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A structural model of the effects of preschool attention on kindergarten literacy

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Abstract Factors that lead to poor achievement in literacy are evident prior to a child beginning kindergarten. In the present study, we examined the importance of including attention in a model for predicting emergent literacy in prekindergarten and subsequent reading abilities in kindergarten. The sample was 250 children attending public prekindergarten and kindergarten. Structural equation modeling was used to test our hypothesis that children's early literacy skills mediate the relationship between preschoolers' attention and kindergarten decoding abilities. Using early literacy as a mediator between early attention and later decoding provided a good model fit. Results suggest that attention was integral to the fit of the model and that attention in preschool is related to the development of early literacy skills above and beyond the contribution of maternal education to these skills. The implication of our study is that attention in early childhood should be considered an important part of literacy development.

Keywords Attention · Emergent literacy · Kindergarten · Literacy · Maternal education · Preschool

Introduction

Children's readiness for school is currently a major priority in educational research (Thompson & Raikes, 2007; Corey, 2002). There is substantial evidence that early

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literacy skills are critical for later academic achievement (Duncan et al., 2007). Differences between children's abilities in literacy remain stable from school entry through the elementary school years suggesting that detriments in early literacy have long term repercussions for reading outcomes (Juel, 1988; Pianta & McCoy, 1997). By exploring how factors in early childhood influence literacy development at school entry, professionals can work more effectively with children, deficits and problems in literacy may be able to be prevented, and policies for improving literacy outcomes can be informed.

Evidence supports the theory that problems with attention predate learning problems and that longitudinal investigations of the relationship between attention and literacy are critical for understanding how literacy develops (Arterberry, Midgett, Putnick, & Bornstein, 2007; Rabiner, Coie, & Conduct Problems Prevention Research Group, 2000; Spira, Bracken, & Fischel, 2005; Spira & Fischel, 2005; Walcott, Scheemaker, & Bielski, 2010). Research suggests that children with attention problems earlier than kindergarten may miss out on opportunities for learning in the prekindergarten classroom due to inability to attend (Blackman, Westervelt, Stevenson, & Welch, 1991). Most studies on the influence of attention on children's literacy outcomes in later elementary school focus on children with extreme attention problems (Lonigan et al., 1999; Morgan, Farkas, Tufis, & Sperling, 2008; Rabiner, Coie, and the Conduct Problems Prevention Research Group, 2000; Shaywitz & Shaywitz, 2008; Spira & Fischel, 2005).

Links between attention and literacy skills in prekindergarten and kindergarten have been recently examined in typically developing children. Lonigan, Anthony, Bloomfield, Dyer, and Samwel (1999) found that the relationship between concurrent attention and phonological and print knowledge was strong in preschool children regardless of income. Walcott et al. (2010) found that attention problems in prekindergarten predicted phonological awareness and letter knowledge one year later. Welsh, Nix, Blair, Bierman, and Nelson (2010) showed a link between a composite of executive function abilities including attention in prekindergarten and early literacy abilities in kindergarten. Dally (2006) showed evidence of a relationship between phonological processing and inattentive behavior in kindergarten on reading acquisition in second grade. These studies suggest that early attention problems may influence the acquisition of emergent literacy skills. More evidence is needed with typical populations to provide support for including attention in models predicting literacy at school entry. The present study builds on previous research with a larger sample and a more theoretically comprehensive set of emergent literacy skills than most studies use to provide evidence for the importance of including attention problems in models that predict literacy at school entry. Our interest here is in the relationship of attention problems to general emergent literacy skills.

Recent studies examining the connection between early literacy and attention have examined emergent literacy domains separately (Walcott et al., 2010; Welsh et al., 2010) but evidence suggests an interrelationship between multiple emergent literacy skills including alphabetic knowledge, phonological awareness, and receptive and expressive vocabulary (Lonigan et al., 2009; McDowell, Lonigan, & Goldstein, 2007). Both vocabulary knowledge and oral language skills are

