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Relative Contributions of Pre-Kindergarten and Kindergarten to Children's Literacy and Mathematics Skills

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Abstract

A difficulty for developmental researchers is disambiguating children's general maturation from the influence of schooling. In this study, we use a natural experiment to examine the influence of pre-kindergarten and kindergarten schooling experiences on the development of literacy and mathematics. Children ($n = 60$) whose birthdates fell within two months of the state-determined cut-off date for pre-kindergarten and kindergarten entry were administered four subtests of the Woodcock-Johnson Tests of Achievement III in the fall and spring of the school year. Using hierarchical linear modeling coupled with propensity score matching, children who were starting kindergarten, and who had prior experience in pre-kindergarten, had higher scores on measures of phonological awareness, early reading, and mathematics skills than did children who had not attended pre-kindergarten previously, even though they were essentially the same age. Fall vocabulary scores did not differ in relation to whether children had pre-kindergarten experience. In addition, although children who attended kindergarten as well as those who attended pre-kindergarten exhibited growth on all measures during the school year, children who attended kindergarten demonstrated greater gains in early reading and vocabulary during the school year. These findings highlight the potential of early schooling processes to facilitate children's intellectual growth.

Keywords

schooling; cutoff; literacy; mathematics; development

Recently, there has been increased investigation of children's academic development during the preschool and kindergarten years (Justice, Bowles, Pence Turnbull, & Skibbe, 2009; Rimm-Kaufman & Pianta, 2000; Stipek, 2006). This focus on early learning is in part due to legislation associated with *No Child Left Behind*, which specifies that schools should provide all children with high-quality educational experiences (U.S. Department of Education, 2001). Notably, there is substantial variability in children's early cognitive development (e.g., Hart & Risley, 1995), and individual differences in language, literacy, and mathematics skills predict how successful children will be later in their schooling careers (Cunningham & Stanovich, 1997; Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998; Skibbe, Grimm, Stanton-Chapman, Justice, Pence, & Bowles, 2008). As one example, children's skills at the end of preschool predict first-grade achievement in literacy, mathematics, and phoneme knowledge (Downer & Pianta, 2006). Thus, providing effective early learning experiences is a key strategy for promoting all children's long-term academic achievement and meeting the goals that NCLB has set forth.

Multiple forces, including parental beliefs and practices (Bennett, Weigel, & Martin, 2002; Sénéchal, 2006; Skibbe, Justice, Zucker, & McGinty, 2008), sociocultural factors (e.g., Schleppenbach, Perry, Miller, Sims, & Fang, 2007), and child characteristics (e.g., McClelland, Cameron, Connor, Farris, Jewkes, & Morrison, 2007) contribute to children's academic skills in the first years of school. Yet, over and above the effects of these child, family, and community factors, children's schooling experiences in pre-kindergarten and kindergarten (Gormley, Gayer, Phillips, & Dawson, 2005; Magnuson, Ruhm, & Waldfogel, 2007; NICHD Early Child Care Research Network, 2005a) are uniquely linked to their learning (e.g., Crone & Whitehurst, 1999; Morrison, Alberts, & Griffith, 1997; Skibbe, Connor, Morrison, & Jewkes, 2011). Indeed, a cost-benefit analysis of several preschool programs indicated that these educational opportunities can positively affect children's cognitive skills, even when programs are heterogeneous in quality and implemented by teachers rather than researchers (Karoly, Kilburn, Bigelow, Caulkins, & Cannon, 2001; Wong, Cook, Barnett, & Jung, 2008).

Despite the recognition that early childhood education is important, teachers report that numerous students do not have the prerequisite behavioral and academic skills needed to succeed in kindergarten (Rimm-Kaufman, Pianta, & Cox, 2000). Because early individual differences in some academic areas, such as literacy, remain fairly stable over time, it is often difficult for young children to catch up once they fall behind (Morris, Bloodgood, & Perney, 2003; Scarborough, 1998; Storch & Whitehurst, 2002). To better prepare children for kindergarten, many school districts have begun to replace the second year of preschool (when children are four years old) with a structured pre-kindergarten class designed to support the academic and social skills needed in kindergarten. Thus, in this article, we use the term preschool to refer to socially-oriented programs for three-year-olds whereas the term pre-kindergarten is used to reflect the more structured, academic programs designed for four-year-olds. In particular, pre-kindergarten has been advocated as a proactive means of leveling the playing field for children at-risk for underachievement in kindergarten (Lee & Burkam, 2002; Reynolds, 1995).

