teacher racial match (Alexander, Entwistle & Thompson, 1987), or teacher experience (DuPaul, Reid, Anastopoulos & Power, 2014). Measurement issues around attention are further complicated by the potential for biases related to student race, ethnicity, and gender. Chang and Sue (2003) define this bias as the variation in

teacher ratings of behavior—including inattention—based on student characteristics, such that views of *typical* versus *atypical* behavior vary across race, poverty status, and gender, and lead to different perceptions of similar actions or behaviors. In other words, perceptions about students' attention behaviors might systematically vary by child characteristics and, in turn, these perceptions may have implications for student performance. It is thus possible that differences in attention problems may explain, at least in part, some of the observed performance gaps between White and Black students. The extent of this possibility is understudied in the literature.

The current study builds off of prior work to further explore the links between inattention and reading proficiency, in particular, the study examines whether these relations vary by child race, gender, and economic status—issues that have been understudied to date. In the following sections, a review of the literature on reading development, attention problems, and the relationship between attention problems and reading development is presented. The review of the literature is followed by a description of the analytic methods and a presentation of the analytic model. Key results are then highlighted, and a discussion of major findings and their implications are presented.

Reading Development

Children's ability to read develops over time, begins early in a child's life, and depends on the incremental acquisition of a range of language skills (Lervag, Braten & Hulme, 2009). Reading involves both *inside out skills,* such as the ability to translate written text into meaningful sounds, and *outside in skills,* or the conceptual knowledge of language, narrative, and print conventions (Whitehurst & Lonigan, 1998). The classical work by Marsh, Friedman, Welch, and Desberg (1981) describe a process by which children begin to read through linguistic guessing and may recognize words via simple rote association and guess at words in a story

based on what makes sense in context. Children then progress to the *discrimination net guessing phase*, where they begin to use cues such as word length, word shape, and letter identity to make sophisticated guesses about new words. Next is the *sequential decoding phase*, during which children learn that print encodes speech. They may also recognize letter-sound correspondences and may try to sound out new words. Finally, when children reach the *hierarchical decoding* stage, their letter-sound correspondences are context-sensitive, and children begin to use analogy as a strategy for decoding new words (i.e., if recognizing 'hand,' the child may recognize the 'and' sequence in 'band').

Children who lag in their development of early reading skills are likely to fall behind their peers and have difficulty across academic subjects and over time (Alexander & Entwisle, 1996; Ehm et al., 2016; Lonigan, 2006). The consequences associated with slower development of early reading skills are not evenly distributed across all students. Data from national studies indicate that students of different backgrounds do not have equal opportunities for success in reading. By fourth grade, Black students' reading ability is one grade level lower than that of White Students (NCES, 2015). In addition, children living in poverty enter school with less well-developed skills, and make fewer gains during elementary school (Campbell et al., 2000; Duncan et al., 2007; Kianz, 2019; Magnuson & Votruba-Drzal, 2009). Existing data and literature on reading performance among students from different racial and economic backgrounds provide important descriptive information about reading skills in elementary school at moments in time. However, there has been less study about how the developmental trajectory of reading skills may vary among children with different identities and how this may be linked to demographic differences in children's attention skills. Addressing this gap will allow for enhanced theories on

reading development and will generate knowledge essential to the creation of intervention components to help children learn.

Attention and Attention Problems

Attention is 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) alerts and prepares the student to anticipate incoming stimuli (Posner & Peterson, 1990, 2012); and (3) supervises and enables planning, problem-solving, conflict resolution and decision making (Posner & Rothbert, 1998; Shallice & Burgess, 1996; Wang, Liu & Fan, 2012). Either "top-down" or "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. Bottom-up processes, on the other hand, are driven by external stimuli, such as a flash of light or unexpected noise, and are relatively reflexive and automatic (Klein & Lawrence, 2012).

The implementation of lab tests and tasks, brain imaging, and genetic testing have illuminated how brain structures that are linked to attention develop from birth through adulthood (Posner & Peterson, 2012). Orienting attention is measurable in *utero* (Kisilvesky et al., 2009), and some aspects of selective attention are in place during infancy (Garon et al., 2008). In the first year of life, fundamental changes in alerting, orienting, and executive attention systems are evident (Bell, Calkins & Posner, 2012; Deater-Deckard & Wang, 2012). Effortful control focused attention, and selective attention are observable by age three (Dunham, 1990), with improvements in these areas continuing through middle childhood and into adulthood (Deater-Deckard & Wang, 2012; Kaye & Ruskin, 1990). Atypical development of these attention systems has been linked to psychopathology, including ADHD (Castellanos et al.,

2002), Tourette syndrome (Leckman et al., 2010), Obsessive-Compulsive Disorder (Fitzgerald et al., 2005), and depression and anxiety (Rothbart, Posner & Boylan, 1990).

Children with attention problems may experience loss of focus, lack of attention to detail, failure to listen when spoken to, even in the absence of obvious distraction, lack of follow-through on instructions, disorganization with tasks and activities, disengagement with tasks requiring mental effort; they may also frequently lose items necessary for tasks and activities, be easily distractible and forgetful in daily activities (American Psychiatric Association, 2013). Many students experience attention problems; in fact, ADHD is the most commonly diagnosed mental health disorder among children in the United States (Froelich et al., 2007; Pastor & Reuben, 2005; Sciutto & Eisenberg, 2007).

Numerous studies have shown that students of color and boys tend to have higher ratings for problematic behavior relative to White children and girls (e.g., Peters et al., 2014; Rabiner et al., 2003). DuPaul and colleagues (2014) found that both the severity of attention symptoms and the level of symptom-related impairment is associated with student age, gender, race, and ethnicity, with Black and male students being rated higher in symptom and impairments. Another study that explicitly explored variation in reported measures of children's behavior as a function of informant and child race/ethnicity found that teachers report higher levels of attentional problems for Black versus White students relative to observer and parent reports of the same students (Lawson et al., 2017).

Attention and Reading Performance

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 (Allan et al., 2018; Eisensmith & Kainz, 2019; Isbell, Calkins, Swingler & Leerkes, 2018;

Rabiner & Coie, 2000). Successful reading requires a complex set of simultaneous processes, including the ability to understand cause and effect, compare and contrast, to identify sequences of events, to note details, to make inferences and generalizations, all of which are difficult for children with attention problems (Beike, 2009).

Although attention problems and reading difficulties have long been linked, the process by which attention problems related to reading development remains somewhat elusive (O'Neill et al., 2016). It has been suggested that the association between children's reading ability and attention can be explained by a reciprocal, transactional relationship between early attention and reading problems (Hinshaw, 1992; McGee, Prior, Williams, Smart & Sanson, 2002; Spira & Fischel, 2005). This theory of causality overlaps with the Transactional Model of Development, which stresses the dynamic nature of child development (Sameroff, 1975, 2009). The Transactional Model of Development holds that growth in any given year of schooling may depend on the child's experiences in previous years, as these experiences affected the reading skills that children bring to their new classroom (Sameroff, 1975, 2009). As this relates to attention, it has been suggested that students who enter kindergarten with poor attention skills do not fully develop important reading skills during kindergarten, and are thus more likely to be disadvantaged in subsequent grades in terms of their reading and attention skills. Among preschool student samples, higher levels of inattention were directly and significantly related to lower 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) and school grades (Rabiner, Goodwin & Dodge, 2016). In addition, among

children followed from preschool through elementary school, inattention has been found to have 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). Furthermore, 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).

