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INTERVENTION, EVALUATION, AND POLICY STUDIES

Behavioral Attention: A Longitudinal Study of Whether and How It Influences the Development of Word Reading and Reading Comprehension Among At-Risk Readers

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Abstract: The purpose of this study was to examine the extent to which teacher ratings of behavioral attention predicted responsiveness to word reading instruction in first-grade and third-grade reading comprehension performance. Participants were 110 first-grade students identified as at risk for reading difficulties who received 20 weeks of intensive reading intervention in combination with classroom reading instruction. Path analysis indicated that teacher ratings of student attention significantly predicted students' word reading growth in first grade even when they were competed against other relevant predictors (phonological awareness, nonword reading, sight word efficiency, vocabulary, listening comprehension, hyperactivity, nonverbal reasoning, and short-term memory). Also, student attention demonstrated a significant indirect effect on third-grade reading comprehension via word reading but not via listening comprehension. Results suggest that student attention (indexed by teacher ratings) is an important predictor of at-risk readers' responsiveness to reading instruction in first grade and that first-grade reading growth mediates the relationship between students' attention and their future level of reading comprehension. The importance of considering ways to manage and improve behavioral attention when implementing reading instruction is discussed.

Keywords: Attention, intervention, reading

Many students with behavioral inattention demonstrate chronic academic underachievement (e.g., Barkley, 2006), perhaps especially in reading (e.g., McGrath et al., 2011; Willcutt et al., 2010). Indeed, the link between attention and literacy is well documented, from prekindergarten children (Sims & Lonigan, 2013) to adults (Samuelsson, Lundberg, & Herkner, 2004), and it persists even when controlling for literacy-related variables such

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as phonological awareness and vocabulary (e.g., Saez, Folsom, Al Otaiba, & Schatschneider, 2012). What is less understood is the relation between attention and reading skills among children primarily identified as at risk for reading difficulties, and more specifically, how attention influences such children's responsiveness to intensive reading intervention and classroom instruction. In this study we extended the literature in two ways. First, we examined whether attention influences at-risk children's responsiveness to instruction. Second, we explored the development of these children's reading comprehension 2 years post-intervention to assess (a) whether pretreatment attention exerts a direct and unique effect on their reading comprehension or (b) if it influences comprehension indirectly through word reading and listening comprehension.

ATTENTION AND RESPONSIVENESS TO INSTRUCTION

Longitudinal studies demonstrate that children who display poor attention in preschool or kindergarten exhibit lower levels of reading achievement in elementary school (e.g., Dally, 2006; Vaughn, Hogan, Lancelotta, Shapior, & Walker, 1992). Researchers have suggested that attention may support the acquisition of reading skills by allowing children to maintain their focus on relevant information and to suppress irrelevant information during the instructional process (Saez et al., 2012).

One might predict that attention has less influence on reading growth when instruction occurs in small groups or one-on-one, because the instructor has an opportunity to direct the student toward the lesson's most relevant information and away from distractors. However, student behavior reliably predicts responsiveness to reading interventions even when conducted in small groups (Al Otaiba & Fuchs, 2006), including one-on-one (e.g., Torgesen, Wagner, Rashotte, Rose, et al., 1999; Vadasy, Jenkins, Antil, Wayne, & O'Connor, 1997). Torgesen, Wagner, Rashotte, Rose, et al. (1999), for example, examined the efficacy of three one-on-one phonological interventions that occurred from fall of kindergarten to spring of second grade—in total, 88 hr of intervention. Across the three treatment groups, the researchers evaluated the simultaneous prediction of word identification growth curve parameters by phonological variables (awareness, naming, and memory), cognitive factors (verbal and nonverbal ability), and other measures (home background, reading experience, type of instruction, and teacher behavior ratings). Behavior ratings were the best predictor of the participants' word identification growth, controlling for all other variables in the model. More support for the importance of behavior in determining responsiveness to instruction comes from a meta-analysis conducted by Nelson, Benner, and Gonzalez (2003). Across seven studies, problem behavior, in addition to rapid naming and phonological knowledge, was a unique predictor of responsiveness to reading intervention.

A majority of these studies examined the relation between behavior and responsiveness to intervention, with *behavior* defined broadly. That is, researchers have typically collapsed across multiple aspects or dimensions of behavior (e.g., ratings of attention, hyperactivity, social skills, and problem behaviors) rather than exploring the unique contribution of each of them. One exception is a study by Aro, Ahonen, Tolvanen, Lyytinen, and de Barra (1999), who compared the degree to which pretreatment attention and hyperactivity predicted responsiveness to two 9-month academic interventions for children identified as struggling readers. Results indicated that among children with attention deficit hyperactivity disorder (ADHD) symptoms, pretreatment attention—but not hyperactivity—predicted posttreatment reading scores. However, Aro et al. did not report the relative influence of attention and hyperactivity across the entire sample (i.e., for those who demonstrated

ADHD symptoms and those who did not). So, additional work is needed to understand the unique influence of attention in determining student responsiveness to intensive reading instruction. Given that some studies suggest that attention may be malleable (e.g., Stevens et al., 2013), a strong influence of behavioral attention on responsiveness to instruction may suggest a need to emphasize attention enhancement in instruction.