important in learning to read (Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003; Sénéchal & LeFevre, 2002). Some research suggests that, by second grade, vocabulary is the primary determinant of reading success (Dickinson et al., 2003; Roth, Speece, & Cooper, 2002). Much research identifies early alphabetic knowledge and phonemic awareness skills as particularly helpful in preparing children to decode early texts (Shanahan & Lonigan, 2010). It has been suggested that preschool oral language and vocabulary skills operate by helping children develop sound discriminations between words that later help them learn to read (Bracken, 2005). A meta-analysis conducted by Scarborough (1998) indicated that phonological awareness, letter identification, and vocabulary in kindergarten were among the best predictors of later reading, with predictive median correlations between .38 and .52. In other studies, all three of these skills have been found to be amongst the strongest predictors of short- and long-term literacy success (Adams, 1994; Whitehurst & Lonigan, 1998). There is an emerging consensus that it may be useful to distinguish code-related from oral language skills (National Early Literacy Panel, 2009). It has been suggested that the interrelation of emergent literacy skills makes it unclear what trajectory and in what direction skills operate in a causal way to determine later reading ability (McCardle, Scarborough, & Catts, 2001; Pearson & Hiebert, 2010). Indeed, for the purposes of the current study, we believe that it may be useful to conceptualize emergent literacy as a holistic set of inter-related and inter-dependent skills learned in context. Indeed, our focus here is on how attention problems may be negatively related to emergent literacy per se.

In addition to emergent literacy skills, the importance of word decoding skills has been discussed extensively in the context of early reading achievement (Juel, 1988; Stanovich, 1985). Our model adds decoding as an outcome to build on previous studies of early childhood literacy that only examine the relationship between attention and emergent literacy domains. Early in the process of learning to read, decoding plays a more substantial role than linguistic comprehension and has been shown to predict later elementary reading skills (Juel, 1988; Lonigan et al., 2009; Stahl & Murray, 1994). There is evidence of a link between decoding and earlier alphabetic knowledge (Bond & Dykstra, 1967; Stevenson & Newman, 1986), phonological awareness (Bowey, 2005; Burgess & Lonigan, 1998; Bryant, MacLean, Bradley, & Crossland, 1990; Lonigan, Burgess, & Anthony, 2000; Plaza & Cohen, 2007; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993), and vocabulary (Nation & Snowling, 2004; Schwanenflugel & Noyes, 1996; Stahl, 1999; Storch & Whitehurst, 2002). Thus, decoding is a good measure of kindergarten reading ability and is useful for relating the current research to other studies that have used decoding as a predictor.

Theories of child development should reflect the complex nature of multiple influences on children's literacy. From a bioecological theoretical perspective, a child's literacy abilities at school entry are strongly influenced by socioeconomic status (Bowey, 1995; Bronfenbrenner, 2005; McDowell, Lonigan, & Goldstein, 2007). Maternal education has been shown to be a stronger predictor of a composite of socioeconomic status than income or welfare receipt status in low-income preschool children (Mistry, Biesanz, Chien, Howes, & Benner, 2008). Research has provided evidence of a link between the education level of caregivers and school-

age children's reading abilities (Leppanen et al., 2008). A link has also been shown between maternal education and emergent literacy skills in preschool and first grade (Cadima, McWilliam, & Leal, 2010; Curenton & Justice, 2008). Evidence supports the theory that it is a lack of early experiences with print that accounts for differences in reading at school entry (Sénéchal, LeFevre, Thomas, & Daley, 1998; Smith & Dixon, 1995) and that maternal education is directly related to children's early experiences with print (Skibbe, Justice, Zucker, & McGinty, 2008). Given the well-established relationship between maternal education and literacy, effects on kindergarten decoding that exist in addition to maternal education would be an important addition to a model for predicting early literacy.

In the present study, we examined the influence of attention in prekindergarten on kindergarten decoding abilities. Specifically, we were interested in showing the importance of including attention in a model for predicting emergent literacy in prekindergarten and subsequent reading abilities in kindergarten. The major question that guided our analyses was the following: Does prekindergarteners' attention significantly contribute to emergent literacy abilities and later reading abilities? We hypothesized that children's emergent literacy skills mediate the relationship between preschoolers' attention and kindergarten decoding abilities over and above variance contributed by maternal education.

Methods

Sample

Participants were 250 children attending public, lottery-funded prekindergarten in 26 classrooms in 18 schools from three urban and metropolitan counties in northeast Georgia. The children were a subset of a federally funded study named PAVEd for Success (Schwanenflugel et al., 2010). The subset for the present study was selected from a sample of 339 children to include all native English-speaking children who participated in the study from preschool to kindergarten and whose mother reported education level. The resulting sample size was 250 with an age range from 4.00 to 4.99 years ($M = 4.5$, SD = .29) at the beginning of prekindergarten. See Schwanenflugel et al. (2010) for detailed sampling procedures. To examine differences between children included in our sample and those not included, we conducted independent samples t-tests for each of the variables in our study and none were significant.

