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The Impacts of Sleep Duration, Problem Behaviors and Health Status on Letter Knowledge in Pre-Kindergarten Children

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Abstract

This study investigated the impacts of sleep habits, problem behaviors and health status on differential fall-to-spring gains in letter knowledge found in pre-kindergarten children. Four-year-olds attending pre-kindergarten programs who could identify 0–3 letters at school entry in the fall were studied. Two groups were created based on letter knowledge in the spring, one composed of children who continued to only identify 0–3 letters and the other composed of children who correctly identified 4 or more of 15 letters. The two groups of children (24 males, 36 females) were matched on age, general cognitive skills, and gender. Parental reports about the children's sleep habits, problem behaviors, and health status were obtained using a questionnaire. Scores were used to differentiate group gains in letter knowledge. Children making small gains in letter knowledge were characterized by shorter nighttime sleep duration, multiple problem behaviors that parents regarded as very descriptive of their child, and the presence of more than one chronic health problem.

The academic orientation of many pre-kindergarten programs is changing with the accumulation of research evidence documenting the importance of literacy skills for kindergarten readiness and success in reading during the primary grades. For example, Denton and colleagues (Denton & West, 2002; West, Denton, & Germino-Hausken, 2000) report that children who are proficient (based on quartile scores) in identifying alphabetic letters at kindergarten entry show stronger skills at the end of kindergarten and in first grade on measures of phonological processing and word reading compared to

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children who are not proficient. Letter knowledge also is linked in those reports with proficiency in reading in first grade. Researchers have identified letter knowledge as an important skill for the development of reading (Adams, 1990) because of the importance of distinguishing between letters for word decoding and the importance of learning letter-sound relations for the development of phonological awareness skills (Badian, 1995; Bond & Dykstra, 1967; Bowey, 1994, 1995). Letter knowledge has become one of the key skills included in preschool literacy curricula as well as included in school readiness evaluations at kindergarten, such as the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) (Good & Kaminski, 2002).

However, there is evidence that despite an emphasis on the development of letter knowledge and other emergent literacy skills in preschool classrooms, there are differential gains seen in learning across children. For example, Molfese et al. (2006) examined the development of letter knowledge in a sample of 57 four-year-olds participating in pre-kindergarten programs targeting children at academic risk because of poverty. The children attended preschool programs with reading curriculum that emphasized several emergent literacy skills, including letter knowledge skills. When studied across the school year, a group of children (n = 30) was identified who made small or no gains (0–3 letters) in letter naming from fall to spring compared to classmates (n = 27) with gains averaging 7 letters. The children's fall-to-spring gains in letter identification were found to correlate with scores on phonological processing, rhyme detection, environmental print, and scores from Get Ready To Read (Whitehurst and Lonigan, 2001), a screening scale that taps skills across all of these areas.

When children do not show gains in learning with classroom instruction that benefits most of the other children, then the explanation should focus on characteristics of the child, rather than on teacher or curriculum characteristics. Indeed, the small gain and the big gain groups of children were found in the Molfese et al. (2006) study to differ on age, gender, and/or general cognitive skills. Children making small gains were younger and had lower General Cognitive Ability scores (Elliott, 1990, Differential Ability Scales [DAS]). Other child characteristics not measured in that study also may influence the development of literacy skills in early childhood.

Researchers studying sleep characteristics have found that sleep quality and quantity in childhood impact early learning. From birth through preschool and early school age, children spend a significant portion of time asleep, and they require more sleep than adults. On average, 3- to 6-year-old children require 10 to 12 hours of sleep during nighttime hours (Bates, Viken, Alexander, Beyers, & Stockton, 2002; National Sleep Foundation, 2004; Thiedke, 2001). Yet, there is evidence that many young children get insufficient amounts of sleep, and growing evidence shows that sleep insufficiency or impairment may impact children's learning and behavior (Archbold, Giordani, Ruzicka, & Chervin, 2004; Bluden, Lushington, & Kennedy, 2001; O'Brien & Gozal, 2004; Sadeh, Gruber, & Raviv, 2003). Research by Bates et al. (2002) found that parental reports of the sleep characteristics (e.g., amount of sleep, variability and lateness in bedtimes) of their 4- and 5-year-old children were related to teachers' ratings of the children's adjustments to preschool. Lavigne et al. (1999) found that parental reports of the amount of sleep 2- to 5-year-old children were getting at night and within a 24-hour period was related to problem behaviors reported by parents and obtained from clinical measures.