ATTENTION AND READING COMPREHENSION

Gough and Tunmer's (1986) Simple View of Reading proposes that reading comprehension is the product of word identification and listening comprehension (also see Hoover & Gough, 1990). Therefore, reading comprehension difficulties can stem from poor word reading, poor oral language, or a combination of the two. However, the Simple View may require greater nuance. A number of studies report an association between attention ratings and reading comprehension (e.g., Brock & Knapp, 1996; Miller et al., 2013). Less is known about how relations between these constructs develop over time. In the present study, we tested whether behavioral attention exerts a direct effect on reading comprehension or, in stricter accordance with the Simple View, it indirectly influences reading comprehension by affecting word reading, listening comprehension, or both.

Previous studies (Cain & Bignell, 2014; Dally, 2006) suggest that student attention influences reading comprehension indirectly through reading at the word level. Dally (2006) used a longitudinal design to explore the relation between kindergarten attention ratings and reading comprehension in second grade. There was no direct effect. But there was an indirect relation through word reading, suggesting that attention influences children's ability to learn words, which in turn influences their reading comprehension. Because Dally did not model listening comprehension, however, it is unknown whether listening comprehension also mediates the relationship between attention and reading comprehension. In the current study, we examined whether a similar developmental pattern exists among at-risk first graders who received one-to-one intensive reading intervention, in combination with classroom instruction, and we tested whether attention influences reading comprehension indirectly by facilitating word reading and/or listening comprehension.

STUDY PURPOSE

Our study was conducted in the context of a larger investigation in which we compared the effectiveness of two reading treatments to a no-treatment control group. One treatment addressed decoding and fluency skills. The other was designed to strengthen decoding and fluency and reading comprehension. (For a description of the participant recruitment, screening, and findings from the larger study, see Fuchs et al., 2012.) In the current study, we used data on two cohorts of the at-risk children in the larger investigation who participated in 20 weeks of decoding/fluency training. We excluded children in the reading comprehension training group and no-treatment control group. We excluded the comprehension training group to increase this study's external validity. Few schools implement intensive strategy training in reading comprehension at first grade. We excluded the control group because we wished to examine the relation between behavioral attention and reading comprehension among children receiving intensive instruction. We were *not* interested in distinguishing between attention's influence on responsiveness to intensive intervention and its effects

on classroom instruction. Thus, we had no need for controls (who participated only in classroom instruction).

Our first goal was to examine the predictive value of teacher ratings of behavioral attention in determining children's "responsiveness to instruction," operationalized as growth (i.e., a difference score) from pretreatment (fall of first grade) to posttreatment (spring of first grade) on measures of word reading and listening comprehension. Our second goal was to explore how first-grade responsiveness to (one-on-one and classroom) instruction and behavioral attention relate to reading comprehension performance in spring of third grade. We explored the direct and indirect effects of student attention on meaning derived from narrative texts. Specifically, we tested whether behavioral attention exerted a direct influence on reading comprehension or, consistent with a Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), if attention (a) produces an effect on single word learning, which in turn influences reading comprehension or (b) influences development of listening comprehension, which affects reading comprehension.

We examined the relations among attention, responsiveness to instruction, and reading comprehension in the context of additional relevant variables. These represented the domains of behavior (hyperactivity), cognition (nonverbal reasoning, short-term memory), language (vocabulary, listening comprehension), and literacy (phonological awareness, nonword reading, sight word efficiency) to better understand the *relative* importance of attention in reading development. Identifying the extent to which teacher ratings of attention predict student responsiveness to instruction carries possibly important instructional implications. A strong influence of behavioral attention, for example, may suggest a need to emphasize attention-maintaining procedures as a core component of intensive reading intervention and classroom instruction.

METHOD

Participants

Students. Our initial sample comprised 134 students (M age = 6.43, SD = .37) who represented two cohorts in consecutive years of the study. Students came from 19 public schools in a southeastern metropolitan school district. Ten students were excluded from our analyses because their teacher did not return reports of attention/behavior. As indicated in Table 1, the sample was evenly divided by gender. There were as many White children as African American children. Nearly two thirds of the sample qualified for free or reduced lunch. The children were nominated by their teachers as at risk for reading difficulties. Previous reviews of research (e.g., Hoge & Coladarci, 1989) indicate that teacher judgment of student achievement has strong validity. Of the children nominated by their teachers, we selected those with the lowest scores on a battery of reading and decoding measures to participate in the study. Fourteen students left the study after first grade and did not participate in testing in the spring of third grade. Thus 110 participants completed all phases of the study. There were no significant differences between children who began and those who completed the study on any pretreatment variable.

Teachers. There were 71 study teachers. Demographic information was returned by 70 of them. As indicated in Table 2, a majority were female and Caucasian and had an average of 15.09 (SD = 11.30) years of teaching experience. They received a small cash stipend at the end of the school year for working with the research staff to collect student consent

Table 1. Participant demographics

Variable	*n*	%
Male	63	50.8
Race		
African American	53	42.7
White	49	39.5
Hispanic	14	11.3
Other	8	6.5
Reduced/free lunch	80	64.5
School-identified disability	16	12.9
English language learners	9	7.3
Retained	8	6.5

Note. $n = 124$.

forms; to work with staff on tutoring and testing schedules; and to complete evaluations of student behavior, motivation, and disability status.