Demographic information was gathered from forms parents filled out for the purposes of school registration. Of the sample of 250, 39% received free or reduced school lunch and 49% were female. Nineteen percent of parents did not report ethnicity. Independent samples *t* tests showed no differences on the study variables for children whose parents did and did not report ethnicity. Of those reporting, 65% identified themselves as African-American, 32% Caucasian, and 3% identified themselves as Hispanic, Asian, or Bi-racial. The question about maternal education was open-ended and asked "What is the last grade that you completed in school?" Responses were coded for this study, with 3% completing middle school, 13% some

high school, 54% completing high school, 12% some college, 12% Bachelors degree, and 6% Masters degree or higher.

Procedures

Children were assessed within a month of pre-kindergarten entry (Time 1) and over a year later, within a month of the end of their kindergarten year (Time 2). Assessments occurred within the first month of school in prekindergarten because it is considered influential in the early literacy factors of interest (Dickinson et al., 2003). Informed consent was obtained from parents at school registration and verbal assent was obtained from the children on the day of testing. Assenting children were taken from their classroom and administered the test in a quiet area at their school. Each of the four assessments took approximately 15–20 min to administer. Children were assessed over two days, counterbalancing the order of the assessments across children. Children were provided with stickers upon completing each test and with children's books for their participation in the study.

Children were tested individually following a standardized test protocol. The order of the tests was counterbalanced except that the PPVT always immediately preceded the EVT, as per the manual (Dunn & Dunn, 1997). Assessments were conducted by 18 undergraduate and graduate students with prior experience in child assessment or instruction. Testers were trained on each instrument, practiced delivery of the measures under the supervision of experienced child assessors, and were later assessed for knowledge of the measures. A random sample of children was assessed on the measures by two different assessors to ensure reliability across administration. Standard scores on child measures administered by both assessors were compared and found to be fully consistent.

Assessment of attention

Attention was measured using the attention problems dimension of an experimental short form (Yanosky, 2005; Yanosky, Kamphaus, & Schwanenflugel, 2011) of the Teacher Rating Scale—Preschool of the Behavioral Assessment System for Children (TRS-P BASC, Reynolds & Kamphaus, 1992). The BASC is one of the most widely used assessments of behaviors in young children (Graziano, Reavis, Keane, & Calkins, 2007; Naar-King, Ellis, & Frey, 2004) that includes a teacher rating, a parent rating, and student observer ratings of behaviors at home and in the classroom. It has been shown to be reliable, with internal consistency of the teacher rating scale between the low .70 s to high .80 s in multiple nationally normed samples (Reynolds & Kamphaus, 1992). Teacher ratings of children's attention and behavior are commonly used to screen children for problems in public schools because teachers have experience and context within which to rate children most validly. Research suggests that teacher ratings are promising for identifying a variety of child adjustment problems (Lochman, 1995; Taylor, Anselmo, Foreman, Schatschneider, & Angelopoulos, 2000). There is evidence that teachers are more temporally stable than parents in rating children's externalizing behaviors and attention problems (Merydith, 2001). Studies of the psychometric properties of the

BASC led to a revised version (Reynolds & Kamphaus, 2004). At the time the data for the present study were collected, the BASC was widely presented as the measure of behavior in childhood in handbooks for educators and clinicians and was so widely used in the field of educational psychology that its face and content validity were treated as the standard against which other tests of attention were judged (Flanagan, Alfonso, Primavera, Povall, & Higgins, 1996; Naar-King, Ellis, & Frey, 2004; Oehler-Stinnett, & Boykin, 2001; Ostrander, Weinfurt, Yarnold, & August, 1998). As a measure of attention, the BASC provides a global measure that is grounded in dimensions identified by developmental psychologists as part of an executive attention system (Reynolds & Kamphaus, 1992).