Researchers have also found that behaviors termed "learning-related social skills" (McClelland & Morrison, 2003) are important for academic achievement beginning in preschool. Such behaviors include listening and following directions, staying on task, self-regulation and cooperation. McClelland, Morrison and Holmes (2000) studied a sample of kindergarten children with poor ratings on learning-related behaviors by their teachers. The learning-related behaviors predicted children's kindergarten skills in various areas, including letter knowledge, vocabulary, and reading, above and beyond what was predicted by child, family, and sociocultural variables. Lonigan et al. (1999) also found that preschool children's impulse and attention problems, as reported by their parents, were related to growth in the children's emergent literacy skills. Learning-related problem behaviors of children include the ability to concentrate on a task, hyperactivity, confused behaviors, over or lack of involvement with others, unpredictable behaviors, low frustration tolerance, uncooperativeness, and having a high energy level.

Health status may also influence preschool children's learning and classroom behaviors by affecting school attendance, energy level, and sense of well being (Currie, 2004). Huffman, Mehlinger, and Kerivan (2000) report that children with poor learning-related social skills are characterized by health and medical problems. While some studies (Bender, 1999; McLoughlin, Nall, & Petrosko, 1986) report no direct relations between individual health problems, such as asthma, allergies, ear infections, and colds, and learning in childhood, others report that the number of illnesses experienced by a child, as reported by parents or taken from medical records, are related to school readiness, learning problems, and academic achievement (Corrigan, Stewart, Scott, & Fee, 1996; Currie, 2004; Rydell, Bondestam, Hagelin, & Westerlund, 1991; Wunderlich, 1977). Newacheck and Stoddard (1994) reported that 20% of the children from the National Health Interview Survey on Child Health (N = 17,710) had at least one chronic health condition, 5% had more than two chronic conditions, and less than 1% had three or more. Socioeconomic status has been found to contribute to the higher incidence of acute and chronic illnesses that characterize young children (Bradley & Corwyn, 2002).

In many studies, information about young children's sleep patterns, problem behaviors and health status come from parental reports. Glascoe (1997, 2000) has reported that using parental concerns about their preschool child's cognitive skills, learning and behaviors is an efficient and effective means of obtaining information useful for educational purposes. She linked parental concerns obtained from a questionnaire with evaluations of children in several areas of learning disabilities and impairment as assessed by a battery of standardized tests, and found that 73% to 85% of children with learning disabilities and other impairments were accurately identified based on parental concerns in one or more area. Further, typically developing children were accurately identified by parental reports and were characterized by the absence of concerns or different types of concerns. In the present study, parental reports of the sleep patterns, behaviors and health status of their children were used to determine whether children who lagged behind their classmates in learning letter names in pre-kindergarten classrooms differed from children showing growth in this important literacy skill on these characteristics.

In this study, the development of letter knowledge was studied over the course of the pre-kindergarten year. A sample of children was selected, based on letter knowledge scores in the fall and spring. All children in the sample entered the pre-kindergarten

programs knowing 0 to 3 of 15 letters in the fall. The sample was divided into two groups based on performance on the letter identification assessment in spring: those children who continued to identify only 0 to 3 letters and those who could identify 4 or more of 15 letters. Groups making small gains and big gains were matched for age, sex, and general cognitive skills so we could specifically examine relations between sleep characteristics, behavior and health status and children's emergent letter knowledge. It was hypothesized that children showing smaller fall-to-spring gains in letter knowledge would be characterized by less nighttime sleep, more problem behaviors and more health risk conditions compared to children making larger fall-to-spring gains.

Method

This study was approved by the University of Louisville Institutional Review Board. Parents of participants provided informed consent for the parent/child dyad to participate in the study and the child provided assent to participate.