There is empirical support for bi-directional influences between reading and attention problems. Rowe and Rowe (1999) found that inattentiveness is strongly and negatively related to reading achievement, while poor reading achievement leads to increased inattentiveness in class. McGee, Prior, Williams, Smart, and Sanson (2002) similarly reported that attention problems and reading ability are best modeled via dual-developmental paths. Similarly, Dally (2006) found partial evidence of a reciprocal relationship between inattention and early word reading skills. Further, there is emerging evidence of genetic factors that have multiple effects on attention and reading, as well as shared neuroanatomical features among people with reading and attention difficulties (Beike & Zentall, 2012; Willcutt et al., 2001).

Although these prior studies suggest that attention and reading skills are concurrently, longitudinally, and inter-related, they do not explore whether these relationships vary by child gender, race, or economic status. Because racial, socioeconomic, and gender-based gaps are observed both in reading performance and in ratings of attention problems, it follows that the study of the relationship between these constructs is warranted and emergent. For instance, higher levels of internalizing and externalizing behaviors—two correlates of attention problems—have a greater impact on reading scores for Black students relative to White students (Kremer et al., 2016). Eisensmith and Kainz (2019) similarly reported that the relation between

teacher ratings of students' attention and children's reading scores significantly differed across racial groups such that higher ratings of attention problems had a more robust impact on reading scores for Black and Latinx students relative to White students. Finally, results from my dissertation paper titled "Path to Proficiency" suggested that race, gender, and family poverty status moderate the relationship between attention problems and third-grade reading proficiency. The current study builds upon prior research and my previous work in this area by exploring the concurrent, longitudinal, and reciprocal relations between children's attention and reading skills from kindergarten through third grade, and whether these relations differ across children by socioeconomic status, race, and gender. More specifically, this study aims to extend the existing research base by modeling the growth of attention problems and reading proficiency simultaneous using a latent variable approach to address the following broad research questions:

1. Among elementary school students participating in the ECLS-K:2011, is growth in attention problems from kindergarten through third grade associated with growth in reading skills over the same period?
2. Among elementary school students participating in the ECLS-K:2011, do attention skills and reading skills at school entry vary by child race and gender?
3. Among elementary school students participating in the ECLS-K:2011, does the rate of growth of attention skills and reading skills from school entry through third grade vary by child race and gender?

Answering these questions will address an important gap in the literature related to mechanisms that contribute to observed performance gaps, and will inform ongoing intervention development for children with attention problems.

Methods

Sample

Analyses presented in this paper use data from the Early Childhood Longitudinal Study – Kindergarten Cohort of 2011 public access data file (ECLS-K: 2011). The ECLS-K: 2011 is a nationally representative sample of approximately 20,000 children enrolled in 1,319 schools beginning the 2010-11 school year and following through elementary school (Tourangeau et al., 2017). The ECLS-K: 2011 sampling procedure progressed in three stages. First, counties or groups of contiguous counties were selected as primary sampling units. Next, public and private schools within sampled counties were selected. Finally, students within sampled schools were selected. There were 4,144 students in the final sample.

Variables

Analyses use data from direct child assessments and parent, teacher, and administrative assessments from Fall 2010 through spring 2013. Published reports and the ECLS-K: 2011 user's guide were used to select and describe study variables (Mulligan, Hastedt, & McCarroll, 2012; Tourangeau, Nord, Lê, Sorongon, Hagedorn, Daly, & Najarian, 2017).

Child outcomes. Trained assessors administered child reading performance tests in the Fall and Spring of each school year using computer-assisted administration and test easels. The reading assessment included questions measuring basic skills (e.g., word recognition), vocabulary knowledge, and reading comprehension. All students participated in a language screener before completing the assessments and completed a common set of initial reading items in English. ECLS-K staff converted students' raw scores to scale scores appropriate for cross-sectional and longitudinal performance. Kindergarten, second and third-grade reading scale scores ranged from 0 to 120 and represented children's overall reading knowledge (e.g., basic skills, vocabulary, and comprehension), with higher scores indicating greater reading knowledge.

The average readings score at school entry was 52.41 (SD=10.89). At the end of kindergarten, second grade, and third grade, the average reading scores were 66.40 (SD=13.45), 105.55 (SD=15.73), and 114.76 (SD=15.20), respectively.

Teacher ratings of *children's attention* were measured in Fall and Spring kindergarten, Spring second grade, and Spring third grade. Six items from the Children's Behavior Questionnaire (Putnam & Rothbart, 2006, subscale α=.87) and Temperament in Middle Childhood Questionnaire (TMCQ, Simonds & Rothbart, 2004, subscale α=.95) prompted teachers to report on students' attentional focus. Using a seven-option response scale, teachers indicated how "true" or "untrue" statements were about students' reactions to situations in the past six months. Higher scores indicate that the child exhibited more behaviors that demonstrate the ability to focus attention on cues in the environment. Teacher ratings were reverse coded so that higher scores indicate that the child exhibited greater levels of attention problems. The average teacher rating of student attention problems at school entry was 3.39 (*SD*=1.37). At the end of kindergarten, second grade, and third grade, the average teacher rating of attention problems was 3.21 (*SD*=1.38), 4.63 (*SD*=1.13), and 4.65 (*SD*=1.39), respectively.

Poverty status. The ECLS-K: 2011 defined poverty level using the U.S. census definition of a poverty threshold based on parents' reports of multiple income sources adjusted for household size. Households with an exact income below the appropriate threshold were classified as "below the poverty threshold." Households with an exact income at or above the poverty threshold but below 200% of the poverty threshold were classified as "at or above the poverty threshold, but below 200% of the poverty threshold." Households with a total income that was at or above 200% of the poverty threshold were classified as "at or above 200% of the poverty threshold." Categories were collapsed such that a score of 1 reflected students from

households below 200% of the poverty threshold, and a score of 0 reflects that students are from households that are at or above 200% of the poverty threshold.

Child gender. The ECLS-K:2011 dataset identifies whether children are boys or girls. Child gender was determined by researchers at the school-based assessment and confirmed via the initial parent interview. A score of 1 reflects that students are boys, and a score of 2 reflects that students are girls.

Child race. Child race is provided in the ECLS-K:2011 dataset. Parents provided information on child race in the parent interview. The ECLS-K:2011 accounts for six categories of race (i.e., Black, White, Hispanic, Asian, Native Hawaiian/Pacific Islander, American Indian/Native Alaskan, and Two or more races). The present study limited the sample to Black and White students, as the specific gap in performance between White and Black students is recognized as one of the most significant challenges facing public schools (Rothstein, 2004). A score of 0 reflects that students were identified as White, and a score of 1 reflects that students were identified as Black.

Additional child-level characteristics. Teacher ratings externalizing problem behaviors, and internalizing problem behaviors were included in analyses as known covariates of reading performance (Duncan et al., 2007; Kremer, Flower, Huang & Vaughn, 2016; Lawson, Nissley-Tsiopinis, Nahmias, McConaughy & Eiraldi, 2017; Peters, Kranzler, Algina, Smith & Daunic, 2014; Rabiner, Godwin & Dodge, 2016). A composite score for internalizing (response range 1-4, α=.79) and externalizing (response range 1-4, α=.88) behavior problems was computed when teachers provided a rating on at least a minimum number of the items that composed the scale (i.e., four of six externalizing problem behaviors items and three of four internalizing problem behaviors items). Teachers were asked to indicate how often each child engages in behavior

using a three-point response scale where 0= never, 1=sometimes, and 3=very often. Sample items for externalizing problem behaviors include: “fights with others,” and “threatens or bullies others.” Sample items for internalizing problem behaviors include: “acts sad or depressed” and “shows anxiety about being with a group of children” (Gresham & Elliot, 1990). Higher scores on both scales indicate that the child exhibited the behavior represented by the scale more often. The ECLS-K: 2011 also collected child age at assessment in months.

