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Relations Among Student Attention Behaviors, Teacher Practices, and Beginning Word Reading Skill

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Abstract

The role of student attention for predicting kindergarten word reading was investigated among 432 students. Using SWAN behavior rating scores, we conducted an exploratory factor analysis, which yielded three distinct factors that reflected selective attention. In this study, we focused on the role of one of these factors, which we labeled *attention-memory* behaviors, for predicting reading performance. Teacher ratings of attention predicted word reading above and beyond the contribution of phonological awareness and vocabulary knowledge. In addition, the relations between four teacher practices and attention ratings for predicting reading performance were examined. Using HLM, significant interactions between student attention and teacher practices observed during literacy instruction were found. In general, as ratings of attention improved, better kindergarten word reading performance was associated with high levels of classroom behavior management. However, by mid-year, better word reading performance was not associated with high levels of teacher task- orienting. A significant three-way interaction was also found among attention, individualized instruction, and teacher task re-directions. The role of regulating kindergarten student attention to support beginning word reading skill development is discussed.

Keywords

attention; reading; teacher practice; kindergarten; classroom instruction

Self-regulation positively impacts a student's ability to learn by promoting social competence, academic achievement, goal-directed behaviors, and emotional states (Buckner, Mezzacappa, & Beardslee, 2009). More specifically, it comprises "cognitive, evaluative, and behavioral processes that guide goal-directed action and emotional responsiveness" (Rudolph, Lambert, Clark, & Kurlakowsky, 2001, p.931). In the classroom, self-regulated behaviors are critical to student learning because they enable self-sustained efforts toward achieving a teacher's instructional goals. Over time, a self-regulated learner has a greater chance of acquiring new academic skills as a result of shared learning goals that bring about purposeful actions before, during, and after instructional activities within a lesson. For example, the self-regulation of attention may be important for helping kindergarten students become competent readers (Smith, Borkowski, & Whitman, 2008). However, as noted by Schunk (2008), there is a need for researchers to more precisely specify the mechanisms that facilitate self-regulation. Therefore in this paper, we focus on the role of self-regulated attention (as a specific self-regulated behavior) for strengthening word reading skill acquisition.

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The Component Model of Reading (CMR) proposes that three types of components contribute to the acquisition of reading skills: cognitive, psychological, and ecological (CMR; Aaron, Joshi, Gooden, & Bentum, 2008). Consistent with this view, we believe that elements within the classroom learning environment work together to shape how well children learn to read. For example, in the current study, we hypothesize that interactions between a cognitive component, student attention, and an ecological component, teacher practices, are related to kindergarten reading outcomes. We suspect that the strength of this relationship for predicting word reading performance is dependent upon the presence of student self-regulation. In other words, as the need for teacher-regulation of student attention to instruction increases (i.e., because of weak self-regulation), the interaction between attention and teacher practice is likely to have a greater impact on reading performance. However, in order to test whether this relation impacts beginning word reading, we need to clarify our use of the term “attention” as a cognitive component that manifests as observable behaviors that can be managed either by the self or other (in this case, the teacher).

The Role for Attention in Self-Regulated Learning

Undoubtedly, there are many facets to “self-regulation”. Borrowing from the executive functioning literature, we focus on the construct of *selective attention*, which we believe is particularly useful for understanding how mechanisms of controlled attention might support learning (Rueda, Posner, & Rothbart, 2005). For example, selective attention is theorized to allow for “efficient and focused processing of goal-relevant stimuli, with minimal intrusions from goal-irrelevant stimuli” (Lavie, 2000, p. 175). In other words, this type of focus could benefit kindergarten students as they begin to acquire reading skills because it would guide learners toward engagement with literacy instruction provided, and away from distractions caused by other elements present within the classroom environment. Moreover, it would serve to structure classroom learning opportunities by enabling students to: identify and distinguish between relevant and irrelevant information, sustain focus, and resist forgetting.

The classroom is a complex learning environment, encompassing both teacher-level characteristics (e.g., teacher experience, knowledge, and skills; Cunningham, Zibulsky, Stanovich, & Stanovich, 2009), student-level characteristics (e.g., prior knowledge, cognitive processing constraints, motivation; Verhoeven, Schnotz, & Paas, 2009), as well as their interaction (e.g., Connor, Morrison, Fishman, Ponitz, Glasney, Underwood et al., 2009). Within a typical kindergarten classroom, there are a number of cognitive demands that compete for student attention and, therefore, threaten efforts at goal-directed learning. For example, multi-step directions (“Put your book away, take a pencil out, and write your name at the top of this paper”), task requirements (“Change the *t* in *mat* to make a new word”), and classroom distractions may contribute to the creation of a cognitive load burden, which if unmanaged, could overwhelm students and throw goal-directed learning “off-course” (as discussed in Schnotz & Kürschner, 2007). This is especially critical for kindergarteners transitioning from preschool or home environments into more formal schooling expectations for learning. Thus, in order to profit from instruction, in addition to acquiring basic skills, a child needs to also cultivate particular self-regulatory behaviors that can successfully manage the learning process.

“Effective” classroom literacy instruction can decrease the likelihood of cognitive burden and increase the likelihood of self-regulatory behaviors through the use of well-structured teacher practices with clear instructional goals. That is, teachers can support and sustain students’ focus and efficiency by highlighting what is important for learning and reducing non-goal relevant “cognitive noise” that can impair the recall and production of developing skills. For example, teachers might align task demands to student abilities (i.e., provide differentiated instruction), manage classroom behaviors effectively, encourage and model self-regulation, provide a cooperative and positive climate, and explicitly teach skills (Pressley, Wharton-McDonald, Allington, Block, Morrow, Tracey et al., 2001). These practices foster goal-directed learning by affording manageable skill practice and reducing disruptions, both of which can buffer against the risk of cognitive strain on attention capabilities (Feldon, 2007; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). In other words, they make clear to students that skill practice is important because it improves performance, whereas disruptions hinder learning and achievement. Initially, the teacher manages goal-directed learning by guiding student attention to instructional goals and related activities. In due course, these practices become routine (i.e., knowing how to behave, how to practice skills, etc.), thereby fostering student self-regulation of attention to behaviors that promote skill acquisition. But, why might attention to non-content specific elements of instruction affect reading skill development?

Selective Attention Components

A recent multi-study investigation of third grade reading found that attention behaviors, as rated by teachers and mothers, was one of the strongest predictors of reading performance, following reading and math skills at school entry (Duncan, Dowsett, Claessens, Magnuson, Huston, Klebanov et al., 2007). In addition, in a study of kindergarten reading, sound awareness and letter/word identification were reliably predicted by both a behavioral measure of attention (the “Head-to-Toes” task, which involves memory and inhibitory control functions, described below) and teacher ratings of student self-regulation (Matthews, Ponitz, & Morrison, 2009). Combined, these results imply a relationship between self-regulation and attention for supporting early reading competence. Barkley (2000) proposed that executive functions may mediate this relation because they play a role in the development of behaviors that allow for the self (rather than others) to exert control over human activity. In other words, the development of executive functioning affords individuals the ability to regulate “when” and “whether” actions, which are necessary for goal-directed, intentional behavior. For example, knowing when and whether or not to engage in a particular behavior supports planning, intentional resistance to distraction, shifting of actions to meet task demands, persistence to achieve goals, problem solving and strategy choice (as discussed in Barkley, 2000).