Participants

The participants were drawn from a database of 105 children (49 males and 56 females) attending academically-oriented pre-kindergarten classes in the local school district. District-wide enrollment in these preschool programs was 91% based on family income eligibility. The children were typically developing, with English as a first language, and were distributed across 8 classrooms in 3 schools. The sample included children who participated in fall and spring testing and who could identify only 0 to 3 letters in the fall. Children were assigned to one of two groups based on their letter identification skills in the spring: children with letter naming scores ≤ 3 were in the *small gain* group ($n = 63$, 34 males), and those with scores ≥ 4 were in the *big gain* group ($n = 42$, 15 males). Children in each group were matched on age, sex and on General Conceptual Ability (GCA) scores obtained from the Differential Ability Scales (Elliott, 1990, DAS). Matching resulted in 30 pairs of children, 12 male and 18 female pairs. The ages of children in the fall sample ranged from 38 to 58 months ($M = 47.76$, $SD = 5.28$), and GCA scores ranged from 62 to 119 ($M = 86.9$, $SD = 11.54$).

Scores on the GCA are standardized with a mean (M) of 100 and a standard deviation (SD) of 15. The GCA scores of the children in the present study ranged from below to above average. Preschool children from low-income families entered preschool with great variability in their experiences and in their cognitive development compared to children from higher income homes. For decades, research documented the impacts that low income, low parental education levels and less stimulating home environments can have on children's cognition (see Bradley & Corwyn, 2002 for a review). The National Academy Press reported in Eager to Learn the potential effects of positive early educational experiences on later learning and school performance for economically disadvantaged children (Bowman, Donovan, & Burns, 2001). A significant finding from the body of research was that preschool programs can be particularly important in enhancing school readiness for children from low-income and educationally disadvantaged families. For these reasons, federally-funded preschool enrichment programs were established (U.S. Department of Health and Human Services, 2001, 2003). To better interpret the scores of the 18 children with GCA scores below 85 (more

than one *SD* below *M*), scores on expressive vocabulary tests (Expressive Vocabulary Test [EVT], Williams, 1997) were examined as an additional indicator of cognitive functioning. EVT scores were standardized with a mean of 100 and a standard deviation of 15. All children had expressive vocabulary scores of 85 or higher. Therefore, low GCA scores were not be construed as indicative of atypical development, but rather as indicative of less developed skills in verbal areas, such as responding to increasingly complex verbal instructions involved in problem solving tasks, and in nonverbal areas, such as constructing blocks to match a model and identifying similar pictures.

Measures

General cognitive and letter knowledge measures. Measures of verbal, nonverbal and overall cognitive abilities from the Differential Ability Scales (Elliott, 1990, DAS) were obtained to characterize the sample. The Preschool Level of the scale can be used with children aged from 2.6 years through 5.11 years, and includes assessments of Verbal Abilities (Verbal Comprehension and Naming Vocabulary) and Nonverbal Abilities (Picture Similarities, Pattern Construction, and Copying). These measures, plus Block Building and Early Number Concepts, were used to obtain GCA standard scores (M = 100, SD = 15). Preschool level test-retest reliabilities over a period averaging 30 days ranged from .90 to .94. The criterion-related validity of the Preschool Level of the DAS GCA was reported against the Stanford-Binet: Fourth Edition Composite (Thorndike, Hagen, & Sattler, 1986, SB-IV), with which it correlated .77, and against the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1989, WPPSI), with which it correlated .89 (Elliott, 1990, DAS Examiner's Manual).

The Wide Range Achievement Test-Reading subscale (Wilkinson, 1993, WRAT) includes a test of letter identification in which the child first identifies by pointing to and then naming 15 uppercase letters presented in random order. Alternate test forms of the WRAT-Reading subscale were available which facilitated the repeated testing design of the project. A different version was administered in the fall (tan version) and in the spring (blue version). The WRAT was standardized for use with individuals from age 5-years-old onward. Because children in our study ranged from 3.2 years to 5.3 years, WRAT standard scores could not be used. Raw scores are reported.