For this study, we used an experimental short form of the BASC Teacher Rating Scale- Preschool (TRS-P, Reynolds & Kamphaus, 1992) called the BASC Screener (Yanosky, 2005; Yanosky et al., 2011). The full TRS-P of the BASC is a 109-item 4-point Likert-type scale asking teachers to estimate the frequency of a child's behaviors. The BASC Screener includes 25 items and was developed to reduce the amount of teacher time needed to assess children in the classroom (Yanosky, 2005; Yanosky et al., 2011). An exploratory factor analysis of a nationally normed sample strongly suggests the existence of 3 factors: poor social skills with peers, attention deficits, and affective deficits (DiStefano & Kamphaus, 2007), and a similar structure was found in the larger sample of the current data, $n = 339$ (Yanosky, 2005; Yanosky et al., 2011). Only the items loading on the attention deficits factor have been included for the current study, and they address issues of attention shifting, attention span, concentration, listening attentively, listening to directions, and distraction. Higher scores on the attention problems subscale of the BASC Screener indicate greater problems with attention. An internal consistency reliability statistic for the 6-item subscale was promising for the effective sample of children in the current study, $\alpha = .934$. Split-half reliability was also high, $\alpha = .842$. Teachers completed the BASC Screener (Yanosky, 2005; Yanosky et al., 2011) for each child within a few weeks of the child's emergent literacy assessments in the fall of their prekindergarten year. Ratings were provided by 26 teachers on 250 children. To test whether the assumption of independent observations was violated, we calculated a two-way random effects intraclass correlation, ICC = .01, as suggested by Shrout and Fleiss (1979). This low ICC suggests that the data do not violate the assumption of independence required for accurate analysis.

Assessment of emergent literacy skills

Alphabetic knowledge includes recognizing letter shape, name, and sound (Juel, 1991). Alphabetic knowledge was measured through an experimenter-developed alphabetic knowledge test. All 26 uppercase and 26 lowercase letters were presented in random order on a single large sheet of cardstock. Children were asked to produce letter names and sounds for upper and lower case letters. The experimenter pointed to each letter sequentially and asked, "What's this letter?" If the children named the letter, they were asked, "What sound does it make?" If they made the sound first, they were asked, "What's the letter called?" Items were dichotomously scored for both name and sound knowledge. Letters tested in random order are as

successful as many readiness tests accounting for up to one third of the variance in reading in grades one through three (Snow et al., 1999). Cronbach's alpha reliability using the sample for the present study for upper and lower case letter name and sound knowledge scores was .81.

Phonological awareness is defined as the awareness of, and ability to manipulate the phonological segments in words at the phoneme, syllable, and rime level (Blackman, Westervelt, Stevenson, & Welch, 1991; Treiman & Zukowski, 1991). Phonological awareness was measured by a subset of items from the Phonological Awareness Test (PAT, Robertson & Salter, 1997). The PAT is designed to diagnose deficits in phonological processing and phoneme-grapheme correspondence for children ages 5 to 9. The subset included four tasks that are considered potentially significant predictors of reading ability (Bryant, MacLean, Bradley, & Crossland, 1990). Each task contained 10 items, each scored dichotomously. The four tasks administered were rhyme discrimination, syllable segmentation, initial phoneme isolation, and phoneme blending. Modifications were necessary to accommodate the younger population of this study. Accommodations included the inclusion of three practice trials for each task with feedback, and discontinue rules that ended a particular task if the child got all practice trials incorrect or if he or she missed three items in a row during a task. A Cronbach's alpha value of .71 for the sample for the present study on the 4 subscale total scores suggests sufficient internal consistency of this measure. Webb, Schwanenflugel, and Kim (2004) reported subscale Cronbach's alpha internal reliability estimates at prekindergarten entry of .92 on rhyme discrimination, .87 on syllable segmentation, .98 on initial phoneme isolation, and .87 on phoneme blending and convincing evidence of construct validity using Messick's (1989) theoretical unity construct validity framework.

Receptive vocabulary was assessed using the Peabody Picture Vocabulary Test-III (PPVT-III, Dunn & Dunn, 1997). The developers of the PPVT-III report a Cronbach's alpha of .95, test–retest value of .91 to .94. The measure has high correlations with other vocabulary scales, $r = .69–.91$ (Dunn & Dunn, 1997), suggesting high convergent validity and is used in large-scale federally funded preschool research projects, such as the Family and Child Experience Study (FACES, U.S. Department of Health and Human Services, 2003), Even Start (U.S. Department of Education, 2004), and The Early Childhood Longitudinal Study (National Center for Education Statistics, 1999, 2001).