Description of Decoding/Fluency Treatment

The Decoding/Fluency treatment required the use of 10 books, selected and ordered according to reading difficulty. Each book included between seven and 17 lessons, and students progressed through increasingly difficult material. The level of instruction was adaptive to students' individual needs in two ways. Their initial book was determined on the basis of their performance on the Decoding/Fluency Placement Test, and they were allowed to

Table 2. Teacher demographics

Variable	*M*	*SD*	*n*	%
Years teaching experience	15.09	11.30		
Age				
21–29			18	25.71
30–39			14	20.00
40–49			11	15.71
50–59			21	30.00
60+			6	8.57
Female			66	94.29
Highest degree earned				
B.S./B.A.			37	52.86
M.Ed./M.S.			30	42.86
Ed.S./Ph.D			3	4.29
Race				
African American			14	20.00
Asian American			6	8.57
Caucasian			50	71.43

Note. $n = 70$.

repeat or skip lessons based on their performance during the tutoring sessions throughout the 20-week intervention. Each Decoding/Fluency lesson consisted of six scripted components: (a) Sight Words, (b) Sounds, (c) Decodable Words, (d) Spelling, (e) Text Reading and Fluency, and (f) Sight Word Challenge, which are described following an explanation of the Placement Test.

Placement Test. The Decoding/Fluency Placement Test was designed to help tutors determine the book in which students would begin. The test consisted of 125 items, divided into five bands of 25 items. Each band, and items in a band, aligned with a book. There were two types of test items, grapheme-phoneme correspondences (GPCs; or the links between letter patterns and sounds) and decodable words. Every GPC in a book was tested. Decodable words were selected if judged representative of all the words in a given book, both in terms of the frequency (using the standard frequency index) and length (number of letters). The selected decodable words fell within 1.25 standard deviations of the mean frequency and length for the book. Words meeting both criteria were randomly selected to fill out the band. Sight words were not included in the Placement Test. Students began with the GPC items in each band, and students completed the bands in order. The ceiling for the Decoding/Fluency Placement Test was six incorrect items in any band. Once a student made six errors, the examiner discontinued the test and recorded the number of items missed in the band. If students had five or fewer errors, they would continue to the next band.

Sight Words. The tutor read 12 sight words to the student. After each word, the student reread the word aloud. This process was completed twice, in a different order the second time. Then the student and tutor completed one of five practice activities. For example, in the "Ninja Words" activity, the tutor covered all the words with small cards and then directed the student to uncover each one and read it. If the student read a word incorrectly, the tutor repeated the word and had the student read it again. Students again reread missed words at the end of the activity. The Sight Words activity concluded with students independently reading all 12 words in random order. Their performance (in combination with their performance on the Decodable Words, described next) determined whether they would proceed to the next lesson, repeat the current lesson, or skip the next lesson in the following tutoring session.

Sounds. The Sounds activity provided instruction and practice with sound-symbol correspondence. These sound-symbol pairings included single phoneme-grapheme correspondences, digraphs, vowel-consonant-E, phonograms (i.e., word families), past tense (i.e., the sounds of –ed), and letters or digraphs representing multiple phonemes (e.g., y or ow, termed "alerts"). Tutors referred to a visual representation of the correspondence on the Sound Page (e.g., a snake for the /s/ sound). The Sounds component concluded with students independently identifying the sounds, without the support of the visual reference.

Decodable Words. The tutor and student followed a technique called "tapping and sounding out." The tutor pointed to each grapheme in a word on the lesson page, where dots were written under the single letter graphemes and lines were drawn under digraphs and vowel-consonant-E patterns. The tutor pronounced each sound, tapping the dot or line. Then she read the word slowly, and read it again naturally. The student then completed the same cycle of tapping, sounding out, and reading words. Following this, the student practiced the words in the context of one of five games. In the "Sound Spy" game, the tutor said, "I spy a word

with the /a/ sound." The student was to circle the appropriate word. Incorrectly identified words were corrected and the student repeated the correct word. After the game, students independently reread all eight words in random order. Their performance (in combination with their performance on Sight Word reading) determined whether the child would repeat the lesson, proceed to the next lesson, or skip the next lesson

Spelling. The tutor asked the student to use spelling tiles to spell words in the Decodable Word lesson, reflecting sound-symbol correspondences that the student had already learned. Each spelling tile contained a single sound-symbol correspondence (i.e., digraphs and phonograms were written on a single tile).

Text Reading and Fluency. Each of the 10 books was divided into short sections and typed on separate pages to eliminate visual cues. A different section of the book was read aloud every day. First, the tutor read the lesson's "story words" (difficult words students would encounter in the story). Then the tutor and student read chorally (aloud and at the same time) from the section of text read the prior day. Second, the tutor read each sentence on the new story page, and the student immediately read the same sentence, proceeding through all of the sentences on the page. Then the tutor and student read the page chorally. Finally, the student read the text twice on her own. The tutor timed the student's reading rate, encouraging her to read faster the second time.