Factor analytic studies have identified three executive, or “cognitive control”, functions that underpin selective attention, which may shed light on how self-regulated attention could benefit the acquisition of reading skills: *memory updating, mental set shifting*, and *inhibitory control* (Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Willcutt, Pennington, Boada, Ogline, Tunick, Chhabildas, et al., 2001). Although highly related, these functions presumably play unique roles in supporting a student's need to selectively attend, depending upon skill level and task demands (as discussed by Garon, Bryson, & Smith, 2008; Huizinga, Dolan, & van der Molen, 2006; Tomasi, Chang, Caparelli, & Ernst, 2007). Moreover, it is possible that stronger selective attention capabilities reduce the need to rely upon teacher-regulated aspects of learning (i.e., sufficient cognitive support is available to sustain self-regulated behavior; Buckner et al., 2009). In this paper, we will refer to these three executive functioning terms as *attention-memory, attention-set shifting*, and *attention-inhibitory control*, respectively, in order to underscore the role that attention (as an observed behavior) and its underlying elements (as theoretical constructs) play in classroom-based learning.

For example, the regulation of attention-memory is likely important for acquiring academic skills because it supports the working memory processing needed for complex task performance by keeping information current in mind (Garon et al., 2008; Gathercole, Alloway, Kirkwood, Elliott, Holmes, & Hilton, 2008; van der Sluis, de Jong, & van der Leij, 2007). That is, in a kindergarten classroom, this capability may allow a student to remember multi-step directions by allowing him/her to hold task-relevant steps in mind and disregard other, irrelevant, information. This would also serve to foster sustained task focus and resistance to forgetting during instruction.

Indeed, studies of individual differences in working memory span among schoolchildren suggest that deficient working memory constrains the demonstration of behaviors that facilitate classroom learning. For example, weak memory spans are associated with problems in following directions (Bignell & Cain, 2007; Engle, Carullo, & Collins, 1991), and are related to observed inattention and forgetting behaviors (Gathercole, Lamont, & Alloway, 2006). In addition, students with working memory impairments have been judged by their teachers as having difficulties with concentration, as well as organizing and monitoring the quality of their own work (Alloway, Gathercole, Kirkwood, & Elliott, 2009). These students likely find self-regulation of attention a challenge because they require external support in order to "stay on course" (i.e., their weakness in working memory impairs their ability to selectively attend to relevant information, sustain focus, and remember).

In a related manner, attention-set shifting capabilities allow learners to move away from irrelevant mental states toward more goal-appropriate ones (Miyake et al., 2000). This may include flexible changes in emotional states (e.g., moving from angry to more task-focused) or cognitive states (e.g., selecting to use one strategy over another). For example, set shifting may support the maintenance of instructional goals during transitions between activities by resisting perseveration on prior events and helping the child to effortlessly advance to the next task. Inhibitory control, on the other hand, allows learners to suppress inappropriate thoughts and behaviors, such as interruptions and outbursts (Lawrence, Houghton, Douglas, Durkin, Whiting, & Tannock, 2004; Miyake et al., 2000). For example, inhibitory control may enable the child to sit still during instructional activities or suppress task-irrelevant thoughts. Thus, together, the three selective attention functions likely support reading skill development by sustaining a goal-directed focus on instruction-related activities. Moreover, in doing so, they also decrease the influence of competing and irrelevant cognitive demands, which facilitates purposeful engagement.

The Current Study

Findings from a recent longitudinal study of beginning reading indicate a negative relationship between teacher ratings of student inattention and word reading performance (Dally, 2006). There are at least two possible explanations for the relationship between inattention and poor reading. Dally found that kindergarten inattentiveness predicted second grade deletion skills above and beyond the contribution of letter sound knowledge and prior phonological skills, suggesting a particular role for attention in phonological processing. That is, attention may enable beginning readers to actively attend to symbol and sound correspondences needed for decoding (Wagner, Torgesen, Rashotte, Hecht, Barker, Burgess, et. al, 1997). This role would correspond with accounts of "phonological loop" memory support for reading (de Jong, Seveke, & van Veen, 2000; Meyler & Breznitz, 1998; Steinbrink & Klatte, 2007). However, other researchers have found a low concurrent correlation between inattention and phonological sensitivity among preschoolers (Lonigan, Bloomfield, Anthony, Bacon, Phillips, & Samwel, 1999), suggesting that there may be other means by which attention is associated with early reading skills acquisition.

In this study we consider a second possibility, which is that attention supports the development of emerging reading skills by helping students regulate the cognitive demands inherently part of learning within a kindergarten classroom environment. To this end, we examine the predictive relationship between teacher ratings of attention-based behaviors and word reading performance. That is, we assume that selective attention capabilities are observable to the extent that students engage in particular “organizing”, “sustained focus”, and “remembering” behaviors. To account for the possibility that the role of attention in kindergarten word reading performance is restricted to phonological processing support (as described above) we statistically control for phonological awareness skills in our models. We hypothesize that selective attention contributes to word reading performance above and beyond the contribution of phonological awareness and vocabulary knowledge, two well known predictors of beginning reading (Lonigan, Burgess, & Anthony, 2000; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993).

Moreover, consistent with the Component Model of Reading, we assume that individual differences in the ability to sustain attention will emerge as a consequence of literacy instruction demands (Aaron, Joshi, Palmer, Smith, & Kirby, 2002). That is, we assume that the skill of learning to read words is impacted both by student attention capabilities exhibited in the classroom and teacher practices used during literacy instruction. In particular, we explore the relations between selective attention and three teacher practices (task orienting, behavior management, and individualizing instruction) associated with achievement among young students. We anticipate interactions between ratings of student attention and observed teacher practices, two classroom components likely to impact reading skill acquisition (Aaron et al., 2008). In other words, we expect that these teacher practices will play a different role in predicting word reading performance to the extent that they regulate student attention in support of literacy instruction.

Task orienting

For example, task orienting, the non-content specific time spent by teachers to prepare students for task engagement, is associated with first-grade reading performance (Cameron, Connor, Morrison, & Jewkes, 2008). In classrooms observed three times during the school year (fall, winter, and spring), students in Cameron et al.'s study demonstrated the greatest word reading gains in classes that began the year with clear teacher task orienting-organizing, but that over time was faded (as evidenced by the reduction of these teaching behaviors across the school year). One interpretation of these results is that by mid-year, students had sufficiently internalized teacher orienting behaviors, resulting in the need for less evident teacher regulation and allowing for greater student self-regulation.