Analytic Strategy

All analyses were conducted in Stata version 16 (StataCorp, 2019) and Mplus version 8.1 (Muthen & Muthen, 2018). Before fitting a parallel growth model for the concurrent development of reading skills and attention problems, growth in each outcome was modeled separately to identify the best functional form for each trajectory. Latent growth trajectories for sample members were estimated using two latent growth parameters—an intercept and a slope—to account for observed reading assessment performance and attention problems in the Fall (time 1) and Spring (time 2) of kindergarten, the end of second grade (time 3) and the end of third grade (time 4) when controlling for child gender, age, race, and socioemotional problems. For both latent growth models, time was coded so that the intercept reflected average sample performance at kindergarten entry, and the slope reflected the average change in reading performance across time points (Curran, Obeidat, Losardo, 2010). The loadings between intercept and observed assessments were fixed at 1, and slope loadings for reading proficiency were coded as 0 for time one, freely estimated for time two, coded as 3 for time three, and coded as 3.5 for time four. The slope loadings for attention problems were coded as 0 for time one, freely estimated for time two, and were coded as 1 for time three and time four.

To address the second and third research questions, a parallel latent growth model was used to simultaneously depict students' growth trajectories in reading skills and attention problems from kindergarten entry through the end of third grade. Figure 3.3 represents a path model showing the hypothesized relations between growth trajectories in attention problems and reading proficiency between kindergarten and third grade for students in the sample. The top portion of the figure represents a student's reading development between kindergarten and third grade as a function of time. The four indicators that constitute the two-factor measurement model represents the four testing periods (Fall and Spring kindergarten, Spring second grade, Spring third grade). Similarly, the bottom portion of the figure represents the development of attention problems between kindergarten and third grade as a function of time, with four indicators that constitute the two-factor measurement model representing the four testing occasions.

Single-headed and double-headed arrows in the center of the model depict the residual covariances of the reciprocal relations hypothesized to exist among the individual growth parameters describing the change in attention problems and reading proficiency between Fall kindergarten and Spring third grade. Path A tests whether initial levels of attention problems at the start of kindergarten predict students' rate of change in reading proficiency over the four years that students are followed. Path B tests whether initial levels of reading proficiency at the start of kindergarten predicts students' rate of change in attention problems over the study period. Path C tests the covariance between the two slopes or rates of change in reading proficiency and attention problems. Path D indicates the covariance between initial levels of both skills, reflecting whether higher initial values of attention problems are associated with higher initial reading proficiency values on average in the sample. The sample average intercepts and slopes

were allowed to vary as a function of child, family, and school characteristics at kindergarten entry—child race, gender, emotion regulation, and family SES.

The MLR estimator and "TYPE=COMPLEX" feature were used to account for non-normality and non-independence of observations (Cheong, MacKinnon & Khoo, 2003; Savalei, 2014; Yuan & Bentler, 2000; Schreiber, 2007). Finally, because the sample was drawn from different schools, the cluster option in Mplus was used to correct for potential clustering in the standard errors and chi-square estimation. Rates of missing data for study variables ranged from 1%-23%, which is common in educational studies (Enders, 2003). Best practices for multiple imputation to address missing data and attrition with repeated measures of outcomes were followed (Biering, Hjollund, & Frydenberg, 2015).

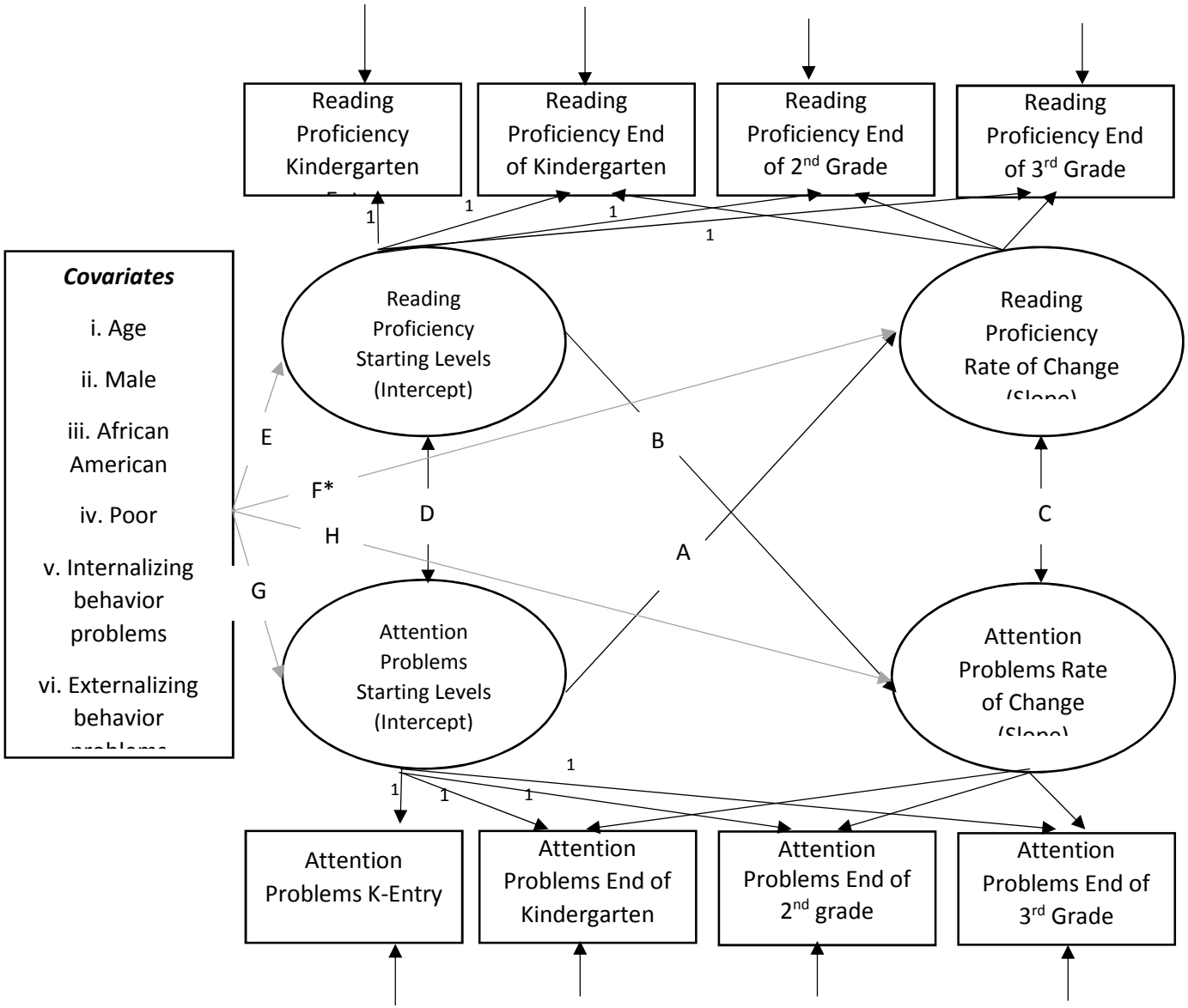

Figure 4. 1. Path model showing the hypothesized relations between initial levels and growth trajectories in attention problems and reading proficiency. Values for each latent construct, covariate, and path are listed in Table 4.3. (Note: * indicates that paths E,F,G,H reflect Ei-Evi, Fi-Fvi, Gi-Gvi, and Hi-Hvi).

Model Fit Assessment of Path Models and Selection of Final Model

The fit of all models to the observed data was assessed using four recommended fit criteria: $\chi 2$/df ratio (good if > 1, lower values indicate better fit [Eveland, Hayes, Shah & Kwak, 2005]); root mean square error of approximation (RMSEA; mediocre fit if between .08 and .10, good if ≤.05); comparative fit index (CFI; acceptable if > .90, good if > .95); and the Tucker-Lewis index (TLI; acceptable if > .90, good if > .95) (Hu & Bentler, 1999; Kline, 2005).