Nevertheless, little is known about the unique effects of pre-kindergarten on children's learning, relative to what children experience in preschool and kindergarten. It is plausible that pre-kindergarten would engender the same rate of learning as kindergarten, perhaps because teachers in both settings deliver similar amounts of academic instruction. Alternatively, pre-kindergarten might result in even greater learning among children, as the readiness-related mission of the program could encourage teachers to spend a great deal of time on academic skills. Finally, pre-kindergarten might support less growth than kindergarten, with teachers providing less academic instruction than kindergarten teachers (but perhaps still more than preschool teachers would). As the number of school districts employing pre-kindergarten classrooms expands, it is important to understand the effects of this experience. At the same time, rates of growth will be largely influenced by children's increasing maturation and thus pre-kindergarten instructional experiences may not be a primary force behind gains in cognitive skills. The current study examines the relative contributions of pre-kindergarten and kindergarten on young children's literacy and mathematics development.

The present study examined children's literacy and mathematics development at the start of, and throughout, pre-kindergarten and kindergarten using the school cutoff method (e.g., Bisanz, Morrison, & Dunn, 1995; Morrison, Griffith, & Frazier, 1996; Skibbe et al., 2011). As part of the school cutoff design, we observed children born within two months on either side of the arbitrary date set for entering kindergarten, permitting examination of how different schooling experiences relate to rates of academic growth while effectively controlling for age and maturational effects. Children were tested at two points in time

during the school year: fall and spring. Scores in the fall reflect the collective effect of children's school experiences the year before enrollment into the current study (that is, during preschool or pre-kindergarten, depending on whether children were in the older or younger half of the cutoff sample). When fall scores are accounted for, scores in the spring represent changes in academic skills that occur during the observed school year (that is, during pre-kindergarten or kindergarten). By comparing the changes over time exhibited by two groups of children almost identical in age, but in two different academic environments, we can directly examine the extent to which growth is due to age-related or schooling-related processes. This technique has been used successfully to demonstrate how schooling relates to differential growth in kindergarten and first grade for short-term memory (Morrison, Smith, & Dow-Ehrensberger, 1995), aspects of narrative recall (Varnhagen, Morrison, & Overall, 1994), general mathematics skills (Bisanz et al., 1995), and metalinguistic knowledge (Ferreira & Morrison, 1994). With the exception of one study (Skibbe et al., 2011), the school cutoff technique has not been used to examine how children's experiences before kindergarten relate to their skill development. In contrast to the current work, Skibbe and colleagues (2011) focused on how the number of years children spent in preschool related to differential literacy and language growth within preschool and made no efforts to examine children during the transition into kindergarten. In addition, unlike the current study, they included no information about the instruction occurring within the classroom, limiting the ability to explain observed differences related to time spent in school.

The current study examined four areas of academic development for possible schooling effects in pre-kindergarten and kindergarten: phonological awareness, early reading skills, vocabulary, and mathematics. Phonological awareness represents children's proficiency in analyzing the sound structure of language. This skill is related to children's success at conventional reading and writing (Catts, Fey, Zhang, & Tomblin, 2001; Cunningham & Stanovich, 1993; Scarborough, 1998; Storch & Whitehurst, 2002), suggesting that being able to discriminate between individual sounds facilitates reading (Byrne & Fielding-Barnsley, 1995; Morrison et al., 1995; O'Connor, Notari-Syverson, & Vadasy, 1996). Wagner et al. (1997) demonstrated that individual differences in children's phonological awareness skills predicted children's subsequent word-level reading abilities at each time point studied from kindergarten through fourth grade. Phonological awareness is strongly emphasized in early education classrooms (Juel, Biancarosa, Coker, & Deffes, 2003), and the amount of time previously spent in school has been associated with children's skills in this area (Cunningham & Carroll, 2011). Thus, although it is expected that children's phonological awareness skills will be associated with time spent in school, it is unclear whether children's experiences in pre-kindergarten differentially affect children's growth relative to their experiences in kindergarten. Thus, the current study will examine how time spent in pre-kindergarten and kindergarten relates to children's growth in this skill set.

Children display early reading skills even before preschool, as they begin to express an understanding of the graphological features of written language (van Kleeck, 1998). During and after preschool, however, these skills become increasingly sophisticated and play a critical role in learning to read (Kaplan & Walpole, 2005; Morris et al., 2003). Indeed, Hammill (2004) compared results from 450 studies examining early predictors of later reading performance and found that print-related skills were the strongest predictors of children's later reading skills ($d = .47$). Previous work has indicated that children who spent two years in preschool demonstrated more sophisticated early reading skills at the end of the school year than did children who only spent one year in preschool (Skibbe et al., 2011). Nevertheless, it remains unclear how experiences in kindergarten relate to early reading growth relative to that observed in pre-kindergarten. Decoding is emphasized strongly during kindergarten (Al Otaiba et al., 2008) and previous research suggests that teachers

who focus on decoding skills during the preschool years have students who make greater gains in early reading, although there is considerable variability regarding the degree to which these skills are actively targeted (Connor, Morrison, & Slominski, 2006). Given previous work in this area, we hypothesize that children who attended pre-kindergarten will have higher early reading scores in the fall of their kindergarten year than children without this prior experience and will exhibit greater growth during the school year as well.