We view task orienting as a means for preparing students for instructional learning opportunities by drawing their attention to upcoming expectations for action (e.g., a teacher might say to students, “Get your pencils out for the next assignment” or “After I read the sentence, you will circle...”). Thus, we suspect that this teacher support may impact students differently depending upon their ability to attend to classroom routines as well as stay organized across the school day. In other words, consistent with the findings from Cameron et al. (2008), by mid-year, we expect that average attention capabilities require less teacher orienting in order to promote reading skill development. On the contrary, we expect the reading skill development of students with weak attention (i.e., because of limited self-regulation of attention) to continue to rely on teacher task orienting to help maintain instructional focus.

Behavior management

A second variable that might impact the development of reading skills may involve how well the teacher manages student behaviors in the classroom. Although teachers’ use of effective behavior management is associated with self-regulatory behaviors in kindergarten, including time on-task (Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009), its direct effect on early reading achievement is not known. We suspect that teacher-implemented behavior management positively impacts beginning reading achievement by directing students to focus on instructional activities rather than to problem behaviors that may disrupt learning. Thus, we hypothesize that when implemented effectively, high levels of behavior management are positively associated with word reading performance.

In this study we distinguish between teacher re-directs (i.e., reminders to students to return their attention to task engagement) and the more general use of behavior management systems (e.g., clearly posted and enforced classroom rules, use of positive behavior support strategies) because we believe that they may be more sensitive to managing inattention in the general education classroom. That is, in line with our hypotheses regarding the role of attention in literacy skill learning, the use of behavior management for reducing disruptive behaviors may play a different role than teacher re-directs in supporting beginning reading skill development. That is, among students with weak attention, teacher redirects are likely to be critical to reading skill acquisition (because these students require external attention regulation), whereas we anticipate a smaller role among students with average or better attention.

Individualized instruction

In addition, the use of individualized instruction has been found to positively contribute to first grade reading skill development (Connor, Piasta, Fishman, Glasney, Schatschneider, Crowe, et. al, 2009). That is, greater growth in word reading was found among students participating in a classroom intervention designed to support teacher delivery of differentiated (i.e., in the type and amount of) instruction based upon student skill levels. These results suggest that small group instruction alone is insufficient to support beginning word reading, but rather, that teacher alignment of student ability to task demands is also needed. However, the success of this method may be affected by how well students can attend to the instructional activities provided. For example, in a study that compared the effectiveness of three reading interventions from kindergarten to second grade, kindergarten classroom ratings of attention and activity level was one of the most reliable predictors of student “response to intervention” (see discussion in Torgesen, Wagner, Rashotte, Rose, Lindamood, Conway, & Garvan, 1999, p. 591). That is, even under conditions of 1:1 instruction, students’ inability to attend and moderate their activity level in kindergarten negatively impacted their ability to profit from instruction.

Similarly, we expect the effectiveness of individualized instructional practices to be affected by student attention. In other words, consistent with the findings in Connor et al. (2009), for students with at least average attention, the use of individualized instruction is likely to promote word reading skills acquisition. However, in line with our proposed role for attention in classroom learning, we expect that the general effect of individualized instruction may be less powerful in benefitting word reading performance among students with weak attention. That is, we suspect that weak attention may mediate the effectiveness of individualized instruction (i.e., we hypothesize that these students would also need external behavior regulation support, such as teacher re-directions, in order to benefit from task-ability alignment).

In sum, we propose that student attention impacts beginning literacy skill development, and furthermore, interacts with particular instructional practices to support kindergarten word reading performance. Thus, we had the following overarching research questions:

1. Are teacher ratings of observed student attention behaviors related to kindergarten word reading above and beyond the contribution of vocabulary and phonological

awareness? Which attention behaviors are most predictive of kindergarten word reading performance?

2. What effect do classroom instructional practices have on this predictive relationship? That is, do student attention-memory behaviors interact with teacher use of task-orienting, behavior management techniques, and individualized instruction?

Method

Participants

Four hundred forty-two kindergarten children participated in the current study. These students were sampled from 10 different schools within the same school district in northern Florida that were part of a larger two-year NICHD-funded randomized-control study examining response to literacy instruction (see Al Otaiba, Connor, Folsom, Gruelich, Meadows, & Li, in press). Mean age for the sample was 5.8 years (*SD* = .46). Student racial composition was 58.4% African American, 31.7% Anglo American, with the remainder of students reported to be Multiracial (5.3%) or Other (4.6%). Roughly 60% percent of students qualified for a free or reduced lunch. Gender was fairly evenly distributed across the sample: 54.7% were boys, 45.3% were girls. All students were taught in general education classrooms that used the *Imagine It*! curriculum for reading instruction, with 17-22 students per classroom.

During this second year of the project, *all teachers* (i.e., teachers from both treatment and wait-listed comparison conditions in the prior year of the project) in Al Otaiba et al.'s (Al Otaiba et al., in press) study received professional development that covered how to individualize instruction within small groups based upon student performance data, how to use research-based reading strategies to support reading development, how to manage reading centers, and Response To Intervention (RTI) research. In addition, these 32 teachers were provided with training in how to use A2i software (for a description, see Connor, Morrison, Fishman, Schatschneider, & Underwood, 2007), which was developed to give teachers differentiated instruction recommendations regarding amounts and types of reading activities to administer based upon student needs. Thus, in this study, all students received instruction by teachers trained in how to individualize instruction within the context of a general education classroom (the teachers formerly designated as “treatment” received two years of training while the others received only one year of training). All of the participating teachers were female; 72% were Anglo American, 25% were African American, and 3% were Hispanic. A majority of teachers held bachelor degrees (72%), and years of experience ranged from 1 to 40 (*M* = 12.7, *SD* = 10.48).

Measures

Teacher ratings of attention behaviors—We used teacher ratings on the 30-item Strengths and Weaknesses of ADHD symptoms and Normal behavior rating scale (SWAN; Swanson, Schuck, Mann, Carlson, Hartman, Sergeant, et al., 2006) as an indicator of observed student attention behaviors. Previous research conducted with teacher ratings has provided an adequate account of classroom behaviors and their related cognitive processes (e.g., Dally, 2006; Isquith, Gioia, & Espy, 2004). The purpose of the SWAN is to rate students’ attention-based behaviors (compared with same- aged peers) along a 7- point continuum that ranges from “far below” to “far above”, based upon observations made “over the past month” (Swanson et al., 2006). SWAN items were developed in line with the Diagnostic and Statistical Manual (DSM-IV; American Psychiatric Association, 2000) criteria used for identifying individuals with Attention Deficit Hyperactivity Disorder. One of the distinct advantages to using the SWAN is that it captures diverse abilities across the continuum of attention behaviors. For example, in a recent study of twins (ages 3, 7, 10, and 12) that compared the use of the SWAN to the Child Behavior Checklist, SWAN scores were found to be normally distributed rather than skewed toward extreme behaviors (i.e., they captured a range of high and low attention behaviors, rather than just indicating inattention or hyperactivity; Polderman, Derks, Hudziak, Verhulst, Posthuma, & Boomsma, 2007).