Results

Sample Descriptive Statistics

There were 4,144 students in the analytical sample. Table 4.1 displays the correlations among all stable predictor variables, reading proficiency, and attention problems. Student attention problems and reading are negatively and significantly correlated across all time points.

Table 4. 1. Correlations among study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. K-entry reading	1												
2. K Spring reading	.80	1											
3. 2nd grade reading	.60	.71	1										
4. 3rd grade reading	.56	.66	.86	1									
5. K-entry attention problems	-.37	-.38	-.42	-.40	1								
6. K Spring attention problems	-.34	-.41	-.44	-.43	.70	1							
7. 2nd grade attention problems	-.28	-.36	-.43	-.44	.50	.53	1						
8. 3rd grade attention problems	-.28	-.34	-.43	-.44	.45	.49	.61	1					
9. Age	.15	.13	.04	.03	-.08	-.07	-.04	-.04	1				
10. Girl	.08	.10	.14	.13	-.20	-.21	-.25	-.25	-.05	1			
11. Black	-.18	-.21	-.26	-.32	.13	.14	.13	.15	-.06	.00	1		
12.Poor	-.27	-.26	-.31	-.34	.19	.18	.18	.22	.02	-.02	.39	1	
13.Internalizing problems	-.12	-.14	-.14	-.15	.25	.19	.15	.12	.02	-.07	-01	.07	1
14. Externalizing problems	-.16	-.21	-.24	-.25	.57	.48	.43	.40	.02	-.21	.10	.13	.30

Table 4.2 displays the means, standard deviations, minimum and maximum values, and skewness of the variables used in our linear growth model for the total sample and by student race and gender.

Table 4. 2. Means and standard deviations for study variables in the overall sample and by subgroup

	Overall n=4,144	Boys n=2,149	Girls n=1,988	Black n=1,672	White n=2,472	Poor n=1,523	Not poor n=1,666
3rd grade reading	114.76(15.20)	112.91(15.96)	116.82(14.01)	108.49(14.19)	118.56(14.52)	110.28(14.25)	120.62(13.23)
2nd grade reading	105.55(15.73)	103.55(16.38)	107.72(14.68)	100.36(15.29)	108.83(15.12)	101.34(15.96)	111.20(14.0)
K Spring Reading	66.41(13.45)	65.14(13.46)	67.77(13.29)	63.33(12.78)	68.63(13.48)	64.66(12.53)	70.72(13.87)
K-entry reading	52.41(10.89)	51.54(10.91)	53.33(10.91)	50.37(9.70)	53.90(11.45)	50.24(9.24)	56.19(12.07)
3rd grade att. prob.	4.66(1.14)	4.93(1.13)	4.36(1.07)	4.87(1.11)	4.54(1.13)	4.88(1.14)	4.38(1.09)
2nd grade att. prob.	4.63(1.13)	4.91(1.12)	4.34(1.06)	4.81(1.11)	4.52(1.13)	4.81(1.11)	4.40(1.11)
K Spring att. prob.	3.21(1.38)	3.50(1.41)	2.90(1.27)	3.41(1.38)	3.07(1.35)	3.41(1.40)	2.91(1.29)
K-entry att. prob.	3.39(1.34)	3.67(1.38P	3.08(1.28)	3.58(1.39)	3.25(1.33)	3.59(1.27)	3.07(1.28)
K-entry int. prob.	1.46(.49)	1.49(.49)	1.42(.48)	1.45(.51)	1.46(.51)	1.49(.49)	1.42(.47)
K-entry ext. prob.	1.64(.66)	1.78(.71)	1.50(.57)	1.73(.70)	1.59(.63)	1.72(.71)	1.54(.59)
K-entry age (mo.)	67.82(4.42)	68.05(4.52)	67.57(4.30)	67.50(4.52)	68.04(4.35)	67.93(4.64)	67.71(4.20)

Results of Growth Modeling

According to the pre-specified criteria, the latent growth models for each outcome had an adequate fit to the data: *Reading Performance*: $\chi 2/df = 43$, RMSEA=.090 (90% confidence interval [.08, .10]), CFI=.980, TLI=.971; *Attention Problems*: $\chi 2/df = 28.22$, RMSEA=.072 (90% confidence interval [.062, .083]), CFI=.971, TLI=.965. Next, I fit the parallel process model to the data. The model demonstrated acceptable model fit $\chi 2/df = 16$, RMSE=.071 (90% confidence interval [.07, .08]), CFI=.944, TLI=.91. Corroborating findings from the univariate models, the positive significant slope values for reading performance and attention problems indicated that on average, both attention problems and reading performance independently experienced growth from kindergarten through third grade and that higher starting levels of both attention problems and reading performance were related to a slower rate of positive change over time (see Table 4.3).

Attention problems and reading problems grow independently over time, and growth in each is associated with growth in the other. On average, kindergarten students scored 53.31 points on the reading assessment at kindergarten entry (*SE*=.20, $p<.001$), and their scores increased by 17.70 points (*SE*=.07, $p<.001$) between each time point. Average scores for attention problems among kindergarteners was 3.29 (*SE*=.02, $p<.001$), and ratings of attention

problems increased by 1.33 (*SE*=.02, *p*<.001) between each time point. Path A linking initial levels of attention problems to rates of reading change from the beginning of kindergarten through the end of third grade was negative and significant (ß=-.20, *SE*=.04, *p*<.001), suggesting that on average, higher levels of attention problems had a negative impact the growth in students' reading skills over time. Surprisingly, and as discussed in the next section, Path B linking initial reading skills to rates of change in attention problems was positive and significant (ß=.20, *SE*=.04, *p*<.001), suggesting that on average, higher levels of reading skills at kindergarten entry was associated with an increase in the rate of change in attention problems. Finally, I found a strong, negative relation between initial levels of reading performance and attention problems (Path D, ß=-.50, *SE*=.02, *p*<.001) and rates of growth in attention problems and reading skills (Path C, ß=-.40, *SE*=.04, *p*<.001), controlling for the impact of sociodemographic factors and the initial levels of attention problems and reading proficiency. Thus, on average, students with more rapid rates of growth in attention problems experience slower growth in their reading skills from kindergarten through third grade.

Table 4.3. Unstandardized and standardized parameter estimates from the analytical model in raw and imputed data