Vocabulary represents a critical component of children's academic achievements (Catts et al., 2001). As one example, the NICHD Early Child Care Research Network (2005b) demonstrated that vocabulary predicted word recognition skills, thus promoting skilled reading for children. Associations between schooling and vocabulary growth have been mixed; some studies have found schooling effects (Aarnoutse, Van Leeuwe, Voeten, & Oud, 2001), whereas others have not (Christian, Morrison, Frazier, & Massetti, 2000; Cunningham & Carroll, 2011; Morrison et al., 1995). Previous research using the cutoff method has not uncovered schooling effects on vocabulary during the preschool years (Skibbe et al., 2011). Although instructional emphases in preschool have yet to be studied, kindergarten teachers place only a small emphasis on vocabulary instruction when helping children to learn to read (Baumann, Kame'enui, & Ash, 2003; Juel et al., 2003), perhaps explaining null associations in early childhood settings. Given the divergent findings in the field, the current study explored whether growth in vocabulary was associated with children's experiences in pre-kindergarten and kindergarten.

Experience in a preschool setting has been shown to foster better mathematical skills in both kindergarten and first grade (Jones, Gullo, Burton-Maxwell, & Stoiber, 1998; Magnuson, Meyers, Ruhm, & Waldfogel, 2004). Previous research has indicated that, when compared to literacy, preschool and kindergarten teachers do not prioritize the teaching of mathematics in their classrooms (Ginsburg, Lee, & Boyd, 2008; Graham, Nash, & Paul, 1997). Nevertheless, using a nationally representative data set, Magnuson and colleagues (2007) found that children who attended preschool had significantly higher mathematics scores in kindergarten and first grade than children who did not utilize center-based care. This suggests that early schooling experiences may promote mathematics skills for young children. When analyzed specifically, schooling effects have been associated with some aspects of mathematics, particularly as related to arithmetic, in both kindergarten and first grade (Bisanz et al., 1995). We hypothesized that the growth in mathematics observed in pre-kindergarten and kindergarten would be associated with children's schooling experiences.

Research Aims

For children who were essentially the same age, we investigated the effect of their experiences in pre-kindergarten compared to kindergarten by analyzing the initial level and growth of their literacy and mathematics skills over the course of one school year. We recognize that, even with the restricted age range, we might have selection bias across the two groups resulting from factors not associated with schooling. Thus, we use propensity scores (Rubin, 1997) to account for the possibility that children were in one grade or another (i.e., pre-kindergarten or kindergarten) based on children's age, gender, ethnicity, and self-regulation, as well as maternal education and employment. Schooling effects for pre-kindergarten were assumed when children who were starting kindergarten (and thus had previous experience in pre-kindergarten) demonstrated higher scores in the fall of the school year than children with no prior experience in pre-kindergarten, controlling for propensity scores. Kindergarten schooling effects were indicated when children attending kindergarten developed skills at a faster rate during the school year compared to children attending pre-kindergarten, over and above the propensity scores. In addition, to illuminate potential

instructional drivers behind children's academic development during pre-kindergarten and kindergarten, we observed classrooms to document the amount of time spent in literacy and mathematics instruction during the winter of the school year. It is hypothesized that children would spend more time engaged in instruction related to literacy and mathematics skills in kindergarten than in pre-kindergarten, which would be associated with stronger growth during the kindergarten year.

Method

Participants

Participants were 60 children (37 girls and 23 boys) who were enrolled in a five-year longitudinal study that examined the nature and sources of children's academic and social development over the school transition period. Children attended one of 42 classrooms in 7 schools located in a diverse suburban school district in the Midwest. This district was chosen, in part, because of its policy of separating children into preschool and pre-kindergarten classrooms by age. Pre-kindergarten classrooms were designed to be more academically rigorous, in an effort to prepare children for kindergarten. Using the school cut-off technique, children were only enrolled into the current study if their birthdates fell within two months before or after the state-determined cut-off date for kindergarten entry (i.e., Dec 1st) and their grade placement was consistent with their cutoff age. This resulted in 34 young kindergarteners (*Mean Age* = 4.98 years; *SD* = .07) and 26 old pre-kindergarteners (*Mean Age* = 4.78; *SD* = .10) at the time of the fall assessment period. Children in this cutoff study were not systematically different from the larger sample of children in the longitudinal study in terms of ethnicity, gender, parent education, disability status, or time spent in child care ($p > .10$ for all). All children attended school the year prior to data collection.