Sight Word Challenge. This activity employed a list of 500 high-frequency sight words, ordered according to their frequency in the Teacher's Word Frequency Book (Zeno, Ivens, Millard, & Duvvuri, 1995). Students read as many words as possible in 30 s in Year 1; the time limit was increased to 60 s in Year 2. Once the student read a word correctly in three consecutive lessons, it was crossed off the Sight Word Challenge page and was not practiced in the next lesson. The tutor then reviewed words read incorrectly. As many as four words could also be placed on the "My Sight Words" page, containing words especially difficult for the student to read.

Protocol Changes Across Years. For the first nine weeks of tutoring in Year 1, Sight Word Challenge was only conducted if at least 2 min remained in the lesson. Midway through the Year 1 intervention (Week 10) the activity was made part of the "core" set of activities and included in each lesson. It remained a core activity in Year 2. In Year 2, we also added a seventh component to the Decoding/Fluency intervention: Sentence Read. It was designed to provide students more practice reading each lesson's sight words and decodable words in context. The sentences increased in complexity and length throughout the scope and sequence of the program, and a variety of fonts were deliberately used to expose students to differing representations of text.

Fall of First Grade Pretreatment Measures

Literacy Measures. Word reading was measured by the Test of Word Reading Efficiency, Sight Word Efficiency subtest (Torgesen, Wagner, & Rashotte, 1999). The test consists of 104 sight words, arranged in order of difficulty from easiest to most difficult. The child's score is the number of words read correctly in 45 s. The alternate-form reliability coefficient is .97 as reported in the TOWRE manual for children 6 years of age. *Nonword reading*

was measured by the Test of Word Reading Efficiency, Phonemic Decoding Efficiency (Torgesen, Wagner, & Rashotte, 1999), which consists of 63 pseudowords (e.g., *pim*) arranged from easiest to most difficult. The score is the number of items a student correctly identifies in 45 s. The alternate-form reliability coefficient is .97, as reported in the TOWRE manual for children 6 years of age. *Phonological awareness* was measured by CTOPP Sound Matching. The student selects a word from three options that either begins (section 1) or ends (section 2) with the same sound as a word that the tester reads aloud. There is also a picture that represents each of the three words, which the tester points to as she reads the words. Both sections of this CTOPP subtest begin with three practice items, and the sections are discontinued after the student incorrectly answers four out of seven test items. The test consists of 20 items, and the score is the total number of correct items.

Cognitive Abilities. Nonverbal IQ was measured by the Matrix Reasoning subtest of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999). It measures nonverbal fluid reasoning and general intelligence. It consists of 32 items. For each item, participants select one of five options that best completes a visual pattern. Reliability exceeds .92. *Short Term Memory* was measured by the Backward Digit Recall subtest of the Working Memory Test Battery for Children (Pickering & Gathercole, 2001). Following practice items, the student is asked to listen as the tester reads a set of digits. The student is then requested to say the digits in backward order. In Span 2 there are two digits; in Span 3, three digits, and so on, through Span 7. There are a total of 36 items. A score of one is given if the student reads the digits in the correct backward order. The score is the number of correct items.

Behavior. Teacher rating scales are known to provide strong sensitivity and specificity with respect to identifying attention problems (American Academy of Pediatrics, 2000). Teacher ratings of attention are reliable across raters and across different rating scales (Loughran, 2003). Teachers are considered ideal evaluators because they observe children's behavior across many settings over extended periods, and their experience interacting with other same-age children provides them with an important normative perspective (Evans, Allen, Moore, & Strauss, 2005).

We employed the SWAN, an 18-item teacher rating scale (Swanson et al., 2004) based on the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) criteria for ADHD for attention (SWAN Items 1–9) and hyperactivity/impulsivity (SWAN Items 10–18). Items are rated as 1 (*far below*), 2 (*below*), 3 (*slightly below*), 4 (*average*), 5 (*slightly above*), 6 (*above*), and 7 (*far above*). We report data for attention and hyperactive/impulsive behavior as the average rating across the nine relevant items of each subscale. The SWAN correlates well with other dimensional assessments of behavior related to attention (http://www.adhd.net). Cronbach's alpha was .96 for the Attention subscale and .97 for the Hyperactivity subscale.

Reading Comprehension. Iowa Test of Basic Skills, Reading Comprehension (Riverside Publishing, 1994) includes three sections: Sentences, Picture Story, and Story. For Sentences, the student reads a sentence with a missing word and selects from three words to fill in the blank. Picture Story has four questions and requires selection of an answer from three potential options to describe a picture. The Story section asks the student to read a short passage, which is followed by four questions. The student selects the answer from three options. The test consisted of 19 items.

Listening Comprehension. Woodcock Reading Mastery Test–Revised/Normative Update: Listening Comprehension (Woodcock, 1998) is a cloze procedure. The tester reads aloud a sentence that is missing the final word and asks the student to provide a word that completes it. The test is discontinued after six consecutive incorrect responses.

Follow-Up Measures

We provide data on two reading measures administered after first-grade treatment implementation in spring of Grade 1: word reading (Test of Word Reading Efficiency, Sight Word Efficiency subtest) and listening comprehension (Woodcock Reading Mastery Test–Revised/Normative Update: Listening Comprehension). These same measures, together with the Iowa Test of Basic Skills, Reading Comprehension, were administered again in spring of Grade 3.