	Raw Data		**Imputed Data**	
	Unstandardized coefficient(SE)	Standardized Coefficient(SE)	Unstandardized coefficient(SE)	Standardized Coefficient(SE)
Growth factors				
Reading intercept	53.67(.22)***	53.31(.20)***	52.71	48.90
Reading slope	17.73(.07)***	17.70(.07)***	17.61	15.95
Att. probs. intercept	3.26(.03)***	3.29(.02)***	3.34	3.86
Att. probs. slope	1.34(.02)***	1.33(.02)***	1.32	.98
Associations between Growth Factors				
Att. prob intercept →reading slope (Path A)	-.625(.130)***	-.23(.02)***	-.64(.12)***	-.21(.04)***
Reaing intercept →att. probs slope (Path B)	.010(.00)***	.20(.04)***	.01(.00)***	.23(.04)***
Reading intercept correlated with att. prob intercept (Path C)	-.499(.06)***	-.39(.04)***	.52(.05)***	-.42(.04)***
Reading slope correlated with att. prob. slope (Path D)	-3.29(.20)***	-.49(.02)***	-3.39(.17)***	-.54(.02)***
Covariates predicting reading intercept (Paths Ei-Evi)				
Age	.51(.05)***	.21(.02)***	.48(.46)***	.21(.02)***
Male	1.14(42)**	.06(.02)**	1.41(.34)***	.07(.02)***
African American	-1.36(.46)**	-.05(.02)**	-1.50(.38)***	-.07(.02)***
Poor	-5.08(.44)***	-.24(.02)***	-5.00(.38)***	-.25(.02)
Internalizing probs.	-1.71(.44)***	-.09(.02)***	-1.90(.37)***	-.09(.2)***
Externalizing probs.	-1.89(.34)***	-.12(.02)***	-1.64(.28)***	-.11(.02)***
Covariates predicting att. probs. intercept (Paths Fi-Fvi)				
Age	-.03(.00)***	-.13(.02)***	-.03(.00)***	-.12(.02)***
Male	-.26(.04)***	-.13(.02)***	-.30(.03)***	-.12(.02)***
African American	-1.29(.16)**	.06(.02)**	.09(.03)**	-.04(.02)**
Poor	.264(.04)***	.133(.02)***	.28(.03)***	-.14(.02)***
Internalizing probs.	.16(.04)***	.08(.02)***	.20(.03)***	-.10(.02)***
Externalizing probs.	.96(.03)***	.62(.02)***	.93(.02)***	-.61(.01)****
Covariates predicting reading slope (Paths Gi-Gvi)				
Age	-.14(.02)***	-.21(.02)***	-.14(.01)***	-.20(.02)***
Male	.28(.14)*	.04(.03)*	.30(.13)*	.05(.02)*
African American	-1.28(.16)***	-.20(.03)***	-1.26(.16)***	-.21(.03)***
Poor	-.37(.15)*	-.06(.03)*	-.37(.14)*	-.06(02)*
Internalizing probs.	-.17(.15)	-.02(.03)	-.05(.13)	-.01(.02)
Externalizing probs.	.00(.19)	-.01(.04)	-.04(.14)	-0.01(0.03)
Covariates predicting att. probs. Slope (Paths Hi-Hvi)				
Age	.01(.00)*	.08(.04)*	.08(.00)*	.07(.03)*
Male	-.12(.04)**	-.13(.04)**	-.113(.02)**	-.11(.03)**
African American	-.01(.04)	.00(.04)	.02(.03)	.02(.03)
Poor	.05(.04)	.04(.04)	.07(.13)	.07(.03)
Internalizing probs.	-.11(.04)**	-.11(.04)**	-.13(.04)**	-.13(.04)**
Externalizing probs.	-.26(.04)	-.34(.04)***	-11.08(.03)***	-.37(.03)***

Attention and reading scores at school entry vary by child race, gender, or poverty status. Race, gender, and poverty status are significantly related to average reading skills and average levels of attention problems at school entry. Girls had significantly higher average initial reading performance than boys (girls: *M*=53.33*, SD*=10.78 boys: *M*=51.54*, SD*=10.91*;* ß=-.06, *SE*=.02, *p*<.01). Black students have statistically significantly lower average initial reading performance than White students (Black students: *M*=50.37*, SD*=9.79, White students: *M*=53.90*, SD*=11.45*;* ß=-.06, *SE*=.02, *p*<.01). Students from low-income families also have significantly lower average reading performance scores at school entry than students who are not poor (Poor: *M*=50.24*, SD*=9.24, Not poor: *M*=56.19*, SD*=12.07; ß=-.24, *SE*=.02, *p*<.01). At school entry, girls had significantly lower initial levels of attention problems relative to boys (girls: *M*=3.09*, SD*=1.28*,* boys: *M*=3.67*, SD*=1.38; ß=-129, *SE*=.02, *p*<.01). Black students had higher initial levels of teacher-rated attention problems (Black students: *M*=3.58*, SD*=1.40, White students: *M*=3.25*, SD*=1.33*,* ß=.06, *SE*=.02, *p*<.01), as did students whose families are poor relative to other students (Poor: *M*=3.59*, SD*=1.37, Not poor: *M*=3.07*, SD*=1.28*,* ß=.13, *SE*=.02, *p*<.01).

The rate of growth in attention problems varies by child gender, while the rate of growth in reading skills varies by child race and poverty status. Child race and poverty status were found to be statistically significantly related to the rate of change in reading skills from kindergarten entry through third grade. Black students made less growth than White students (ß=-.06, *SE*=.02, *p*<.01), as did students whose families are poor relative to their more affluent peers (ß=-.06, *SE*=.02, *p*<.01). Only child gender was found to be statistically significantly related to the rate of change in attention problems. Attention problems in boys grow at a slower rate than do attention problems in girls (ß=-.12, *SE*=.04, *p*<.01).

Discussion

The present study aimed to model the growth of attention problems and reading proficiency from kindergarten through third grade. While the relation between attention problems and reading development has generally been hypothesized as a parallel process, there remains a lack of broad consensus in support of this description of the relationship. In addition, a nuanced exploration of whether growth in reading skills and attention problems vary by child race, gender, and family poverty status has been virtually unexplored in the literature. This study adds to an existing research base examining attention problems in relation to reading development. In so doing, I describe the developmental trajectory of attention problems experienced by students participating in the ECLS-K:2011 from the beginning of kindergarten through the end of third grade and its relation with reading proficiency, during a developmental period in which students' scores are highly predictive of later performance.

Here, several key findings that emerge from this study are highlighted. In the sections below, the implications of these findings for helping researchers and practitioners conceptualize and support students with attention problems of students are discussed. First, attention problems and reading skills independently grew from first through third grade, on average. Second, initial levels of attention problems were negatively and significantly related to initial reading performance scores and overall rates of change in reading performance scores, such that students with higher levels of initial attention problems experienced reduced growth in reading skills compared to students with lower levels of initial attention problems. Rates of growth in attention problems and reading skills were also significantly associated, such that students with more rapid growth in attention problems experienced less rapid growth in reading skills. Interestingly, and counter to expectations, higher initial reading scores were associated with greater growth in attention problems over time. The examination of the raw data confirmed this pattern was not a

result of an error in the model. Among students whose reading score was at or above the 75th percentile at school entry, the average rating of attention problems at school entry was 2.68 (*SD*=1.12), while students whose reading score was at or below the 25th percentile at school entry, the average initial attention problems was 4.13 (*SD*=1.33). By the end of third grade, strong readers had an average attention problem score of 4.07 (*SD*=1.03), while lower-performing readers had an average attention problem score of 5.35 (*SD*=.98). In other words, the difference in attention problems between high and low readers at kindergarten entry was 1.35 at kindergarten entry but reduced to .97 by the end of third grade. Regression to the mean and random measurement error likely explains this observed finding. As Barnett and colleagues explain (2005), regression to the mean occurs when repeated measurements were made on the same students, and observed values are obtained with random error. Because it is unusual to observe data without random error, regression to the mean is a common phenomenon (Barnett, van der Pols, & Dobson, 2005), particularly in the psychological and educational literature (Jerrim & Vignoles, 2013).

Race, gender, and poverty status were statistically significantly related to average reading skills and average levels of attention problems at school entry, such that White students, girls, and students who are not low-income had higher levels of reading skills and lower levels of attention problems relative to their peers. In addition, child race and poverty status were found to be statistically significantly related to the rate of change in reading skills from kindergarten entry through third grade, such that Black students and students whose families are poor made less growth in reading skills relative to their peers. Only child gender was found to be statistically significantly related to the rate of change in attention problems.

Expanding Understandings of Attention Problems that Guide Research and Practice

The results of this study contribute to the existing evidence base that reading skills and attention problems develop in relation to one another concurrently and over time. These results confirm those of previous studies, which state both that inattentive behavior has the potential to disrupt the development of early word reading skills (Dally, 2006), and that this has a subsequent impact on future attentiveness (Ehm et al., 2016; McGee, Prior, Williams, Smart & Sanson, 2002; Spira & Fischel, 2005).