The Expressive Vocabulary Test (EVT, Williams, 1997) was administered to evaluate children's expressive vocabulary knowledge. This test was chosen because it has high reliability scores, internal consistency with Cronbach's alpha values ranging from .90 to .98, and test–retest from .77 to .90. The EVT was co-normed with the PPVT-III and has fairly high correlations (ranging from .57 to .86) with oral language assessments, supporting its validity (Williams, 1997).

Assessment of kindergarten reading ability

Kindergarten reading ability was assessed using The Early Decoding Test, which is an experimenter-constructed brief assessment designed to identify early readers (Schwanenflugel et al., 2010). There are no existing quick assessments of decoding

for American English-speaking children. For the Early Decoding Test, children were asked to identify 15 words and were given partial scoring (1 if the child did not read the word, or made up a word sharing none of the phonemes, or said single letter sounds without blending any of them; 2 if the child said a word that shared at least one of the phonemes of the target word or blended several sounds from the target word; and 3 if the child read the word as written). The maximum score was 30. Details of this assessment are described in Schwanenflugel et al. (2010). The warm-up item was a card with the child's name and the following 15 word cards included five consonant–vowel-consonant phonologically regular words (considered easiest), five sight words from a list of the 300 most common words used in children's books (Fry, Kress, & Fountoukidis, 2000) that had irregular spelling-sound correspondences, and five words requiring higher order phonics with simple consonant blends and digraphs. An internal consistency analysis showed this measure to be highly reliable with a Cronbach's alpha of .93 for the sample of the present study.

Results

Descriptives

A DeCarlo macro was used to test for multivariate outliers, and only one data point exceeded the Bonferonni critical value for a multivariate outlier of 39.12 ($F = .01/n$, $df = 12,237$) with a value of 50.76. We decided to include this case, which reflected a child with low literacy skills and very positive attention ratings. Because structural equation modeling was used to test our models, a covariance matrix was generated by PRELIS Version 2.52 (Jöreskog & Sörbom, 1996). None of the variables showed any problems with univariate nonnormality, skew values were well below |3.0|, and kurtosis values below |8.0|, cutoff values suggested by Kline (2005). The PRELIS value for relative multivariate kurtosis was 1.152, which is well below the cutoff of |2| recommended by Kline (2005). This suggests that these data are univariately and multivariately normally distributed with adequate kurtosis for structural equation modeling.

Correlations among all variables were computed to assess the relationships between variables. See Table 1 for a full correlation matrix and Table 2 for means and standard deviations for all study variables. All study variables were correlated in the expected direction, providing support for further model analyses. Alpha was set at .05, and the majority of study variables were related at the .001 level. As expected, attention problem items in prekindergarten were highly inter-correlated, ranging from $r = .67$ to $r = .85$, and emergent literacy dimensions in prekindergarten were moderately inter-correlated, ranging from $r = .46$ to $r = .64$. This provides evidence to support their use as indicators of latent variables in the subsequent latent-factor path analysis.

As expected, maternal education was moderately correlated with emergent literacy dimensions, ranging from $r = .40$ and $r = .49$. Maternal education was modestly related to attention problems, correlations ranging between $r = -.16$ and $r = -.27$, providing evidence for including both variables in the model. Emergent

Table 1 Correlations of study variables

		1	2	3	4	5	6	7	8	9	10	11
Prekindergarten												
1	Maternal education											
2	Alphabetic knowledge	.43***										
3	Phonological awareness	.44***	.49***									
4	Receptive vocabulary	.49***	.46***	.49***								
5	Expressive vocabulary	.40***	.50***	.64***	.49***							
6	Attention item 1	−.26***	−.31***	−.27***	−.30***	−.31***						
7	Attention item 2	−.27***	−.29***	−.23***	−.25***	−.31***	.84***					
8	Attention item 3	−.26***	−.24***	−.21***	−.23***	−.27***	.68***	.76***				
9	Attention item 4	−.22***	−.27***	−.20**	−.23***	−.29***	.85***	.85***	.67***			
10	Attention item 5	−.17**	−.20**	−.12	−.15*	−.22***	.65***	.62***	.58***	.65***		
11	Attention item 6	−.16*	−.24***	−.24***	−.24***	−.30***	.69***	.66***	.58***	.70***	.73***	
Kindergarten												
12	Decoding	.36***	.62***	.41***	.51***	.44***	−.30***	−.27***	−.29**	−.27***	−.24***	−.30***