Our primary interest in examining the unique contributions of particular types of attention behaviors to early literacy skill acquisition guided our decision to use factor scores of test items, rather than a summed raw score total for each student, as it is used in clinical practice. Thus, we conducted a principal components factor analysis on the teacher rating scores, which allowed us to identify a latent variable structure among test items. We used two methods for identifying factors, The Kaiser-Guttman rule (i.e., eigenvalues greater than 1; Kaiser & Rice, 1974), and the scree test (Cattell, 1966). Because we assumed that the factor scores were correlated and reflected the same theoretical executive functioning attention system, we used an oblique (promax with Kaiser) rotation. A three-factor model was yielded, which explained 87.94% of the cumulative variance, with the following eigenvalues, respectively: 22.459, 2.873, and 1.050. Inspection of the scree plot supported the retention of this factor structure; only factor loadings greater than .50 were considered meaningful to the interpretation of factors in our pattern matrix (see Table 1).

In general, we found a striking resemblance between the three factors that emerged and theoretical accounts of controlled attention executive functioning (Lehto et al., 2003; Miyake et al., 2000; Willcutt et al., 2001). For example the first attention factor, F1, we labeled *attention-memory* because the loaded items corresponded with behaviors related to holding and updating information in memory to support behavioral manifestations of attention, such as “sustaining attention to tasks”, “follow[ing] through on instructions and finish[ing] school work/chores”, “remember[ing] daily activities”, and “keep[ing] track of things necessary for activities”. The second attention factor, F2, we labeled *attention-set shifting* because the loaded items corresponded with being able to mentally shift away from inappropriate responses, such as “assum[ing] responsibility for mistakes or misbehavior”, “avoid[ing] quarreling”, and “control[ing] anger and resentment”. The third attention factor, F3, we labeled *attention-inhibitory control* because the loaded items corresponded with being able to suppress inappropriate activity, such as “control[ling] movement of hands/feet”, “inhibit[ing] inappropriate running/climbing”, “control[ing] excess talking”, and “control[ing] interrupting/intruding”. As anticipated, the factors were moderately related ($r = .621$ for F1 and F2; $r = .764$ for F1 and F3; $r = .753$ for F2 and F3); however, the item loadings indicated clear (i.e., non-overlapping) distinctions among them. Cronbach's alpha for this measure across all 30 items was .99.

We also tested whether there were significant differences among teachers in their ratings of these perceived attention behaviors. That is, because students were nested within teachers across schools, we wanted to ensure that attention ratings across teachers were similar (e.g., that particular teachers were not more likely to rate their students as demonstrating better or poorer inhibitory control). Using SPSS Statistics 17.0, we ran a series of hierarchical linear models to test whether there were reliable differences in factor score variance among teachers. Our results suggested that there were no reliable differences among teacher ratings for each of the three factor scores (F1 $F[1, 29.998] = .026$, $p = .874$; F2 $F[1, 31.856] = .988$, $p = .995$; F3 $F[1, 32.123] = .001$, $p = .972$).

Phonological awareness skill—Three measures were administered to tap different phonological awareness skills, namely, segmentation, blending, and elision. For example, the Dynamic Indicators of Basic Early Literacy Skills Phoneme Segmentation Fluency task was administered (DIBELS; Good & Kaminski, 2002), which required students to segment orally presented words containing 2-5 phonemes within one-minute (e.g., /m/ /o/ /p/ would be the answer to the presented word “mop”). Students were credited for each correct sound made. We also administered the Elision subtest from the Comprehensive Test Of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999), which required students to delete words, syllables, or phonemes from orally presented words. The Blending Words subtest was also administered, which required students to blend orally presented phonemes, syllables, and words to make words and compound words.

To reduce the variance related to measurement error, we ran a principal component analysis on these three measures in order to create a latent phonological awareness variable. Because these tasks measured related sub-skills, we used an oblique (i.e., promax) rotation. We extracted factors with eigenvalues greater than 1 (Kaiser & Rice, 1974). Thus, one factor was extracted, which accounted for 67.39% of the cumulative variance (eigenvalue = 2.022).

Word reading—In addition, three measures were administered to tap different attributes of beginning word reading skills, namely, letter naming fluency and letter/word recognition under both timed and untimed conditions. That is, we administered the DIBELS Letter Naming Fluency task (Good & Kaminski, 2002), which required students to name as many upper and lower-case letters as possible within a one-minute time limit. We also administered the Letter Word Identification subtest from the Woodcock Johnson- III Tests of Achievement (WJ-III; Woodcock, McGrew & Mather, 2001), which required students to identify letters and words that gradually increased in difficulty. In addition, we administered the Sight Word Efficiency subtest from the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999). This test required students to read as many real words that increased in difficulty, as possible, within 45 seconds. Similar to our phonological awareness variable, we created a word reading latent variable by performing a principle component analysis with promax rotation. We extracted one factor (i.e., eigenvalues greater than 1; Kaiser & Rice, 1974), which accounted for 82.20% of the variance (eigenvalue = 2.466).

Vocabulary knowledge—We administered the Picture Vocabulary subtest from the WJ-III (Woodcock, McGrew, & Mather, 2001) to tap expressive vocabulary knowledge. This task required students to name pictured objects that gradually increased in difficulty. In order to keep all of the achievement measures on the same scale, prior to analysis, the vocabulary scores were standardized ($M = 0$, $SD = 1$).

Literacy instructional practices—A teacher instruction “quality” checklist was used to rate the effectiveness of teacher practices related to literacy instruction. The effectiveness of four practices was rated on a scale of zero (not observed) to three (consistently effective implementation): task orienting, behavior management, individualizing instruction, and teacher re-directing for off-task behaviors. Thus, a classroom lesson rated as “very effective” across these practice variables would have been observed to have clear instructional routines and efficient transitions (task orienting); consistent and successful use of behavior management methods; differentiated small-group instruction of literacy content based upon student assessment results (i.e., individualized instruction); and effective teacher re-directs used to maintain on-task student behaviors. Cronbach's alpha for this measure was .73.

Teachers’ literacy lessons were observed and videotaped by project-trained graduate research assistants with backgrounds in general and special education, psychology, and speech and language pathology. One classroom lesson (1.5 hours) for each teacher was videotaped during the middle part of the school year (i.e., between January and February

2009). Coding of teacher practices was conducted independently by these research assistants only after the reliability of their work was certified as acceptable (i.e., kappa = .75), based upon comparison with the master coder and other coders. In general, coding agreement ranged from .92-1.00. In addition, coders met weekly to discuss issues and questions that emerged, and disagreements among coders were settled by the master coder.

Procedures

All academic measures used in this study (except for the classroom observations) were administered between April and May 2009. Trained graduate student research assistants individually administered these measures in nearby classrooms at the school sites. Teachers were requested to complete the SWAN rating scale during this assessment period for each student in their class. They completed the rating scales at their own pace. Thus, the teacher-level practice variables were collected during the middle of the school year and the student-level achievement and attention variables were collected 3-4 months later.