Furthermore, this study extends the current evidence-base on the concurrent and longitudinal relations between attention and reading skills, presenting evidence that the development of reading and attention skills vary by child race, gender, and poverty status. Exploring growth in these skills among subgroups of students is an important step to identifying mechanisms by which observed performance gaps are perpetuated. The extent to which there are differences in developmental relations of attention problems and reading skills among students of different backgrounds have been understudied in the literature, despite substantial evidence of racial and socioeconomic reading performance gaps (National Center for Education Statistics, 2015; Campbell et al., 2000, Kainz, 2019) by child race and poverty status. There is emerging evidence that similar observed differences in ratings of perceived attention, such that Black students are perceived to have higher levels of attention problems relative to their White peers, even in controlled settings where children are primed to behave identically to one another (DuPaul et al., 1997; Epstein, March, Conners, & Jackson, 1998). This study provides initial evidence that child race, gender, and poverty status are related not only to initial levels of reading skills and attention problems, but also to the rates at which they change from kindergarten through third grade. Future research exploring the developmental relations between reading performance and attention problems with an emphasis on potential differences among children of

different demographic backgrounds are needed to bolster the validity of conclusions drawn from the present study.

Findings from this study point to a need for developing and evaluating intervention approaches that promote attentional capacity to support the development of students reading skills more effectively. Small group reading (Allan et al., 2018), one-on-one reading instruction (Allan et al., 2016; LRRC, Jiang & Farquharson, 2018), literacy and speech interventions (Pham, 2016), computerized attention and working memory training (Rabiner, Goodwin, & Dodge, 2016) have been recommended for promoting attention skills and reading development among students with attention problems. In addition, findings from this study highlight the potency of teacher ratings of students' attentive behavior in predicting their academic outcomes. In addition to intervening at the level of the individual child, it is imperative that practitioners and researchers aim to address potential bias in ratings of student behavior, as Black students and students from low-income families were found to have higher levels of attention problems than their peers. These differences may reflect true variation in attentional capacity; however, there is compelling evidence that implicit bias affects ratings of student behavior (DuPaul et al., 2014; Kremer, Flower, Huang & Vaughan, 2016; Peters et al., 2014). Participation in and advocacy for anti-bias teacher training, use of pedagogical approaches and culturally-responsive instructional material, and recruitment and retention of racially and ethnically diverse teachers have been recommended practices for reducing the potential for bias in teacher ratings of student behavior (Gilliam et al., 2016; Fergusin, 2003; Villegas, Strom & Lucas, 2012).

Finally, this study provides additional evidence of reading performance gaps and levels of attention problems by race, gender, and socioeconomic status. These gaps exist at school entry and grow from kindergarten through third grade. It is important to remember that these

differences are due to interrelated, complex factors at many levels. While the results of this study and prior research indicate that student-level psychosocial, cognitive, behavioral characteristics *do* impact student performance (i.e., Duncan et al., 2007; Hart et al., 2013; Jeynes, 2015; Kiuru et al., 2015; Leach, McKeown, Blackmore & Cuffe, 2016; Rabiner, Godwin & Dodge, 2016), we must not ignore the broader contextual and structural factors that also contribute to these gaps. For instance, school-level characteristics such as school racial and poverty composition, climate, size, discipline policies, and enrollment characteristics also contribute to performance gaps (Morris & Perry, 2016; Reardon, 2016; Rothstein, 2015). Furthermore, structural differences such as inequities in household educational resources, health and nutrition, housing quality, housing policy, politics, school funding, and curriculum also reproduce performance gaps (Beck & Muschkin, 2012; Davis, 2003; Durik, Vida & Eccles, 2006; Hartney & Flavin, 2013; Jeynes, 2015; Rothstein, 2004; Rothstein, 2015). We have yet to create and sustain environments that promote equitable opportunities for our full student population to learn and develop.

Limitations and Directions for Future Work

As few studies to date have explored the potential for differences in the developmental relations of attention problems and reading skills among Black and White students, students from different socioeconomic backgrounds, and girls and boys, additional research is needed to replicate these findings. In particular, studies that investigate this relation over a longer developmental are necessary to inform theory building. In addition, studies, including greater representation of the racial and ethnic composition of the student population, are needed. This study is also limited in its use of a single measure of reading performance and attention problems. Reading proficiency was assessed through performance tests administered by ECLS-K:2011 staff, and no other measure of reading performance was available. Future research,

including student grades and test scores, would build upon the findings of the present study. Attention problems were assessed through teacher ratings in the present study. Unfortunately, teacher ratings are unstable over time (Rabiner et al. 2010). This instability raises questions about the validity of using teacher ratings of attention as the unitary measure of attention. Future studies that incorporate scores from additional raters or performative measures of attention will build considerably upon the present study.

Conclusion

Overall, the findings of this study advance our understanding of the concurrent and longitudinal relations between attention and reading skills and the extent to which they vary by child race, gender, and socioeconomic status. I found that students' attention problems and reading skills grow over time, though the rates at which they grow is different for boys and girls, Black and White students, and students from low-income families relative to their more affluent peers. This study raises important questions about how practitioners and scholars might leverage these findings to support students to become successful readers and full participants in their education.

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CONCLUSIONS

This dissertation followed the three-paper format and focused on the developmental relations between attention problems and reading skills among elementary school students who vary by race, gender, and socioeconomic status. The first paper is a systematic review of studies exploring the developmental relationship between inattention and reading. The second and third papers empirically tested the relation between attention problems and reading skills among subgroups of children using data from the ECLS-K:2011. Together, all three papers address important gaps in the literature and form cohesive yet distinct results that can be used to inform future studies on attention problems and other mechanisms that may drive persistent gender, race, and socioeconomic performance gaps. The results of this dissertation study can also inform intervention development for children with attention problems, who likely struggle when reading. In this concluding chapter of the dissertation study, a summary of results and unique contributions of each paper are presented. A discussion of the dissertation's limitations follows. Next, the implications of the dissertation study are described, followed by concluding thoughts.

Summary of Findings and Unique Contributions

Paper 1 (Attending to Attention)

The aim of Paper 1 was to explore the developmental process by which attention problems relate to reading skills, and whether this process varies across subgroups of children. Five databases of education, psychology, and unpublished research were searched, 1,262 potentially relevant studies were reviewed, 70 studies were screened, and 16 studies were ultimately reviewed. Results from paper suggest that:

(1) there is a clear and consistent negative relationship between attention problems and reading skills, which is consistent with conclusions drawn from previous systematic reviews of attention problems and academic performance (Arnold et al., 2015; Frazier et al., 2005; Gray et al., 2017; and Polderman et al., 2010).

(2) there are multiple pathways (i.e., direct, indirect, and mixed) through which an increase in attention problems has a negative impact on reading skills across measures of attention and measures of reading performance. Shared neuroanatomy (Pham, 2018; Leclerq et al., 2016), genetic underpinnings (Willcutt et al., 2001; Wilcutt et al., 2005), neuropsychological explanations may, at least in part, explain the direct impact of attention problems on the acquisition of early literacy (i.e., attention processes have implications for information processing, and misinterpretations and miscomprehensions of texts). 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). Impairments in these skills, in turn, negatively impact later reading skills.

(3) there was virtually no meaningful study of variation in the development of attention problems and reading skills that included child gender, race, or family poverty status as moderators, either individually in terms of interactive effects. Just half of the studies reviewed for Paper 1 even accounted for variation in attention problems or reading skills as a function of child race, gender, poverty status, or past measures of attention or reading. That the most current literature on the relationship between attention problems and reading skills failed to explore potential differences by child race, gender, and family

poverty status is disappointing because based on compelling evidence from other studies, we have reason to deduce and hypothesize that these differences exist (i.e., DuPaul et al., 2014; Peters et al., 2014; Rabiner, Murray, Schmid & Malone, 2004; Ramtekkar, Reirsen, Todorov & Todd, 2010). It is imperative that social work researchers explicitly investigate for the presence of racial, ethnic, economic, and gender-based disparities in constructs and processes. Ignoring the potential for such differences hinders our understanding of how inequalities are perpetuated, dampens our ability to develop remedies to these processes, and represents a failure to pursue equity and justice.