*** Correlation is significant at the .001 level (2-tailed)

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)

Table 2 Means, standard deviations, and ranges of study variables

	M	SD	Min	Max
Prekindergarten				
Alphabetic knowledge	10.57	14.782	0	51
Phonological awareness	7.30	7.888	0	38
Receptive vocabulary	90.00	16.671	48	131
Expressive vocabulary	96.56	12.574	55	132
Attention item 1	1.99	.916	1	4
Attention item 2	1.88	.867	1	4
Attention item 3	1.68	.803	1	4
Attention item 4	2.04	.954	1	4
Attention item 5	2.02	.864	1	4
Attention item 6	2.21	.900	1	4
Kindergarten				
Decoding	22.02	7.881	15	45

literacy dimensions were, as expected, negatively related to attention, with the exception of the relationship between one attention item and receptive vocabulary, which showed a weak correlation that approached significance, $r = -.12$, $p = .06$. This attention item was about attentive listening, which may require further examination in future studies.

Analyses

All analyses, including a Confirmatory Factor Analysis (CFA) and full structural analysis were conducted using LISREL 8.52 (Jöreskog & Sörbom, 1993). We used this modeling rather than regression to assess the measurement issues as well as simultaneously solving the multiple regression equations. The estimation method used was maximum-likelihood, which is sensitive to misspecifications in samples of this size (Olsson, Foss, Troye, & Howell, 2000).

We hypothesized that children's emergent literacy skills mediate the relationship between preschoolers' attention and kindergarten decoding abilities over and above variance contributed by maternal education. We ran three models, each nested. The first model was a measurement model, which allowed for examination of interrelationships between the items and scores used in the full structural model. It also provided a baseline against which to judge the full structural model. This allowed an examination of the measurement aspects that were not confounded by error but were due to misspecification of the latent variables. We used the measurement model to examine how well the emergent literacy dimensions measured the latent factor of emergent literacy and how well the attention items from the BASC Screener measured a latent factor of attention.

In path models, a model is said to be identified if it is theoretically possible to derive a unique estimate of each parameter (Kline, 2005). Our model was identified using a two-step process (Anderson & Gerbing, 1988; Bollen, 1989). The confirmatory measurement model included no structural paths. Identification was

Table 3 Fit indices

Model	*df*	SRMR	NNFI	CFI	$\Delta\chi^2$	Δdf
1. Measurement model	50	.042	.96	.97	–	–
2. Full Structural model	52	.044	.96	.97	3.12	2
3. Attention path set to 0	53	.096	.95	.96	18.58	1

established with *df* of 50. In the second step, all latent variables were considered observed and part of structural relationships. The structural model was recursive, with no feedback loops, which was a sufficient condition for identification. All three models were sufficiently identified according to recommendations by Kline (2005).

Examining model fit is useful for determining whether data support a proposed theoretical model (Kline, 2005). To examine the influence of attention on literacy we examined the fit of a full structural model to the data. This model included paths from attention to emergent literacy, maternal education to emergent literacy and emergent literacy to decoding. Theoretically, emergent literacy was treated as a mediator between prekindergarten attention and kindergarten decoding. Overall, the fit indices of the measurement model showed adequate fit. See Table 3 for the results of the fit analyses. Based on recommendations of the selection of fit indices put forth by Kline (2005) and Hu and Bentler (1998) for our sample size, we evaluated the fit of each model using multiple indices, including the Standardized Root Mean Square Residual (SRMR), the Non-Normed Fit Index (NNFI), and the Comparative Fit Index (CFI). These indices were chosen due to the fact that they take three different perspectives on assessing model fit. The SRMR is a standalone fit index and assesses how well the model reproduces the sample matrix. It is particularly sensitive to model misspecification. The NNFI is an incremental fit index that compares the model to the target model including the degrees of freedom in the equation. The CFI is another incremental fit index that evaluates fit by comparing the model to the fit of a null model. The use of these three indices complement one another well when interpreting a model's overall fit to the observed data. Using both Kline (2005) and Hu and Bentler's (1999) guidelines for evaluating overall model fit, an SRMR $< .08$, an NNFI $> .95$, and a CFI $> .95$ indicated an adequate model fit to the observed data. These analyses provide evidence that our theoretical model fit the data well. That is, attention and maternal education in prekindergarten predict kindergarten decoding, with prekindergarden emergent literacy as a mediator. See Fig. 1 for the full structural model with path coefficients.