Results

We collected data from 442 students with complete SWAN teacher ratings and achievement scores. However, when we examined the performance on the literacy measures for univariate outliers, 10 students were dropped from the analyses because of extremely high reading scores, indicating that they were not typical readers (i.e., *z* scores > 3.29, as suggested by Tabachnick & Fidell, 2001), reducing the total sample to $N = 432$.

Descriptive statistics

Although we used factor scores in our analysis, we provide raw score means and standard deviations for the attention ratings, phonological awareness, vocabulary, and word reading measures in Table 2. In general, the mean rating of attention for this sample fell within the average range of scores. Standard score performance in word reading and expressive vocabulary also fell within the average range (letter word identification $M = 107.15$, $SD = 14.18$; vocabulary $M = 99.98$, $SD = 10.28$).

Correlations among the latent variables and the vocabulary measure (*z*-score transformed) are displayed in Table 3. A Bonferroni correction was applied, adjusting the critical alpha level to $p < .008$. Although the three selective attention factor scores were found to be highly inter-related (*r* ranged from .62-.76), the attention-memory factor was more strongly related to the phonological awareness, reading, and vocabulary scores than the other factors. That is, attention-inhibitory control and attention-set shifting were only weakly related to the achievement measures (*r* range = .16-.35). Therefore, we limited our analyses to focus on this particular factor (i.e., attention-memory) for predicting kindergarten word reading (i.e., we did not include the other two factors in subsequent analyses).

Hierarchical Linear Modeling—We were primarily interested in the role that student attention-memory behaviors played in the prediction of beginning word reading and whether observed teaching practices during literacy instruction interacted with these behaviors. Because the students were nested within classrooms, we used a two-level hierarchical linear model (HLM) with students at Level 1 and teacher practices at Level 2 to predict word reading performance. We hypothesized that the observed use of task orienting, classroom management, individualized instruction, and teacher re-directs would impact any relationship found between student attention-memory and word reading performance. We used HLM for Windows, version 6.0 (Raudenbush, Bryk, & Congdon, 2009) to test our models.

We first tested the unconditional grand-mean model with word reading as the outcome to determine the proportion of variance at the student and teacher levels. This model was non-significant, $t(2, 31) = .141$, $p = .890$, underscoring the average word reading performance of this sample (i.e., the overall mean did not differ significantly from zero; see Table 4). This intercept-only "baseline" model revealed an intraclass correlation (ICC) of .139, suggesting that nearly 14% of the variance in word reading was associated with Level 2 instructional practice variables, and 86% of the variance remained at the student level.

Next, we began building our conditional model by adding in the Level 1 attention-memory factor scores as predictors, after controlling for the contribution of phonological awareness and vocabulary. Because we were using factor and *z*-transformed scores, we did not center these variables (i.e., they were already centered at the grand mean). As shown in Table 4, in this step the fixed effects were the classroom grand mean intercept and phonological awareness, vocabulary, and attention-memory slopes. Estimating the parameters in our random-coefficients regression model, we found that kindergarten word reading was reliably and uniquely predicted by attention-memory factor scores after controlling for the contribution of phonological awareness and vocabulary scores, $t(11, 31) = 4.968$, $p = .000$. The regression coefficients for all variables were positive and statistically significant, except for the classroom mean intercept (see Table 4). As the word reading outcome was a latent variable, already centered at zero, we did not expect the classroom mean intercept to be significantly different than 0. The r^2 for this model was .513, explaining 51% of the variance at the student level.

The final model we tested, and the model that we use for interpreting our results (i.e., the intercepts- and slopes-as-outcomes model; Raudenbush, & Bryk, 2002), was built with all predictors tested in the model simultaneously. Despite the non-significant intercept found in the random-regressions coefficients model, we hypothesized that teacher practice impacts students' word-reading outcomes. Thus, in our final model, we added in our Level 2 teacher practice predictors of the intercept, as well as the student attention-memory slope, to test for the interaction between attention-memory and instructional practice. Although students' phonological awareness and vocabulary are theoretically and statistically important, we used them only as control variables in our final model, and did not test for teacher influence on their slopes.

The fixed effects results of this final model are displayed in Table 4 and are graphically represented in Figures 1 through 3. To summarize, in this final model, all student- level variables continued to remain positive and significant. Specifically, we found a statistically significant cross-level negative interaction between the attention-memory factor and task-orienting for predicting word reading, $t(11, 27) = -3.448$, $p = .002$. In Figure 1 we probed the interaction by estimating with values of 1 (low levels of teacher task orienting) and 3 (high levels of teacher task orienting) and found that, in general, by mid-year, low levels of teacher task orienting was associated with better reading outcomes. The cross-level interaction between attention- memory and teacher use of behavior management also significantly predicted word reading, $t(11, 27) = 4.170$, $p = .000$. In Figure 2 we probed the interaction by estimating with values of 1 (poorly implemented behavior management) and 3 (highly consistent and clear behavior management) and found that on average, highly consistent and clear behavior management was associated with better word reading performance. In addition, the cross-level interaction between individualizing instruction and attention-memory was positively associated with word reading performance, $t(11, 27) = 2.793$, $p = .010$. Teacher use of re-directs, however, negatively interacted with attention-memory to predict kindergarten word reading, $t(11, 27) = -2.506$, $p = .019$. In this final model, the teacher-level predictors explained 52.5% of the variance at the teacher level, and 51.35% of the variance at the student level.

In Figure 3 we graphically probed the interactions among these variables (1 = low, 3 = high). This visual representation of the HLM results with theoretically important values made it clear that individualized instruction differentially benefitted students, depending upon the degree to which teachers provided re-directs to support on-task behavior. That is, high levels of individualized instruction (i.e., small grouping with differentiated content aligned to student ability), combined with low levels of teacher re-directs was associated with better word reading performance among students with average and above attention-memory ratings. However, for students with weak attention-memory behaviors (i.e., more than 1 *SD* below the sample mean), the role of re-directs made a stronger impact on word reading performance irrespective of the degree to which individualized instruction was implemented. Combined, these results highlight differences in the way that student attention and teacher practices jointly impact word reading performance.

Discussion

In this paper we aimed to examine the role of student attention for supporting kindergarten word reading performance. In particular, we investigated whether student attention-memory and teacher practices implemented to support literacy instruction predicted beginning word reading performance. Based upon the literature reviewed, we proposed that attention-memory behaviors would bolster reading performance because they strengthen a student's ability to remain focused on relevant aspects of reading instruction, thereby guarding against forgetting and mentally organizing learning opportunities (Garon et al., 2008; Gathercole et al., 2008). In other words, at least in kindergarten, selective attention may scaffold reading skill acquisition by holding on to relevant information and sustaining focus, which could reduce the likelihood of forgetting. Consistent with the Component Model of Reading (Aaron et al., 2008) we view cognitive (i.e., attention) and ecological (i.e., classroom instructional practices) variables as unique contributors that interact in critical ways during reading skill development.