Of the 56 children with complete demographic data, 41 were Caucasian (68.3%), 6 were Middle Eastern (10%), 3 were Asian/Pacific (5.0%), 2 were Hispanic (3.3%), 1 was African American (1.7%), and 3 were Multiracial (5.0%). Mothers reported that children in both groups had spent a similar amount of time in childcare in the fall of the school year (*Mean* = 1.5 years; *SD* = 1.32; $t(49) = -.56$, $p = .58$). In addition, both groups of children had mothers with similar average education levels, which were equivalent to a bachelor's degree (*Mean* = 15.77 years; *SD* = 2.00 for kindergarteners and *Mean* = 15.50 years; *SD* = 2.33 for pre-kindergartners, $t(50) = .44$, $p = .66$). However, during the school year, pre-kindergartens provided schooling fewer days per week (*Mean* = 3.81; *SD* = .98) than did kindergartens (*Mean* = 4.82; *SD* = .58), and this difference was significant ($t(58) = 5.02$, $p < .001$). See Table 1 for descriptive information about these two groups of children.

Procedures

All children whose parents provided informed consent were tested twice during the school year, once during the fall (October-November) and again during the spring (April-May). When children provided verbal assent, trained research assistants tested them individually in a quiet place in their schools using a battery of tasks from the Woodcock-Johnson Tests of Academic Achievement (WJ-III; Woodcock & Mather, 2001). Testing lasted approximately 20-30 minutes per child. For each subtest, the first item was based on children's age and testing was terminated when children answered six consecutive items incorrectly, in accordance with the testing manual. Analyses were conducted using *W* scores, the Rasch-based scores provided by the WJ-III. Children who participated received a small gift card at each testing point to thank them for their time.

Literacy Measures

Phonological Awareness—The WJ-III Sound Awareness Test was used to examine children's phonological awareness, including measures of rhyme (e.g., In my house, I saw a little...), deletion (e.g., Say cowboy without the boy), substitution (e.g., If I say penny and then change pen to sun, the new word would be....), and reversal (e.g., Say "corn... pop" backwards). For children 4 to 6 years of age, estimated reliabilities on this measure range from .71 to .93.

Early reading skills—Children's early reading skills were measured using the Letter-Word Identification subtest of the WJ-III, which involves asking the child to verbally identify letters printed on a page, and then to read printed words aloud, regardless of whether s/he understands the meaning of the word. Estimated reliabilities on this subtest range from .98 to .99 for children 4 to 6 years of age.

Picture Vocabulary—Children's vocabulary was tested using the WJ-III Picture Vocabulary Test. In this test, children are asked to name a series of pictures, assessing both expressive language and lexical language knowledge. Reliability on this measure ranged from .70 to .81 for children between the ages of 4 and 6.

Mathematics Measure

The WJ-III Applied Problems Test evaluated children's ability to analyze and complete math problems. As part of this subtest, children listened to a math problem and then performed the necessary calculations (e.g., How many apples are there in this page? Put your finger on the flower with three bees.). For children 4 to 6 years of age, estimated reliabilities on this subtest range from .88 to .94.

Table 2 includes children's scores for each of the measures described above.

Covariates

As indicated above, we measured several key covariates. Children's age in months, gender (female = 1, male = 0), and ethnicity (minority = 1, white = 0), as well as maternal education (master's degree or higher = 1, bachelor's degree or less = 0) and employment (full-time = 1, part-time or unemployed = 0) were collected through parent self-report or a written questionnaire completed at home and returned to the research team using a pre-paid business reply envelope. In addition, we included self-regulation as a covariate in the present study because of its relations with academic achievement in previous work (McClelland et al., 2007) and its availability as part of the larger study. Self-regulation was measured directly in the fall of the school year using the Head to Toes task (Ponitz et al., 2008). In this game-like measure of behavioral self-control, children individually receive 10 prompts asking them to touch their heads or toes, but they are asked to respond to the command by doing the opposite of what is requested (i.e., they should respond to the request to "Touch your toes" by touching their heads), tapping attention and behavioral inhibition. Children received 2 points for each correct response, 1 point for each self-corrected response (in which they initially make the incorrect motion but then adjust their behavior) and 0 points for each incorrect response, for a total score ranging from 0 to 20 points. Teacher experience (in years) and education (master's degree = 1, bachelor's degree = 0) were gauged using a teacher self-report questionnaire completed in the fall of the school year and returned to the research team via business reply envelope.

Classroom Data

Forty-seven (19 pre-kindergarteners, 28 kindergarteners) of the children in the present study were videotaped individually in their classrooms during the winter of the school year for the duration of instructional time in the morning (or afternoon for those classes that only met at that time). There were no significant differences in the fall for any of the outcome variables studied between children who were observed and those who were not. Teachers provided consent to participate in a study designed to observe their typical literacy practices within the classroom. Observations ranged from two to four hours in duration, depending on the amount of time that individual teachers allocated to instructional activities. Observations began when children entered the classroom to begin the school day and concluded when children left for the day, either to go home or to go to other activities (e.g., gym, art, music, lunch) if teachers indicated that instruction would not resume upon their return. Research assistants reported that the activities captured during these formal, videotaped observations were consistent with other, more informal, observations of the classroom completed at various points in the school year. Because observations were designed to capture typical practices, they were scheduled with teachers in advance and not conducted on days featuring special activities (e.g., field trips, special school assemblies).