Removing a variable of interest from the model and reexamining the fit of the theoretical model to the data is one way to examine the influence of a variable on a model. We, therefore, tested a third model with the path from attention to literacy set to zero. By comparing this third model with the full structural model, we examined the role of attention in maximizing the fit of the model. The most dramatic difference was in the SRMR index in which the value increased significantly, resulting in an unacceptably high value. The NNFI and CFI values dropped by very small amounts but the χ^2 difference test between the two models was significant, $\chi^2 = 18.58$, $df = 1$, $p < .05$. The significance of this difference

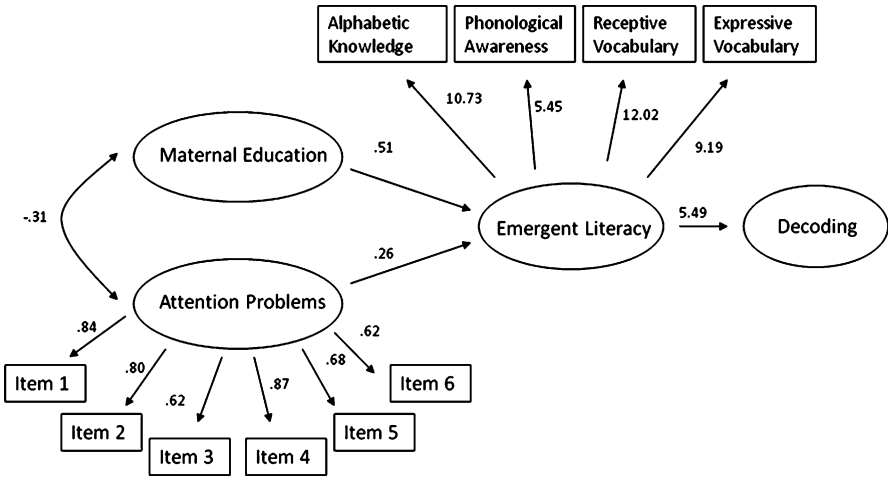

Fig. 1 The full structural model

suggests that individual differences in attention at school entry are related to the development of early literacy skills above and beyond the contribution that maternal education has on the development of these skills.

Discussion

Our basic question in this research was to determine whether children's attention problems as measured by teachers are related to the development of emergent literacy skills and subsequent early reading skills. In a diverse sample of children, we found attention to be related to decoding, with emergent literacy as a mediating variable. Because indicators of socioeconomic status, like maternal education, are such strong predictors of literacy at school entry, relationships found between attention and literacy are conceptually significant. Our study found that attention in preschool is related to the development of early literacy skills above and beyond the contribution of maternal education to these skills.

We also found that attention was integral to this model. That is, a model including attention provided a better account of the data compared to a model without. The results of our study suggest that attention influences the development of emergent literacy in preschoolers, which has an impact on the development of early reading abilities. Children who have poor attention skills may have delayed emergent literacy skills which, in turn, delaythe process of developing early decoding skills by the end of kindergarten. By contrast, children with good attention skills are able to develop good emergent literacy skills, which allows them to develop decoding skills early. Given the stability of decoding skills across early elementary school (Juel, 1988), it is likely that children who show an early ability to decode words will continue to develop those skills, and will be less likely to develop reading problems later.

These findings are consistent with previous studies that show a relationship between attention and literacy in early childhood (Walcott et al., 2010; Welsh et al., 2010). Our study validates models from previous studies by showing that emergent literacy mediates the relationship between early attention and later reading abilities and by using different instruments to measure similar constructs. It also refines the theoretical model of attention's relationship to early literacy.

Future studies should examine the relationship between attention in prekindergarten and attention in kindergarten. We believe that emergent literacy skills are foundational to later decoding skills and that examining a direct relationship between attention in prekindergarten on kindergarten decoding may not be meaningful. With two academic years of school in between data collection times we think there is no theoretical basis for examining direct effects of attention problems at the beginning of prekindergarten on end of year kindergarten reading ability when early literacy skills are taken out of the model. We think that a concurrent measure of attention at kindergarten *would* be meaningful and interesting, but our data collection did not include such a measure. Our study builds on another study by Welsh et al. (2010) that found a relationship between attention in prekindergarten and emergent literacy skills in kindergarten. That study also found that literacy in prekindergarten does not predict attention in kindergarten suggesting that prekindergarten attention and kindergarten attention may be different and that the development of emergent literacy skills in prekindergarten is influenced by concurrent attention. This supports a developmental model of literacy in which children's attention influences a developmental trajectory of emergent literacy skills and subsequent decoding abilities.