Consequently, we anticipated that teacher practices (i.e., task orienting, behavior management, individualizing instruction, and teacher re-directs) would be associated with good reading performance depending upon the degree to which students required teacher regulation in order to profit from literacy instruction (Aaron et al., 2002). By regulating students' attention to upcoming instructional events, acceptable behaviors for maximizing learning, and manageable practice activities to support learning, teachers guide student focus, thereby structuring and enhancing learning opportunities. We found preliminary support for each of these relationships, which we will discuss in turn.

As reviewed in the introduction, the concept of controlled or selective attention (e.g., Rueda et al., 2005) may be a particularly useful construct for understanding the relations between observed attention behaviors and the impact of instructional practice for supporting beginning word reading skill development. Conceptually, selective attention is presumed to allow for "efficient and focused processing of goal-relevant stimuli, with minimal intrusions from goal-irrelevant stimuli" (Lavie, 2000, p. 175). In our factor analysis, those items that loaded most highly on the attention-memory factor (i.e., above .50) characterize this element of selective attention as one that comprises the ability to avoid careless mistakes, sustain attention, follow through on instructions and complete schoolwork, keep track of necessary items, ignore distractions, remember daily activities, and engage in goal-directed activity. Combined, they describe a cognitive-behavioral capability that is crucial for academic learning and likely to influence a student's potential to benefit from classroom instruction. Thus, although all of the teaching practices in this study are commonly thought of as "best practice" and are believed to support self-regulated learning among students (Pressley et al., 2001), we found that they may serve to support word reading skill development differently depending upon how well students can regulate their attention and memory abilities. In other words, although we found evidence consistent with the literature, these previously reported relationships held for most, but not all, students.

For example, similar to Cameron et al.'s (2008) findings that by mid-year, less teacher orienting to task was positively related to first grade reading performance, we found that less teacher task- orienting was positively related to kindergarten word reading outcomes (see Figure 1). Contrary to our expectations, however, this relationship held for all students, including those with weak attention. In addition, we found that having clearly observable classroom behavior management systems in place (and used effectively) was positively associated with better kindergarten word reading performance.

However, we found more mixed results regarding the use of individualized instruction. Consistent with the literature, “effective” individualized instruction was related to higher reading scores among students with average and above attention (Connor et al., 2009). Thus, for kindergarten students who can self-regulate their attention and sustain focus to learning goals, individualizing instruction helps to promote word reading skill acquisition. In contrast, for students rated as weak in attention-memory, high levels of individualized instruction played less of a role than teacher re-directs (see Figure 3). That is, our findings suggest that the benefits of individualized instruction are diminished if teachers do not also regulate “attention to task” behaviors (i.e., provide consistent re-directs) for students who cannot regulate this for themselves. In other words, similar to observations made by Torgesen et al. (1999), even within individualized small groups and carefully aligned- to-ability assignments, if a student cannot attend well, then s/he may not be optimally profiting from instruction.

In summary, our results revealed interactions between student attention and four specific instructional practices that impact kindergarten reading achievement, consistent with the Component Model of Reading (Aaron et al., 2008). That is, depending upon the attention and memory skills brought to bear on word reading skill learning in the classroom, these teacher practices were more or less “effective” for supporting literacy skill development. Although these results are preliminary and correlational, there are two noteworthy implications of this work that should be considered. First, our results highlight the need for student by teacher interactions to be more thoroughly examined when investigating skill development because a singular focus on either level alone inadequately captures the learning opportunities provided to students. This may be particularly important for understanding why some students struggle to respond to instruction.

Likewise, distinguishing between cognitive and ecological elements related to the acquisition of word reading skill may be a fruitful approach to examining factors underlying reading difficulty (Aaron et al., 2002, 2008). Furthermore, while the current study emphasized the teacher-to-student direction of this interaction (i.e., the relation between teacher practices and skill development), it's also quite likely that student attention behaviors impact the degree to which teachers implement particular practices. For example, when students exhibit less attentive behaviors, teachers might be inclined to orient students to task more in an effort to re-direct their focus.

Second, the role of student attention to task is a sorely understudied variable related to achievement outcomes, particularly if some elements of “best practice” are failing to support students because of cognitive overload (Schnotz & Kürschner, 2007). That is, there is a clear need to consider the effect of student attention-related behaviors along with instructional effectiveness in order to design optimal classroom learning environments. Furthermore, this potential role of attention for learning how to read is not restricted to clinical diagnoses of attention deficits as the students sampled in this study were from general education classrooms, and as a group, yielded average ratings of attentive behaviors from their kindergarten teachers. Thus, difficulties with regulating attention to support learning does not appear to be limited to students who have attention deficits, but rather a factor to consider at the beginning stages of skill acquisition among typically developing students, as well.

However, there are limitations to this investigation that also need to be considered. Clearly, a more direct examination of the relationship between self- and teacher- regulation of attention is warranted. Although we propose a role for self-regulation of attention in the development of word reading skill, our study does not address this. Future research will want to measure self-regulatory behaviors in the classroom, as well, in order to better explain the effects of instruction for student learning. In addition, data collected at more points across the year may enhance our understanding of how teacher instruction, student learning needs, and skill development change over time and in what form (linear, quadratic) such development unfolds. Furthermore, there are other variables that need to be included in the predictive model, as evidenced by the moderate amount of variance yet to be explained. Moreover, it is unclear what effect the teacher professional development may have played in making teachers more sensitive, and consequently, responsive to attention-based behaviors. This may have indirectly affected the precision with which they rated student attention, as well as how effectively they managed small groups during instruction. That is, although the role of student attention for learning was not part of the professional development provided to teachers, it is possible that this sample of teachers (because of their participation in a teacher skills training) is somewhat different from the population of teachers at large, limiting the generalizability of our findings.

Our results suggest that students' abilities to attend to relevant information, sustain focus, and resist forgetting (i.e., engage in selective attention-memory behaviors) may be an overlooked, but important, contributor to the development of word reading skills, especially among beginning readers. Furthermore, the regulation of attention is not merely a student "problem" that impacts reading achievement, but rather, may be affected by teacher practices implemented to support literacy instruction. In particular, teachers can explicitly draw students' attention to relevant elements of instruction and away from distractions to reduce the cognitive load associated with classroom learning. In addition, teachers can carefully align instruction with student ability to support manageable application and practice. Moreover, by mid-year, weaning students, or reducing the amount of task orienting, is likely to foster the emergence of students' self-regulatory behaviors, such as selective attention. Combined, these elements may contribute to goal-directed learning that is crucial for new reading skill development.