Data Collection Procedures

In first and third grades, data were collected in multiple 1-hr testing sessions by doctoral- and master's-level research staff who were selected through a competitive interview process. All had previous experience working with young children. They were trained across multiple days. The training was followed by structured role playing with other staff and independent practice. All research staff had to meet a criterion of 90% administration accuracy before the staff was allowed to test students. Following data collection, staff members blind to the research questions listened to 15% to 20% of the tapes to check scoring reliability; greater than 93% agreement was obtained for each cohort at each time point.

DATA ANALYSIS AND RESULTS

We used multivariate path analysis to simultaneously model the complex relations among behavioral, cognitive, literacy, and language measures across time. More specifically, we examined the degree to which attention predicted responsiveness to instruction in the context of other relevant and competing variables. We also explored the relation between pretreatment attention and third-grade reading comprehension by testing whether (a) attention exerted a direct effect on reading comprehension or (b) its influence was indirect through word reading and/or listening comprehension, the two component skills involved in reading comprehension in accordance with the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990).

A path diagram of the complete model is shown in Figure 1. Single-headed arrows represent regression paths; the double-headed arrow between sight word growth and listening comprehension growth represents a covariance. Using Mplus 7.11 (Muthén & Muthén, 2012), we employed full information maximum likelihood to handle missing data to preserve sample size and reduce the risk of biased parameter estimates associated with listwise deletion (cf. Allison, 2003; Enders & Bandalos, 2001; Schafer & Graham, 2002).

The distributions of each of our variables satisfied the assumption of normality, according to Curran, West, and Finch (1996), who suggested that univariate values of skewness become problematic when greater than ± 2, and kurtosis ± 7. Nevertheless, because some of our measures appeared on visual inspection to be skewed, we also ran the model presented

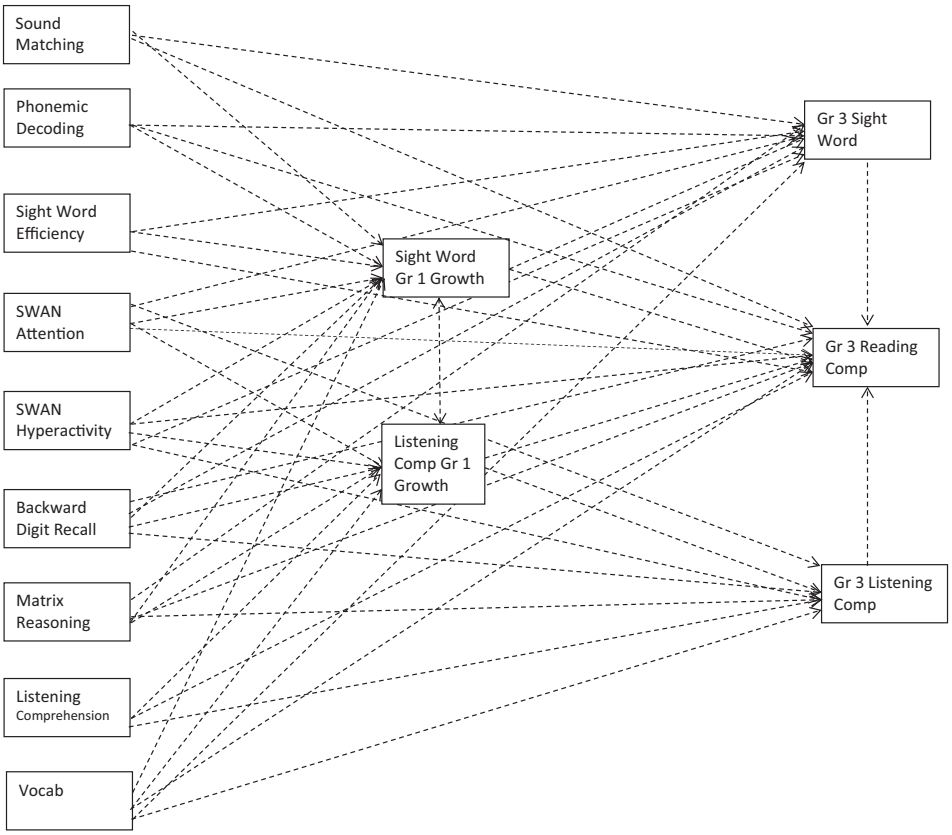

Figure 1. Hypothesized paths. *Note.* Gr = grade.

in Figure 1 using maximum likelihood estimation with robust standard errors, an approach that accounts for possible non-normality of the variables. The parameter estimates that resulted from the two methods of model estimation (i.e., with and without robust standard errors) indicated identical patterns of significant direct and indirect effects. The two estimation methods also resulted in very similar overall model fit. We report the results obtained using ML.

In Table 3, we show raw score means and standard deviations and correlations among the behavior, cognitive, literacy, and language variables. With respect to the behavior variables, attention and hyperactivity were highly correlated ($r = .69$, $p < .001$). Relative to hyperactivity, attention was more highly correlated with each of the other cognitive, literacy, and language measures. Attention was significantly and positively correlated with each of the other pretreatment variables and was also significantly correlated with third-grade sight word reading and reading comprehension but not listening comprehension. Hyperactivity, on the other hand, was only significantly correlated with pretreatment phonemic decoding and backward digit recall.