Videotaped observations were coded using Noldus Observer Pro System (Noldus, Information Technology, 2001). The number of seconds that each child spent engaging in various types of academic instruction was recorded in a way similar to that reported in previous work (Connor et al., 2006). For ease of interpretation, all results are reported in minutes. Coding captured time spent in instruction on each of the following skill sets: phonological awareness (including syllables, rimes, onsets, and phonemes), early reading (including letter knowledge, letter-sound correspondence, and writing), reading comprehension, vocabulary (including explicit instruction in word meanings and storybook reading), and mathematics.

Given that some classes met for more time than others (i.e., some met every day, whereas others met only 2, 3, or 4 days per week), the amount of instruction that children were exposed to during our observation session was weighted to account for the number of days that each child could attend class each week. Specifically, the number of days that the class met each week (1 to 5) was multiplied by individual instructional times. Although some children attended school for full days, the present study did not weight this experience more heavily than a half-day of instruction, as teachers reported that most academic instruction for full-day classrooms occurred in the morning.

Coding was completed by undergraduates who were carefully trained by the master coder, a graduate student. Undergraduates were permitted to code independently only when they attained a reliability of .85 or above on all codes with the master coder. In addition, the master coder scored 15% of the total sample of videos along with the undergraduate coders to ensure that there was no drift in reliability over time.

Analysis Plan

Data Screening

First, because the sample size in the current study was relatively small, data were screened to ensure that assumptions associated with statistical tests employed were satisfied. All variables were normally distributed, and in general, no notable skewness or kurtosis was observed. There were, however, three high-scoring outliers on the early reading measure in fall; thus, a positive skew (skewness = 1.51, SE = .31) and a leptokurtic distribution (kurtosis = 5.77, SE = .61) were observed on this variable. Conversely, three low-scoring outliers on the fall vocabulary measure created a negative skew (skew = -1.57, SE = .31).

and a similarly leptokurtic distribution (kurtosis = 6.33, SE = .61). No similar issues were observed with the early reading measure in spring (skew = .78, SE = .31; kurtosis = 1.11, SE = .61), as many children moved into the higher scoring range, although the same trend remained in the distribution of vocabulary scores (skew = -.90, SE = .31; kurtosis = .30, SE = .61). Data were carefully checked to ensure that outliers reflected valid data rather than errors in data entry and were retained to accurately reflect the variability in the sample. Further, as multilevel regression analyses were conducted, histograms and QQ plots were used to check for the normal distribution of residuals; scatterplots were employed to check that residuals had a mean of 0 and constant variance across both fitted values and predictors. Special attention was devoted to models including early reading and vocabulary outcomes. Analyses revealed no significant departures from these assumptions.

Model Construction

To investigate differences in the learning and development of these same-age children in different educational settings, three-level random-effects models were employed to account for the nesting of children within classrooms. Specifically, children's scores in the fall and spring of the academic year were entered at level 1, nested within children at level 2 and classrooms at level 3.

Propensity scores—In light of the relatively small sample size, rather than including all covariates as separate variables in our models, we created propensity scores to account for fall measures of child age, gender, ethnicity, self-regulation, and maternal education and employment, and teacher education and experience (Rubin, 1997). Specifically, we regressed cutoff status (pre-kindergarten = 1 vs. kindergarten = 0) on child/family covariates and teacher covariates to determine how each covariate was uniquely linked to the outcome. Although only self-regulation was significantly linked to grade (with children entering kindergarten likely to have higher self-regulation), we created a single propensity score (representing the likelihood of being in kindergarten vs. pre-kindergarten) for each child. The propensity score is the unstandardized residual for each child and reflects the likelihood that a particular child would be in the pre-kindergarten group. Adding this single propensity score to the model at level 2, with other time-invariant child and family variables, effectively controls for differences in child-, family-, and teacher-level covariates in a parsimonious way.

Model design—Cutoff status was modeled as a predictor of initial skills, which would reflect an effect of children's previous year – preschool for those currently in pre-kindergarten and pre-kindergarten for those currently in kindergarten. In addition, cutoff status was modeled as a predictor of change in child skills over the course of the year, which would reflect a difference between children's learning in pre-kindergarten and kindergarten. Thus, in a single model, by examining fall scores, we were able to determine whether there was a benefit of pre-kindergarten (relative to preschool) for a particular skill set; and by examining spring scores, we could determine whether there was a benefit of kindergarten (relative to pre-kindergarten). Propensity scores, the sole covariate, were centered at their grand mean (Raudenbush & Bryk, 2002).