Although there have been four other systematic reviews published on the association between attention problems and academic performance in the last 15 years (i.e., Arnold et al., 2015; Frazier et al., 2005; Gray et al., 2017; and Polderman et al., 2010), Paper 1 is the first systematic review to incorporate gray literature in its review of studies linking attention problems to academic skills. Paper 1 is also the first review to focus on reading skills as the academic outcome of interest, even though the acquisition of skills is particularly likely to be negatively impacted by poor attention skills (Frick et al., 1991; Hinshaw, 1992; Rabiner & Coie, 2000). Finally, this dissertation study is the first systematic review to highlight findings on the potential differential relationship between attention problems and reading skills among students overrepresented in ratings of inattention, including boys (DuPaul et al., 2014), Black students (Lawson et al., 2017) and students from families that are poor (Georges, Brooks-Gunn & Malone, 2012; Russel, Ford, Williams & Russel, 2015).

This dissertation study can serve as a call to action for future research to explicitly test for evidence of differential relations to identify processes that perpetuate performance gaps. Ignoring race, gender, and family socioeconomic status is an issue of model misspecification, and

ultimately harmful decision making (Burchard, Ziv, et al., 2003; Paulus & Kent, 2017). Models that are "blind" to race, gender, and socioeconomic status only serve to exacerbate existing disparities. It is thus imperative that social work researchers consider these characteristics in their analyses, and discuss the effects of racism, sexism, and classism when interpreting the result(s) they present.

Paper 2 (Path to Proficiency)

With Paper 2, a multiple-group path analysis design was used to test two competing explanations of how attention problems may be related to reading proficiency among a nationally representative sample of third-grade students. The first model explored whether attention problems at kindergarten entry predict third-grade reading skills directly and through their impact on the acquisition of early reading skills. An alternative model explored whether reading skills at kindergarten entry predict third-grade reading skills directly and through their impact on attention problems in first grade. After using model fit statistics for the proposed models, a final model of best fit was identified. A moderated mediation design was then employed to examine the role of gender, race, and socioeconomic status as potential moderators individually as well as through interactive effects.

Results from Paper 2 suggest that the model reflecting that attention problems at kindergarten entry predict third-grade reading proficiency directly and through its impact on early reading skills had a good fit to the data. This finding confirms and builds on the findings from Paper 1 and is in line with other existing work on the nature of the relationship between attention problems and reading proficiency (i.e., Ogg, Volpe & Rogers, 2016; O'Neill, Thorton, Marks, Rajendran & Halperin, 2016; Plourde et al.,. 2018; van de Sande, Segers & Verhoeven,

2017). Main effects of race, gender, and family poverty status were also reported in Paper 2 such that:

(1) across time points, Black students had higher ratings of average attention problems and lower levels of reading proficiency. This finding is consistent with prior research comparing attention ratings between Black and White students (DuPaul et al., 1997; Epstein, March, Conners & Jackson, Rabiner, Murray, Schmid & Malone 2004), as well as performance gaps (NCES, 2018). These results provide yet more evidence of an enduring need to develop and sustain school environments that promote equitable opportunities for an increasingly diverse student population to learn and develop.

(2) Across time points, boys have higher average levels of attention problems and lower levels of reading proficiency relative to girls. These findings are consistent with published research indicating that boys are overrepresented for identified attention problems (Ramtekkar, Reireson, Todorov & Todd, 2010) and reading difficulties (Mano, Mano et al., 2012) relative to girls. This finding raises a question about whether girls are under-identified for attention problems. It also suggests that interventions that bolster attentional capacities among boys may also promote the acquisition of their reading skills.

(3) Students from families whose families are poor demonstrated higher levels of attention problems and lower levels of reading proficiency when compared to students whose families are not poor. Similar results have been documented for ratings of attention problems (Georges, Brooks-Gunn & Malone, 2012; Russel, Ford, Williams & Russel, 2015) and reading performance (NCES, 2018). This finding, too, provides yet more evidence of a need for opportunities for all students to learn and develop.

Turning to the parameter estimates for the paths linking attention problems to reading skills, the magnitude of the impact of attention problems on reading skills did not paint a consistent picture.

(1) When considering the overall sample, the negative relationship between attention problems and reading skills was stronger for girls, students whose families are poor, and White students. It was surprising to find that the negative relationship between attention problems and reading skills was stronger for girls than for boys, and for White students than for boys. These results do not confirm what has been previously reported (i.e., Eisensmith & Kainz, 2019; Hooper et al., 2010). However, it has been previously reported that compared to boys with attention problems, girls with attention problems display greater intellectual impairment (Gaub & Carlson, 1997; Gershon, 2002). One implication of this finding is that there is a clear need to identify attention problems in girls subsequently engage girls in intervention to mitigate the impact of attention problems on the acquisition of reading skills

(2) In a subsample of children whose families are poor, the negative direct and indirect effect of early attention problems on third-grade reading remains stronger for girls but was stronger for Black students relative to White students. The results of these analyses involving a subsample of children whose families are poor are consistent with what has been reported in extant literature in terms of variation in reading outcomes by child race (NCES, 2018).

(3) In gender-specific samples, the negative direct and indirect effects of early attention problems on third-grade reading was stronger for Black students than for White students. The results of these analyses involving a subsample of girls or boys were more consistent

with what has been reported in terms of variations in reading outcomes by child race (NCES, 2018).

Taken together, these results from Paper 2 suggest that there may be complex and intersecting relations between child race, family poverty status, and gender and variation in attention problems and reading skills.

A primary aim of Paper 2 was to make an inference about the process by which attention problems and reading skills are related. As "theory confirmation is not possible when a theory is tested in isolation," Paper 2 empirically tested two competing models about the relation between attention problems and reading skills (Clarke 2007, p. 886). An empirical test of these competing models reduced the likelihood that author bias influenced the results reported; thus, the conclusion that attention problems at kindergarten entry predict third-grade reading skills directly and through their impact on the acquisition of early reading skills is presented with confidence.

This study is unique in its consideration of how child race, gender, and poverty status, both individually and in terms of interactive effects, are associated with the relation between attention problems and reading skills. Incorporating intersectionality into social work research will enable social work researchers to infuse justice and equity agendas more centrally (Rosenthal, 2016). Failure to do so is in direct conflict with justice-oriented research. This dissertation study can serve as an example of how to implement this lens in the study of factors associated with academic performance. Replication of these results would further strengthen the findings of this study. In addition, future research that expands the discussion to include students of other racial and ethnic backgrounds would push the field forward.

Paper 3 (Developmental Relations between Attention and Reading)

The third paper explored whether growth in attention problems from kindergarten through third grade is associated with growth in reading skills over the same period. Results from Paper 3 indicate that:

(1) Attention problems and reading skills independently experience growth from kindergarten through third grade. These findings are consistent with theories about child development, which state that a child's ability to read takes place over time, begins early in a child's life, and depends on the incremental acquisition of a range of language skills (Lervag, Braten & Hulme, 2009). Similarly, the attention system develops from birth through adulthood (Posner & Peterson, 2012), though attentional capacity is largely stable by first grade (Deter-Deckard & Wang, 2014). That both attention problems and reading skills grow over time suggests that early identification and intervention to promote attention and the acquisition of reading skills is critical for students.