Figure 2 shows the results of the path analysis with statistically significant paths in bold. We used 95% confidence intervals (CI) produced by bootstrapping with 5,000 draws to identify statistically significant parameter estimates. Standardized beta values are shown along the arrows. Overall, our indices of model fit were satisfactory: chi-square test of

Table 3. Means, standard deviations, and correlations among cognitive, reading, literacy, and comprehension variables

	Raw Score		Correlations										
	M	*SD*	1	2	3	4	5	6	7	8	9	10	11
First grade													
1. SM	10.30	4.56	1										
2. PDE	2.49	2.70	.45**	1									
3. SWE	10.44	5.36	.43**	.35**	1								
4. Att	3.34	1.05	.34**	.28**	.26**	1							
5. Hyp	3.87	1.20	.12	.21*	.02	.69**	1						
6. BDR	5.23	3.77	.40**	.29*	.28**	.33**	.22*	1					
7. MR	7.19	4.18	.37**	.29**	.28**	.31**	.13	.30**	1				
8. LC	12.46	4.61	.32**	.21*	.23**	.19*	.06	.33**	.46**	1			
9. Voc	15.79	6.51	.32**	.25**	.24**	.21*	−.02	.21*	.32**	.55**	1		
Third grade													
10. SWE	53.62	12.73	.34**	.35**	.45**	.33**	.14	.25**	.16	.02	.04	1	
11. RC	14.81	6.42	.46**	.23*	.38**	.30**	.06	.31**	.33**	.33**	.40**	.50**	1
12. LC	20.52	3.72	.41**	.22*	.22*	.09	.01	.26*	.51**	.69**	.51**	.17	.49**

Note. SM = Sound Matching; PDE = Phonemic Decoding Efficiency; SWE = Sight Word Efficiency; Att = Attention Ratings; Hyp = Hyperactivity Ratings; BDR = Backward Digit Recall; MR = Matrix Reasoning; RC = Reading Comprehension; LC = Listening Comprehension; Voc = Vocabulary.
$^{*}p < .05$. $^{**}p < .01$.

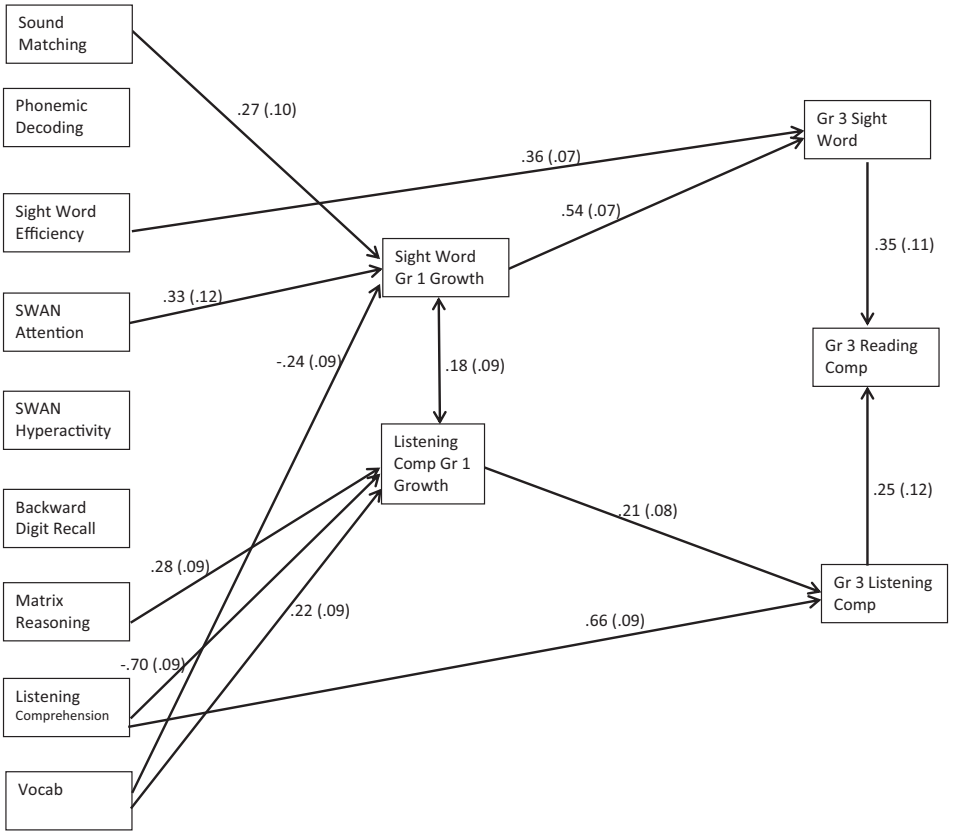

Figure 2. Model displaying only significant paths. Parameter estimates are from the standardized solution. *Note.* Gr = grade.

model fit: $\chi^2(11, N = 124) = 18.77$, $p = .07$; root mean square error of approximation = .08, 90% CI [0.00, 0.13]; comparative fit index = .97, Tucker–Lewis index = .86.