Results

Results of 3-level hierarchical linear models (HLM) are summarized in Table 3. Children starting kindergarten outperformed their peers in fall on the measure of phonological awareness ($B = 21.24$, $p = 0.001$), suggesting that their prior experience in pre-kindergarten supported skill development in this area. Both groups of children grew in this area over the course of the year; however, controlling for fall skills, no differences in learning over the

year were apparent between these groups ($B = 1.53$, $p = 0.601$), indicating that learning across pre-kindergarten and kindergarten was not statistically different. In other words, pre-kindergarteners and kindergartners learned roughly the same amount about these skills over the course of the year.

For early reading, kindergartners outperformed pre-kindergarteners both at the beginning of the year, reflecting a pre-kindergarten effect ($B = 42.44$, $p < 0.001$), and at the end of the year controlling for fall skills, indicating a kindergarten effect ($B = 20.83$, $p = 0.001$).

Vocabulary skills did not differ between kindergartners and pre-kindergartners at the start of the year ($B = 1.38$, $p = 0.748$), although kindergartners learned significantly more vocabulary over the course of the year ($B = 8.39$, $p = 0.005$).

Mathematics skills were higher in fall among children who had already experienced pre-kindergarten ($B = 21.64$, $p < 0.001$), but learning over the year was equivalent between kindergartners and pre-kindergartners ($B = 3.37$, $p = 0.408$).

To understand how differences between these groups might be linked to classroom instruction in pre-kindergarten and kindergarten, we examined descriptive data from the classroom observations. The amount of language arts instruction to which each child was exposed during a given week varied widely ($Range = 356.90$ to 1108.08 minutes; $Mean = 607.63$; $SD = 156.35$). On average, each child was observed to have over two hours of instruction targeting language arts during the individual observation session ($Range = 82.10$ to 221.62 minutes; $Mean = 140.60$ minutes; $SD = 29.85$). When weighting these values to account for the discrepant number of days for which children attended school each week (i.e., multiplying the child's exposure to particular kinds of instruction during the one-day observation by the appropriate number of days per week, yielding an estimated weekly exposure), pre-kindergartners were estimated to have an equivalent amount of language arts instruction, on average ($Mean = 597.09$ minutes; $SD = 222.14$), as kindergartners ($Mean = 612.19$ minutes; $SD = 182.98$), ($t(45) = .25$, $p = .80$, $d = .08$).

Because of the small sample size associated with each group, differences in instruction received by the two groups are interpreted using Cohen's d . Pre-kindergartners spent less time in activities related to phonological awareness ($Mean = 7.35$ minutes, $SD = 9.23$) than kindergartners ($Mean = 11.44$ minutes; $SD = 25.64$), consistent with a small effect size ($d = .20$). There were both similarities and differences in the types and amounts of instruction related to early reading received by each group. Pre-kindergartners were exposed to a similar amount of instruction targeting the alphabet ($Mean = 10.83$ minutes, $SD = 12.42$) as young kindergartners ($Mean = 12.42$ minutes; $SD = 23.02$), consistent with a negligible effect size ($d = .07$). In addition, teachers engaged pre-kindergartners and kindergartners in similar amounts of instruction related to reading comprehension ($Mean$ for pre-kindergartners = 16.87 minutes; $SD = 21.33$, $Mean$ for kindergartners = 17.85 minutes; $SD = 31.91$, $d = .04$) and writing ($Mean$ for pre-kindergartners = 34.58 minutes; $SD = 52.47$, $Mean$ for kindergartners = 38.49 minutes; $SD = 43.07$, $d = .09$). However, pre-kindergartners spent less time each week in activities that required them to link letters to their respective sounds ($Mean = 2.86$ minutes; $SD = 4.84$) than did kindergartners ($Mean = 13.96$ minutes; $SD = 28.24$). This difference is consistent with a large effect size ($d = .51$).

The most frequent language arts instruction observed was storybook reading and minutes spent in this type of activity were similar across groups ($Mean$ for pre-kindergartners = 58.14 minutes; $SD = 28.62$, $Mean$ for kindergartners = 58.99 minutes, $SD = 39.52$, $d = .02$). Activities targeting vocabulary were not focused on much within any of the classrooms observed, but pre-kindergartners engaged in less time working on concepts related to vocabulary ($Mean = 1.76$ minutes; $SD = 3.06$) than kindergartners ($Mean = 5.09$ minutes;

$SD = 10.63$) and these differences are associated with a medium effect size ($d = .43$). Neither group of children was observed to spend much time engaged in mathematics activities each week (*Mean* for pre-kindergartners = 3.48 minutes; $SD = 3.42$, *Mean* for kindergartners = 2.99 minutes; $SD = 11.01$, $d = .06$).