Our study also provides support for a latent factor of emergent literacy including alphabetic awareness, phonological awareness, and expressive and receptive vocabulary. Modification indices, which estimate the amount that model fit would improve (Kline, 2005), indicate that a path from alphabetic knowledge to decoding and a path from receptive vocabulary to decoding would improve the model fit. This is consistent with previous research on alphabetic knowledge being a strong predictor of reading skills (Leppanen et al., 2008) and vocabulary being at least somewhat associated with decoding (Nation & Snowling, 2004; Schwanenflugel & Noyes, 1996; Stahl, 1999; Storch & Whitehurst, 2002). However, these modification indices should be interpreted with caution as they are based on a traditional χ^2 fit index that statisticians have begun to not recommend be used for model fit determination. It lacks power and may not discriminate between good fitting models and poor fitting models (Kenny & McCoach, 2003). Although we identified a single-factor in our depiction of emergent literacy as a good fit for the present data, we understand that our sampling of skills in this emergent literacy construct did not all include all of the potentially relevant emergent literacy skills that we might have sampled in these prekindergarteners (such as alphabet fluency, working memory, emergent spelling, rapid naming, mean length of utterance, environmental print knowledge, etc.). It might be that if we had included skills beyond the four skills that we did sample, we might have found that a more complex conceptualization of emergent literacy would have been needed. On the other hand, we note that our

model fit was a good one, even though we only included a single factor emergent literacy construct.

In addition to addressing the specific aims of this study, we also provided validation for evidence of a latent factor of attention using items from a short form version of the BASC (Yanosky, 2005; Yanosky et al., 2011). This result provides evidence for the attention dimension of the BASC Screener as a unified measure of attention. By finding a relationship between attention problems and emergent literacy, we show that it is important for teachers to screen for the potential presence of attention problems to prevent possible influence on later literacy.

Our conclusions must also be considered in light of its limitations. Our analyses do not allow us to rule out the possibility that attention helps children perform better on the assessments themselves instead of contributing to the development of the skills measured by the literacy assessments. But because these measures are psychometrically strong, they can be considered measures of generally good construct validity. In addition, there are potential validity issues related to the brief measures we used. Only two of the variables in our theoretical model were latent factors, which may reduce the appeal of the path model. We used a latent factor for attention based on the outcomes of previous studies (DiStefano & Kamphaus, 2007), Yanosky, 2005; Yanosky et al., 2011) and emergent literacy as a latent factor because we were interested in the generalized contribution of emergent literacy in prekindergarten to kindergarten literacy. Although a latent dependent variable may improve the theoretical specification of the model, decoding was the outcome of interest and has been shown to be a good indicator of reading ability in kindergarten. The adapted phonemic awareness test has not yet been nationally normed, nor standardized, although we do have evidence of its validity and reliability (Webb et al., 2004). The brief experimental decoding test and alphabetic knowledge assessment has unclear validity but the current study suggests that they operate in ways that one might expect theoretically, suggesting convergent validity. In addition, this study used a short form of the BASC, which is still in the process of being normed, standardized, and validated as a screener. Although we used only 6 items to measure attention, the measure had good internal consistency, and these items were highly connected to the overall measure of attention (Yanosky, 2005; Yanosky et al., 2011). We should note that all of our measures have shown acceptable reliability coefficients and the larger instruments from which the BASC items and phonological awareness tasks were selected have all shown excellent validity and reliability characteristics themselves.

The implication of our study is that attention in early childhood should be considered an important part of literacy development. Educational policy and interventions should acknowledge the importance of children's attention skills in addition to the typical three pillared approach to early literacy (alphabetic knowledge, phonological awareness, and vocabulary). If attention problems and skill development are so intertwined, perhaps the early childhood education field needs to better understand how to support attention development or at least understand how important attention is in the development of skills. How to include attention in models for intervention for developing children should become an objective of early childhood education. There is a lack of information for early childhood educators on how attention develops, how it affects learning, and how to

support attention development in classroom. Future research should continue to explore the contribution of attention problems to the development of other skills in early childhood.

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