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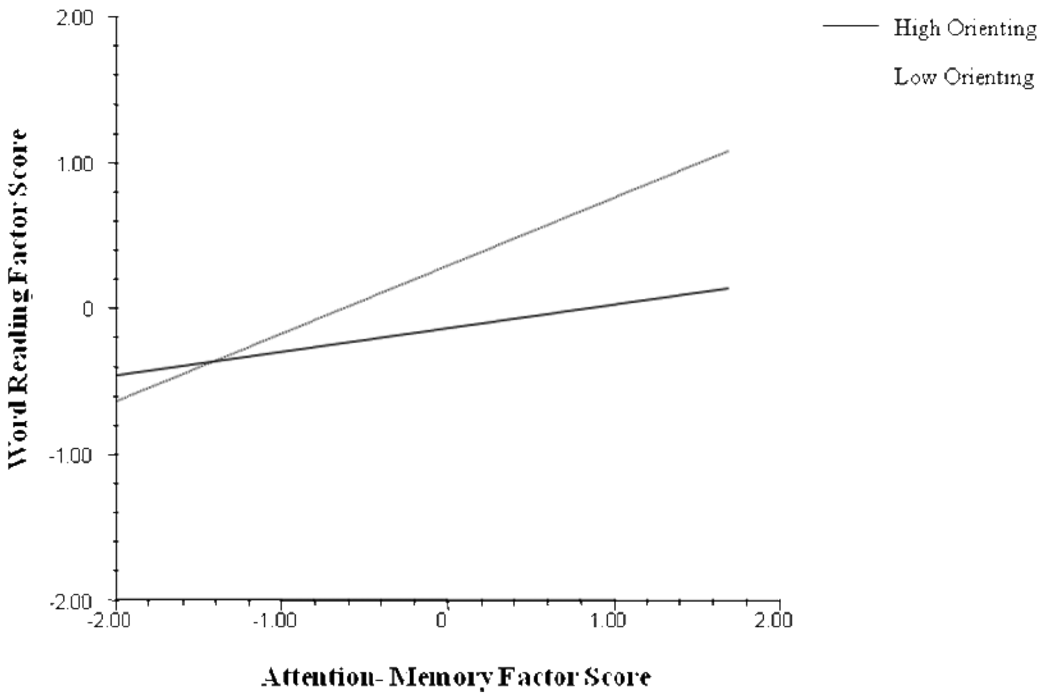

Figure 1.
Predicted word reading performance by student attention-memory factor scores and teacher task orienting practice.

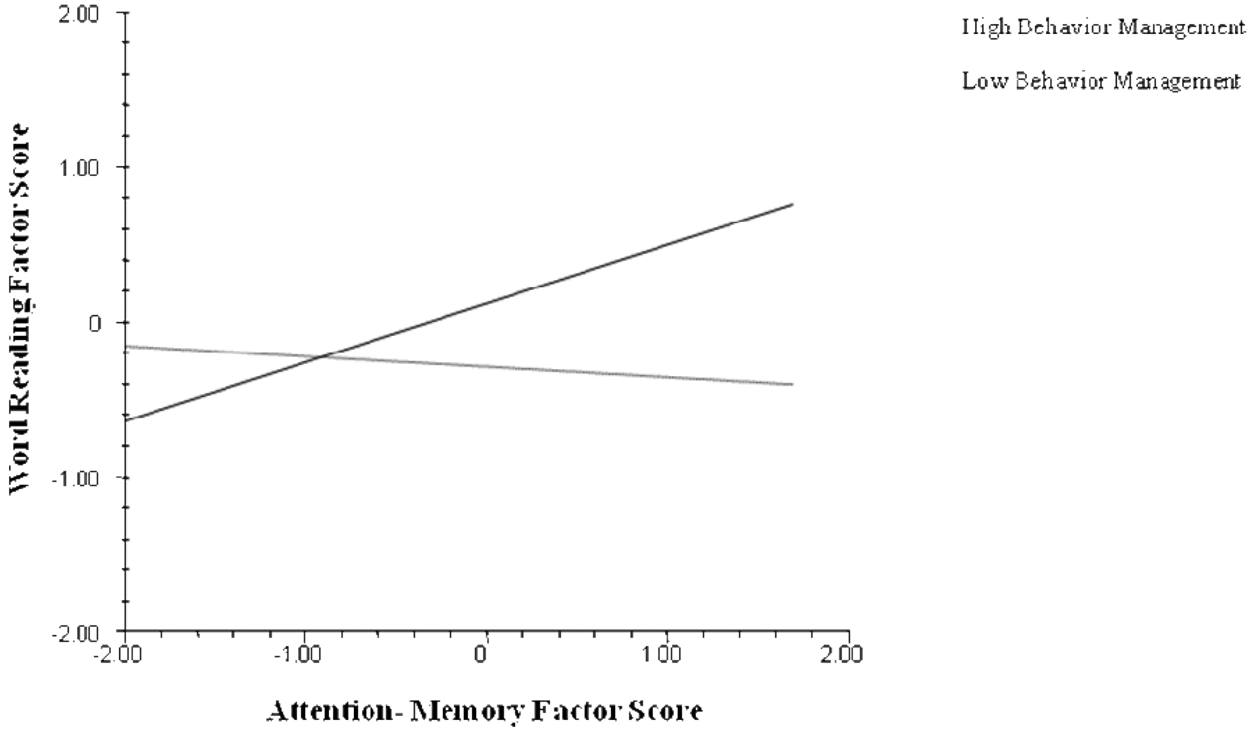

Figure 2.

Predicted word reading performance by student attention-memory factor scores and teacher use of behavior management.

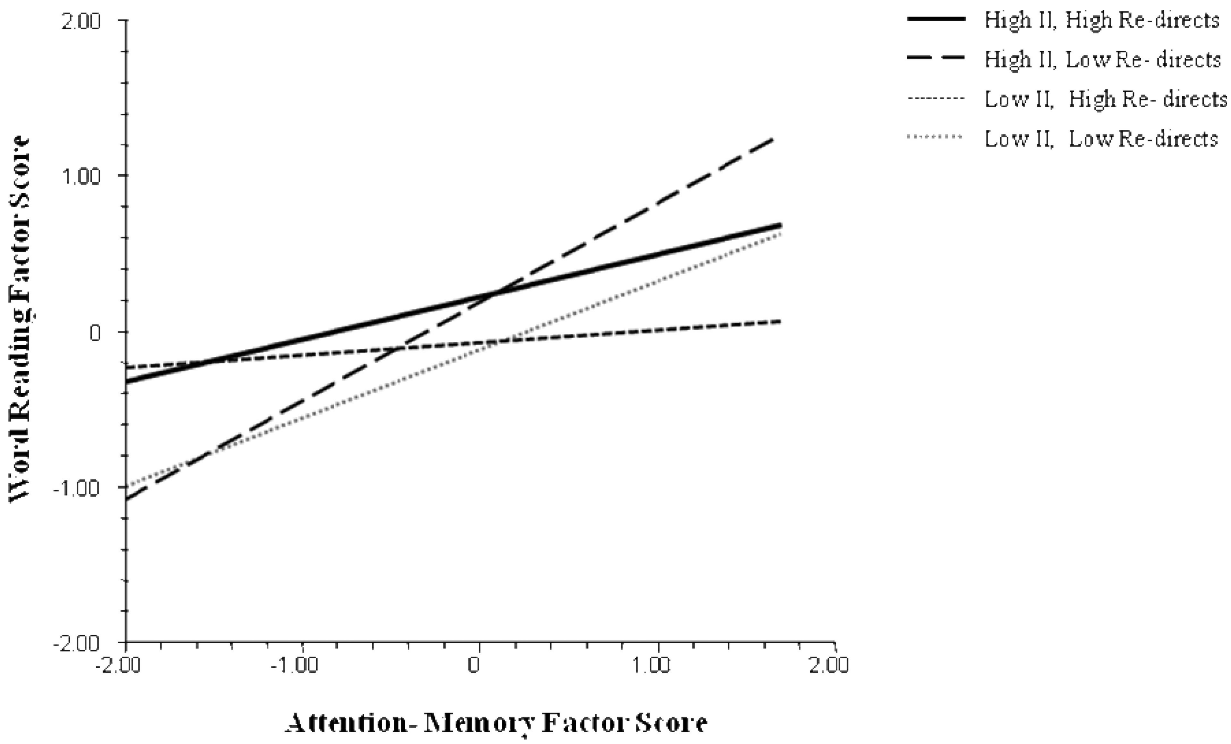

Figure 3.