Discussion

In this study, we conducted a natural experiment utilizing the arbitrary date set for children to start kindergarten. By recruiting children whose birthdays just made or just missed the cutoff date for school entry, we examined the effect of different schooling experiences on children who did not differ in age. Further, by employing propensity scores, we accounted for a variety of other factors not associated with grade level that might also account for differences between the two groups. Beyond these factors, in the fall, children who had already experienced pre-kindergarten, and thus were starting kindergarten, had higher scores on measures of phonological awareness, early reading, and mathematics skills than did children who had not had access to pre-kindergarten the previous year. Children's vocabulary scores did not significantly differ by group in the fall of the school year. In addition, although both groups of children made gains on all measures during the school year, children who attended kindergarten demonstrated greater gains in early reading and vocabulary during the school year than children who missed the cutoff date and attended pre-kindergarten.

Similar to the schooling effects observed for older children (Cunningham & Carroll, 2011), children who were starting kindergarten exhibited greater levels of phonological awareness in the fall than did children who were just beginning their pre-kindergarten year. The schooling effect associated with phonological awareness extends previous research from early intervention programs (e.g., Byrne & Fielding-Barnsley, 1995; O'Connor et al., 1996), by showing that teachers can promote phonological awareness skills successfully within a general pre-kindergarten classroom. In addition, during the school year, children demonstrated similar amounts of growth in pre-kindergarten and kindergarten, suggesting that the two school environments provide an equivalent benefit to children. Children in kindergarten received more instruction targeting phonological awareness than children attending pre-kindergarten, although these differences were associated with a small effect size, and did not appear to be associated with additional growth for children.

Improvement in children's early reading skills was associated with children's pre-kindergarten and kindergarten experiences. That is, children who had attended pre-kindergarten in the previous year had higher scores in the fall of the school year than did those who had attended preschool; in addition, children enrolled in kindergarten made greater gains during the school year than those attending pre-kindergarten. Previous research indicates that children are exposed to a good deal of decoding instruction, relative to other types of instruction, in preschool and kindergarten classrooms (Al Otaiba et al., 2008; Fielding-Barnsley, 1997). Although those children attending kindergarten demonstrated greater early reading growth than children attending pre-kindergarten, teachers in both grades exposed children to a similar amount of alphabet and writing instruction within their classrooms. However, kindergarten teachers used strategies designed to help children connect letters to their respective sounds more frequently than pre-kindergarten teachers. Previous research with first graders demonstrated that children who received more instruction targeting letter-sound correspondence developed reading skills at a faster rate than children who received less of this type of instruction (Foorman, Francis, Novy, & Liberman, 1991). Results from the current study confirm these previous results and suggest that similar benefits may be observed for kindergartners as well.

Children's schooling experiences did not affect their vocabulary growth during pre-kindergarten, similar to previous work examining schooling effects on vocabulary in preschool (Skibbe et al., 2011). However, contrary to previous research suggesting that vocabulary growth is primarily due to age-related factors (Christian et al., 2000; Cunningham & Carroll, 2011; Ferreira & Morrison, 1994), children's vocabulary growth in kindergarten appeared to be affected by children's schooling during that same year. Thus, timing appears to be an important factor to consider when investigating vocabulary growth. During children's first years in school, teachers typically do not focus much on vocabulary development directly during early reading instruction (Baumann et al., 2003), and instead focus more of their time on phonological awareness and decoding (Juel et al., 2003). Similar trends were observed in the present study, as vocabulary instruction was observed much less frequently than instruction targeting other areas of literacy. Nevertheless, kindergarten teachers did spend more time each week targeting vocabulary than their pre-kindergarten counterparts, which may help to explain the greater growth observed during this time.

For mathematics, children who had attended pre-kindergarten during the previous year had higher scores in the fall, but all children, regardless of whether they attended pre-kindergarten or kindergarten, developed mathematics skills at a similar rate during the school year. Results are consistent with previous findings (Bisanz et al., 1995; Christian et al., 2000; Frazier & Morrison, 1998) showing that schooling is positively related to mathematics growth. Such findings are notable given that, similar to previous research (Ginsburg et al., 2008; Graham et al., 1997), teachers did not provide much mathematics instruction within their classrooms, with the majority of children receiving less than five minutes of mathematics instruction in a given week. Results should be interpreted in light of the fact that teachers were told that they were being observed to examine their literacy practices; as such, they may have engaged students in fewer mathematics activities than normal. It is also possible that, for the full-day programs, mathematics instruction occurred during the afternoons, although, based on interviews with teachers, this is unlikely. Finally, children's mathematical skills may have benefited from other types of instruction within the classroom. In particular, because the measure of mathematics in this study relied heavily on children's comprehension of word problems, the literacy instruction observed in the present study could have facilitated growth in this aspect of mathematics as well. Regardless, results from the present study suggest that schooling can positively affect children's mathematics skills even when not a direct instructional focus within the classroom.