Our model addressed two primary questions of interest. The first was, What is the degree to which student attention (in the company of other pretreatment measures) predicted growth on sight word reading and listening comprehension (as a presumed function of students' responsiveness to both classroom instruction and intensive one-on-one intervention)? For growth in sight word reading, the significant predictors were pretreatment sound matching, CI [.11, .92]; attention, CI [.86, 4.42]; and vocabulary, CI [–.54, –.06]. Pretreatment sight word reading, phonological decoding, hyperactivity, backward digit recall, and matrix reasoning were not significant predictors of first-grade growth in sight word reading. For growth in listening comprehension, the significant predictors were pretreatment matrix reasoning, CI [.10, .37]; listening comprehension, CI [–.63, –.37]; and vocabulary, CI [.01, .21]. Pretreatment attention, hyperactivity, and backward digit recall were not significant predictors of first-grade listening comprehension growth.

The second question reflected in our model was, How well did our pretreatment measures of behavior, language, cognition, and literacy, in addition to responsiveness to instruction, predict Grade 3 reading comprehension, sight word reading, and listening comprehension? For Grade 3 sight word reading, the significant predictors were pretreatment

Table 4. Tests of standardized indirect effects from Grade 1 attention to Grade 3 reading comprehension based on bias-corrected bootstrap ($N = 5{,}000$) estimates

	Indirect Effects		95% CIs	
Mediational Pathways	Total Indirect	Specific Indirect	Lower CI	Upper CI
Attention	.11		−.03	.26
Thru Grade 3 SW		.06	−.03	.14
Thru Grade 3 LC		−.01	−.07	.04
Thru SW growth		.01	−.08	.10
Thru LC growth		−.01	−.05	.04
Thru SW growth & Grade 3 SW		.06	.01	.12
Thru LC growth & Grade 3 LC		.00	−.02	.02

Note. CI = confidence interval; SW = Sight Word Efficiency; LC = Listening Comprehension.

sight word reading, CI [.47, 1.35], and Grade 1 growth in sight word reading, CI [.57, 1.08]. Grade 3 reading comprehension was predicted by Grade 3 sight word reading, CI [.06, .32], and Grade 3 listening comprehension, CI [.05, .82]. There was not a significant direct effect of pretreatment attention on Grade 3 reading comprehension. Grade 3 listening comprehension was predicted by pretreatment listening comprehension, CI [.37, .71], and Grade 1 listening comprehension growth, CI [.04, .41].

We next examined whether attention exerted indirect effects on reading comprehension. Following the recommendations of MacKinnon (2008), we specified and calculated the tests of indirect effects using bias-corrected bootstrapping (5,000 bootstrap samples) to produce estimates of each potential indirect effect from attention to Grade 3 reading comprehension while accounting for all the control variables in the model. We specified all indirect paths from attention to Grade 3 reading comprehension. Table 4 provides the total indirect effect estimates and the specific indirect effect estimates and their corresponding 95% confidence intervals. Only one indirect path was significant: Attention indirectly influenced Grade 3 reading comprehension through its contribution to growth in sight word reading and Grade 3 sight word reading.

DISCUSSION

We examined the extent to which teacher ratings of behavioral attention predicted at-risk readers' responsiveness to instruction (i.e., intensive intervention and classroom instruction) in first grade and their reading comprehension performance in third grade. Results suggest attention is an important predictor of at-risk readers' responsiveness to instruction in first grade and that first-grade word reading growth mediates the relation between attention and future reading comprehension.

Attention and Responsiveness to Instruction

We examined whether behavioral attention explained variance in growth on word reading outcomes among a relatively large sample of at-risk first graders whose classroom reading instruction was supplemented by an intensive, one-on-one, 20-week reading

intervention. We examined the influence of attention controlling for behavioral (hyperactivity), cognitive (nonverbal reasoning, short-term memory), language (vocabulary, listening comprehension), and literacy (phonological awareness, nonword reading, sight word efficiency) measures. Consistent with previous findings, pretreatment phonological-processing skills and vocabulary were statistically significant predictors of word reading growth, measured pre- and postintervention. However, pretreatment student attention also explained significant variance in growth on word reading measures, despite that all students participated in one-on-one intervention, an instructional context in which attention is presumably maximized. As discussed next, we believe this finding may have implications for intensive reading intervention.

We also examined whether attention, in the context of relevant control variables, influenced growth on a measure of listening comprehension. Listening comprehension growth was significantly predicted by pretreatment listening comprehension, nonverbal reasoning, and vocabulary. Attention was not a statistically significant predictor. Although we could not find any studies that reported whether attention affects growth in listening comprehension, several have documented a strong relation between the two variables (e.g., Cain & Bignell, 2014). One possible explanation for attention's nonsignificant influence on listening comprehension in this study is that our listening comprehension measure was a cloze task for which children provided a word that was missing at the end of very short passages, one to two sentences in length. Perhaps longer passages require greater sustained attention, and therefore a different measure might have revealed attention's influence on listening comprehension growth. Another potential explanation is that we controlled for the influence of pretreatment listening comprehension and vocabulary, two powerful predictors that may have masked attention's influence.