Predicted word reading performance by student attention-memory factor scores, teacher use of individualized instruction (II), and task re-directions.

Table 1

SWAN Teacher Ratings Item Factor Structure

	Factor 1 Attention-Memory	Factor 2 Attention-Set Shifting	Factor 3 Attention-Inhibitory Control
1. Give close attention to detail, avoid careless mistakes	**.97**	-.09	.03
2. Sustain attention on task	**.85**	-.08	.20
3. Listen when spoken to	**.66**	.13	.20
4. Follow through on instructions & finish school work	**.94**	-.03	.04
5. Organize tasks and activities	**.91**	-.09	.13
6. Engage in tasks that require sustained mental effort	**.98**	-.04	.01
7. Keep track of things necessary for activities	**.90**	-.11	.14
8. Ignore extraneous stimuli	**.59**	.05	.37
9. Remember daily activities	**.96**	-.09	-.00
10. Sit still (control of squirming)	.18	-.02	**.81**
11. Stay seated (when required by class rules/social conventions)	.21	-.02	**.80**
12. Modulate motor activity	.21	-.01	**.77**
13. Play quietly	-.03	.15	**.84**
14. Settle down and rest	.03	.09	**.87**
15. Modulate verbal activity (i.e., control excess talking)	-.05	.22	**.81**
16. Reflect on questions (i.e., control blurting out answers)	-.01	.22	**.75**
17. Await turn	.04	.30	**.66**
18. Control interrupting/intruding	.09	.27	**.62**
19. Control temper	.03	**.93**	-.00
20. Avoid arguing with adults	-.05	**.95**	.05
21. Follow adult request/rules	.26	**.64**	.13
22. Avoid deliberately doing things that annoy others	.02	**.78**	.20
23. Assume responsibility for mistakes/misbehavior	.08	**.81**	.09
24. Ignore annoyances of others	.09	**.68**	.21
25. Control anger and resentment	-.03	**1.03**	-.05
26. Control spiteness	-.05	**1.02**	-.04
27. Avoid quarreling	-.08	**.95**	.09
28. Remain focused on task (does not daydream)	**.71**	.19	.08
29. Maintain appropriate energy level	**.86**	.31	-.28
30. Engage in goal directed activity	**.87**	.29	-.20

Note. Factor loadings >.50 are in bold.

Table 2

Raw Score Means and Standard Deviations for Attention, Achievement, and Instructional Effectiveness Variables

Variable	Mean	SD	Item Range
Student-Level Measures (*n* = 432)			
SWAN Attention Teacher Ratings[a]	4.53	1.48	0-7 (4 = average)
Blending Words[b]	9.98	4.24	0-20
Elision[b]	5.18	3.74	0-20
Phoneme Segmentation Fluency[c]	34.18	14.41	0-72
Letter Naming Fluency[c]	44.97	17.88	0-110
Letter Word Identification[d]	23.12	7.19	0-76
Sight Word Efficiency[e]	15.91	13.51	0-104
Picture Vocabulary[d]	17.81	2.93	0-44
Teacher-Level Variables (*n* = 32)			
Behavior Management System Use	2.47	.80	0-3
Individualized Instruction	1.66	.87	0-3
Task Orienting	2.34	.83	0-3
Teacher Re-directs for Off-task Behavior	2.34	.75	0-3

Note.

[a]SWAN (Swanson et al., 2006)

[b]Comprehensive Test Of Phonological Processing (Wagner et al., 199)

[c]Dynamic Indicators of Basic Early Literacy Skills (Good & Kaminski, 2002)

[d]Woodcock Johnson III (Woodcock et al., 2001)

[e]Test of Sight Word Efficiency (Torgesen et al., 1999).

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Table 3

Intercorrelations Among Attention and Achievement Factor Scores (n = 432)

	1a	1b	1c	2	3	4
1. SWAN Attention Rating						
a. Factor 1 (Attention- Memory)	---	.62	.76	.53	.50	.29
b. Factor 2 (Attention- Set Shifting)		---	.75	.30	.32	.16
c. Factor 3 (Attention- Inhibitory Control)			---	.34	.35	.19
2. Phonological Awareness				---	.65	.43
3. Word Reading					---	.42
4. Vocabulary (z-score)						---

Note. All correlations significant at p <.008.

Table 4

Fixed Effect Results of Hierarchical Linear Models Tested

Model Fixed Effect	Coefficient	Standard Error	T-Ratio	df	P-value
Intercept Only Model					
Classroom Mean Intercept (G_{00})	0.01	0.08	0.14	31	0.890
Random-Coefficients Regression Model					
Classroom Mean Intercept (G_{00})	0.02	0.06	0.31	31	0.758
Phonological Awareness Slope (G_{10})	0.45	0.04	10.64	31	0.000
Vocabulary Slope (G_{20})	0.15	0.04	3.65	31	0.001
Attention-Memory Slope (G_{30})	0.25	0.05	4.97	31	0.000
Intercepts and Slopes as Outcomes Model					
Classroom Mean Intercept (G_{00})	0.01	0.05	0.17	27	0.871
Task Orienting (G_{01})	-0.22	0.08	-2.77	27	0.011
Behavior Management (G_{02})	0.20	0.12	1.68	27	0.103
Individualizing Instruction (G_{03})	0.15	0.07	2.19	27	0.037
Teacher Redirects (G_{04})	0.02	0.12	0.18	27	0.863
Phonological Awareness Slope (G_{10})	0.42	0.04	10.70	31	0.000
Vocabulary Slope (G_{20})	0.14	0.04	3.35	31	0.002
Attention-Memory Mean Slope (G_{30})	0.26	0.04	6.64	27	0.000
Task Orienting (G_{31})	-0.15	0.04	-3.45	27	0.002
Behavior Management (G_{32})	0.22	0.05	4.17	27	0.000
Individualizing Instruction (G_{33})	0.10	0.03	2.79	27	0.010
Teacher Redirects (G_{34})	-0.18	0.07	-2.51	27	0.019