(2) Initial levels of attention problems were negatively and significantly related to initial reading performance scores and rates of change in performance scores, such that students with more rapid growth in attention problems experienced slower growth in reading skills. These findings confirm those of previous studies, which state both that inattentive behavior has the potential to disrupt the development of early word reading skills (Dally, 2006), and that this has a subsequent impact on future attentiveness (Ehm et al., 2016; McGee, Prior, Williams, Smart & Sanson, 2002; Spira & Fischel, 2005).

(3) Rates of growth in attention problems and reading skills were also significantly associated, such that students with more rapid growth in attention problems experienced less rapid growth in reading skills. Students with higher initial scores in reading

experienced worsening attention problems at a greater rate than did students with lower initial scores in reading, though this finding is likely explained by regression to the mean (Barnett, van der Pols, & Dobson, 2005; Jerrim & Vignoles, 2013).

(4) Child race, poverty status, and gender were statistically significantly related to average levels of attention problems at school entry and the rate of change in reading skills. Black students made less growth in reading than White students, as did children whose families are poor relative to their more affluent peers. Only gender statistically significantly predicted the rate of change in attention problems, such that attention problems in boys grew at a slower rate than for girls. This finding represents initial evidence that child sociodemographic characteristics are related not only to initial levels of reading skills and attention problems, but also to the rates at which they change from kindergarten through third grade. These results are in partial agreement with those reported by Hooper and colleagues (2010), but replication studies are needed before definitive conclusions can be drawn.

Paper 3 built off prior work to further explore the links between the development of inattention and reading proficiency and explicitly explored whether these relations vary as a function of child race, gender, and family poverty status. Previous cross-sectional research illustrated a negative relationship between attention problems and reading skills, but could only suggest general associations. The literature has lacked information about rates of change and growth of the link between attention problems and reading skills. By using parallel growth curves to model the development of inattention and reading skills, it was possible to explore whether child race, gender, and family poverty status are related to sample average intercepts and slopes for both constructs of interests. This, in turn, affords the opportunity to gain insight about

when and with whom to intervene to promote student attention and reading skills. Exploring these relations among subgroups of students is an important step to identifying mechanisms by which observed performance gaps are perpetuated. This descriptive focus is an important lens for social work researchers to consider and implement in the quest to ensure healthy development for all youth. In addition, growth curve models also allow for the use of time-invariant (i.e., race) and time-varying (i.e., reading skills, ratings of inattention) covariates, and non-normal data (Curran, Obeidat & Losardo, 2010; DeLucia & Pitts, 2006). This method is a preferred approach for analyzing longitudinal data, and its expanded use in social work research would facilitate the study of youth development.

Synthesis

Together, all three papers fill gaps in the literature related to variation in reading skills and attention problems among students of different sociodemographic backgrounds and over time. Each Paper employed novel and rigorous methods to investigate the relationship between attention problems and reading skills among students of different backgrounds. The dissertation may serve as an example for future research on the relation between attention and reading, or, more broadly, on factors associated with students' academic performance. In addition, Papers 2 and 3 are the first empirical studies to conduct subgroup analyses to explore the relationship between attention problems and reading proficiency by child race, gender, and family poverty status. This explicit aim to describe disparities in attention problems and reading skills by child race, gender, and family poverty is an important step in challenging an overly simplistic understanding of a complex learning environment.

The results of the three dissertation papers tell a compelling story: Early attention problems have a negative direct and indirect effect on 3rd-grade reading skills and stunt the

development of reading skills. Child race, gender, and poverty status are related not only to initial levels of these constructs and levels of these constructs in third grade but also to the rates at which they change from kindergarten through third grade. This storyline begs the question: to what extent are educators and practitioners equipped with the knowledge and competencies they need to ensure the reading development of all students?

Limitations of the Dissertation and Suggestions for Future Research

The findings and contributions of the dissertation project should be considered in light of its limitations. Related to Paper 1, it is possible that both the conceptualization of attention and the search strategy did not allow for the identification of relevant studies. For instance, only studies published in English and samples of students in elementary school were included in Paper 1. Future reviews could consider studies published in other languages and with both older and younger students. In addition, Paper 1 did not emphasize possible differences between inattentive and hyperactive attention problems and symptoms, although they may differ in their relation to academic skills (Gray et al., 2017). Future reviews could explore the impact of either inattentive or hyperactive problems in relation to reading proficiency.

Turning to Papers 2 and 3, the primary analyses are limited by the use of a single operationalization of attention problems and reading performance. The inclusion of multiple raters of student attention, performance-based measures of attention, and school performance information would bolster conclusions inferred from the results of this dissertation project. Unfortunately, the ECLS-K:2011 did not allow for the inclusion of these data for children in kindergarten through third grade. Starting in fourth grade, the ECLS-K:2011 collected an observational measure of visual attention. Future research using this dataset would be advantaged by operationalizing attention problems using both teacher ratings and an

observational measure. In addition, the restricted use datafile of the ECLS-K:2011 includes more detailed data, included information collected from and about teachers and parents. Incorporating information from these respondents would allow for a more complete description of the context in which children develop and would allow for the estimation of family, classroom, and teacher effects on student outcomes. Finally, the analyses were limited in their scope by focusing on comparisons between Black and White students, which does not accurately reflect the diversity of students in the United States. Future research would benefit from the inclusion of students of other racial and ethnic backgrounds.

Implications of Major Findings for Future Research and Practice

Although there are several limitations of the current dissertation project worth noting, the results of the dissertation do point to suggestions for research and practice. There is a need to continue exploring potential differences in ratings of attention problems and reading skills by child race, gender, and family poverty status, which has implications both for social work research and practice. Paper 1 helped highlight that there is a persistent dearth of research on this topic despite substantial evidence that such gaps exist. This lack of study 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. Papers 2 and 3 have established foundational knowledge for conducting subgroup analyses in the study of the relation between attention problems and reading skills. Future studies could draw from this approach, in particular, the consideration of intersectionality. In addition, Paper 3 provides preliminary evidence about the rate of change and growth in the link between attention problems and reading skills. Future studies can replicate and extend these findings by employing longer-term

longitudinal designs and multidimensional measures of attention and reading, and other complexities related to students' academic success.

This dissertation also highlighted the potency of teacher ratings of student attention problems in predicting students' academic performance. Importantly, teacher ratings of student attentions have found to be unstable over time (Rabiner et al., 2010), and have been found to vary by child race and gender (DuPaul et al., 2014), and socioeconomic status (Rametekkar, Reiersen, Todorov & Todd, 2010). Thus, future study of student attention—in relation to reading skills or otherwise—should be mindful to include multiple measures of student attention, including ratings by multiple informants and performance-based tasks to more reliably approximate levels of attention problems in children.

Results indicating the potency of teacher ratings of student attention in predicting academic performance have practical implications as well. In the context of school social work practice, school social workers can facilitate better understandings of 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 also 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, and the use of performance-based measures of attention. Additionally, school social workers can also raise awareness about the relationship between perceived attention problems and reading scores for non-White students. 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.

It is critical that public schools design curricula that incorporate student experiences to promote optimal achievement for all students. Early reading achievement becomes the

foundation for all subsequent academic learning, and thus warrants special attention for curriculum and program design. The persistent negative association between children's attention problems and subsequent reading achievement indicates a socially dynamic process that (1) unfolds in classrooms; (2) is associated with academic achievement gaps; and (3) is ripe for intervention. Public education is at a crossroads. The U.S. population is shifting such that the majority of students attending public school are those that our schools struggle to serve: by 2050, more than half of the U.S. population will be non-White (U.S. Census Bureau, 2006). If we continue to ignore the reality that current methods are failing to teach non-White students to read proficiently, we risk compromising the knowledge, advancement, and future of the majority of public school students.

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