Attention and Reading Comprehension Development

We also examined the relation between our sample's attention in first grade and their reading comprehension in third grade. We tested whether attention exerted a direct effect on third-grade reading comprehension, or whether the nature of this effect was indirect. Consistent with the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), which suggests that reading comprehension is a function of word reading and listening comprehension, we tested whether word reading skill and/or listening comprehension skill mediated the relationship between attention and reading comprehension.

We found no direct effect of first-grade attention on third-grade reading comprehension. Rather, this relationship was mediated by children's first-grade growth in word reading and their third-grade word reading performance. This suggests that inattention interferes with at-risk first graders' growth in word reading. In turn, poor word reading appears to contribute to poor reading comprehension in third grade. This interpretation is consistent with Dally's (2006) study, in which word reading mediated the relation between attention and reading comprehension development in a sample of typically developing readers.

Listening comprehension, on the other hand, did not mediate the relation between attention and Grade 3 reading comprehension. This result is inconsistent with Kieffer, Vukovic, and Berry (2013), who tested whether attention exerted direct and indirect (via word reading and listening comprehension) effects on reading comprehension among fourth-grade students. Kieffer et al. (2013) found that attention had a direct influence on reading comprehension, and that it also had a significant indirect association through listening comprehension, but not through word reading.

Although these results are in direct conflict with our study, the Kieffer et al. (2013) study and our study differ in notable ways. First, Kieffer et al. measured cognitive assessments of attentional shifting and inhibitory control—not attention ratings. Cognitive assessments and ratings of attention represent unique constructs known to make independent contributions to reading comprehension (Epstein et al., 2003; McGee, Clark, & Symons, 2000; Steele, Karmiloff-Smith, Cornish, & Scerif, 2012). Second, Kieffer et al. presented single-point-in-time (or concurrent) data, not longitudinal data, which likely explains why they found a significant direct effect of attention while we did not. Third, our participants were younger: Grade 3 versus Grade 4. Although this 1-year difference may seem inconsequential, these two grades are thought by many to straddle the divide between "learning to read" and "reading to learn" (e.g., Chall, 1983). As children grow older, the nature of comprehension changes such that the influence of decoding decreases and that of oral language increases (Keenan, Betjemann, & Olson, 2008). This could explain why word reading ability (but not listening comprehension) mediated attention's influence among third-grade students, and listening comprehension (but not word reading) mediated attention's influence among those in fourth grade. Future studies might examine how the nature of the relationship between attention and reading comprehension changes as students grow older.

Implications for Intensive Intervention

Results suggest that the behavioral attention of at-risk students should be evaluated and that interventionists and classroom teachers consider the addition of explicit procedures to maintain student attention. Al Otaiba and Fuchs (2002) conducted a review of studies that examined the characteristics of children who were inadequately responsive to reading intervention. They found that 61% of studies failed to measure behavior as a potential predictor of nonresponsiveness. Furthermore, many studies that have examined behavior's impact on responsiveness to intervention have not distinguished the effects of attention from other types of behavior, despite that attention is more highly associated with reading outcomes than other behavioral components, including hyperactivity (Greven, Rijsdijk, Asherson, & Plomin, 2012), internalizing and externalizing disorders (Duncan et al., 2007), and social competence (Lonigan et al., 1999).

Several investigations have explored the effectiveness of embedding attention-boosting procedures within reading interventions (e.g., Dion et al., 2011). For example, Dion et al. (2011) compared reading outcomes for no-treatment controls versus students in one of two treatment groups: students receiving Peer Assisted Learning Strategies (PALS; Fuchs, Fuchs, Mathes, & Simmons, 1997) and students receiving PALS in combination with a behavior management technique called the "Good Behavior Game" (Barrish, Saunders, & Wolf, 1969). Although both PALS groups improved their reading skills, students identified as inattentive at pretest showed little reading gain, even when reading instruction was coupled with the Good Behavior Game. This suggests that decreasing the adverse effect of inattention may be a challenge that is not easy to overcome. Future studies might begin developing and empirically testing procedures that can improve student attention, enabling them to benefit more from reading intervention.

In addition to considering how to strengthen attentive behavior to maximize positive intervention effects, future research might examine the interaction between classroom teacher behavior and student attention. Saez et al. (2012) reported ways in which teacher practices can interact with student attention to affect literacy outcomes. For example, kindergarten students with better attention ratings benefitted from individualized

instruction and demonstrated greater word reading growth. However, for children with poorer attention skills, benefits of individualized instruction were diminished if not accompanied by consistent redirects by the teacher to help students regulate themselves and stay on task.

In summary, results from the present study suggest that teacher ratings of behavioral attention are a valuable predictor of at-risk readers' responsiveness to instruction and development of reading comprehension skills. The present study did not attempt to tease apart how intensive intervention, relative to classroom instruction, impacts the relationship between attention and comprehension, but future studies should further investigate the complexities of this relationship. In addition, future empirical work might evaluate the efficacy of attention-boosting exercises embedded in reading interventions, as well as classroom instruction, with the ultimate goal of strengthening the reading skills of inattentive, low-performing students.

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