Limitations

There are several limitations that need to be considered in the present work. Participants in the current study resided in middle- to upper-class neighborhoods. Research suggests that children residing in non-poor environments are more likely to have teachers who provide high-quality instruction (Pianta, Belsky, Houts, & Morrison, 2007). We assume that most children attending public schools would receive instruction that is similar to the children observed in the current study. Nevertheless, the schooling effects observed in the current study may not generalize to all populations of children (e.g., those living in low-income environments).

In addition, the current study did not consider the complex interplay between children's home environments and the impact of schooling on their development. For example, research by Christian, Morrison, and Bryant (1998) found that the amount of time that children spent in school differentially impacted their mathematics skills, depending on the educational level of children's mothers. Thus, it is possible that, in the current study, schooling effects were moderated by other factors associated with children's academic achievement. Previous research has indicated that children's initial academic and behavioral competencies (McClelland et al., 2007; Skibbe, Grimm et al., 2008) as well as their home

environment (Bennett et al., 2002; Sénéchal, 2006) are predictive of later academic success. Thus, future research should consider additional factors that may interact with schooling to boost children's academic achievement.

Conclusion

The increased academic accountability for students resulting from legislation associated with *No Child Left Behind* has encouraged many schools to offer more academically rigorous pre-kindergarten programs and to move their kindergarten cutoff dates, so that children are older when they enter into kindergarten (Stipek, 2002, 2006). Concerns about enrolling children into school early may be unwarranted and, for those children who do not have access to early education programs, even harmful (Stipek, 2006). Thus, when making decisions about the best time to place a child into a school setting, age should not be the only deciding factor. Findings from the current study suggest that many areas of cognitive development are enhanced by the schooling experiences that children typically receive in both pre-kindergarten and kindergarten. This finding is important as state and federal education policies begin to make pre-kindergarten programs available to more children (e.g., universal pre-kindergarten in Florida). Broadly implemented, high quality pre-kindergarten and kindergarten programs have the potential to provide children with skills that they need to be successful in later grades.

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Table 1

Demographic Information for Kindergarteners and Pre-Kindergarteners

	Kindergartners (n = 34)	Pre-kindergartners (n = 26)
Ethnicity		
Asian Pacific	3	1
Caucasian	23	18
Hispanic	1	1
Middle Eastern	2	4
Multiracial	2	1
Unknown	3	1
Gender		
Boys	12	11
Girls	22	15
Mean age in months (<i>SD</i>)	59.76 (.84)	57.36 (1.20)
Mean years of maternal education (<i>SD</i>)	15.77 (2.00)	15.50 (2.33)

Table 2

Means (SDs) of WJ-III performance for Kindergartners and Pre-Kindergartners

	Kindergartners	Pre-kindergartners
Sound awareness		
Fall	466.18 (17.01)	450.04 (17.17)
Spring	481.12 (15.74)	467.96 (13.39)
Letter word identification		
Fall	369.74 (31.41)	345.04 (19.98)
Spring	403.85 (33.03)	360.00 (25.55)
Picture vocabulary		
Fall	473.03 (16.36)	473.03 (11.20)
Spring	482.38 (12.91)	476.96 (11.33)
Mathematics		
Fall	428.35 (16.20)	412.88 (12.30)
Spring	441.62 (15.29)	427.81 (15.29)

Table 3

Parameter Estimates for the Final Model for each of the Four Outcome Variables

Fixed effects				
Predictor	Early reading	Sound awareness	Vocabulary	Mathematics
Predicted fall mean for PK group	359.22 (3.19) ***	459.28 (1.97) ***	473.22 (1.61) ***	421.75 (1.82) ***
Effect on fall mean of K status (i.e., with prior PK experience)	42.44 (9.72) ***	21.24 (5.54) **	1.38 (4.72)	21.65 (4.83) ***
Discrepant growth from fall to spring for K group (i.e., significant effects indicate that children in K grew more than those in PK)	20.83 (6.10) **	1.53 (2.92)	8.39 (2.92) **	3.37 (4.06)
Random effects:				
Variance component	Outcome			
	Early reading	Sound awareness	Vocabulary	Mathematics
Between classroom (u)	3.37	0.51	0.28	.22
Between child (e)	539.90 ***	196.14 ***	129.07 ***	116.91 ***
Within child (r)	144.12	39.58	39.66	75.09

Note. Values are unstandardized regression parameters. Robust standard errors are in parentheses.

*
p<.05

**
p<.01

p<.001

*
p<.05

**
p<.01

p<.001