Sleep, health and behavior problems measures. The Sleep Questionnaire (Gozal, 1998) contains a series of parental report questions pertaining to sleep habits, childhood illnesses, and behavior problems. This instrument has been extensively validated with a low-income population similar to that sampled for the current study (Montgomery-Downs, O'Brien, Holbrook, & Gozal, 2004). For the purposes of the present study, only selected questions from the full questionnaire that was administered were used. Questions on the Sleep Questionnaire asked parents to report on how long their child sleeps at night on average (4–5 hr, 6–7 hr, 8–9 hr, 10–11 hr, more than 11 hr), the child's bedtime (7:00–8:00 p.m., 8:00–9:00 p.m., 9:00–10:00 p.m.; 10:00 –11:00 p.m., after 11:00 p.m.), and the child's rise time (5:00–6:00 a.m., 6:00–6:30 a.m., 6:30–7:00 a.m., 7:00–7:30 a.m., after 7:30 a.m.). Sleep duration and rise time were scored with least sleep (4–5 hr) and earliest rise time (5:00–6:00 a.m.) = 5 points to most sleep (more than 11 hr) and latest rise time (after 7:30 a.m.) = 1 point. Bedtime was scored with latest bedtime (after 11:00 p.m.) = 5 to earliest bedtime (7:00–8:00 p.m.) = 1.

A series of "yes" or "no" questions on the Sleep Questionnaire asked parents to report whether their child had any of a listing of childhood illnesses or health concerns: adenoids or tonsils removed, allergies, asthma, constant runny nose, ear infections, frequent colds, poor appetite, and poor growth. While subjective, these questions were intended to reflect parental perceptions of their child's well-being. One point was given for each "yes" response. Also included on the Sleep Questionnaire were eight questions from the child behavior checklist (Achenbach & Rescorla, 2000, CBCL) that asked parents to report whether their child had problem behaviors. These eight questions asked about the child's concentration, hyperactivity, confused behaviors, involvement with others, predictability of behaviors, frustration tolerance, cooperation, and energy level. Each question included a three-point scale (*Not True, Somewhat or Sometimes True, Very True*). Scoring was based on the described behaviors being *very true* = 2 points, *somewhat or sometimes true* = 1 point, and *not true* = 0 points.

Procedures

In the fall of the school year, parents of children participating in preschool programs at three schools were sent requests for participation and informed consent letters. Those families returning the consent letters (92%) were sent packets containing the Sleep Questionnaire. Trained researchers administered the Differential Ability Scales and WRAT letter identification scales to the children in the fall (October–November). The WRAT letter identification scale was re-administered the following spring (April–May). At each testing time, the children were tested individually in a room near the child's classroom. To complete the assessments, testing continued for each child across several days if needed because of unavoidable constraints on assessment time during the children's school day.

Results

The means and standard deviations for the independent and dependent measures are shown in Table 1 for the full group of participants and separately for the *small gain* and *big gain* groups. Equivalence of the two groups (*small gain* and *big gain*) on age and GCA were verified by paired *t* tests: t (29) = 1.05, $p > .05$ and t (29) = .63, $p > 05$, respectively. WRAT letter identification scores of the participants in the fall ranged from 0 to 3 letters correctly identified (M = .95, SD = .96): *small gain* group (M = .60, SD = .81) and *big gain* group (M = 1.30, SD = .99). In the spring, WRAT letter identification skills ranged from 0 to 15 letters (M = 5.10, SD = 4.92): *small gain* group (M = 1.03, SD = .89) and *big gain* group (M = 9.17, SD = 3.67). The magnitude of the differences between the two groups was significant by paired *t* test, t (29) = 10.89, $p < .001$.

Table 1
Group Comparisons on Measures of Sleep Patterns, Health Status and Behaviors

Measure	Full group		Small gains group		Big gains group		T-test[a] comparison Small gains–big gains groups
	M	*SD*	M	*SD*	*M*	*SD*	
Fall age	47.78	5.12	47.00	3.66	86.17	12.03	1.05
DAS General Conceptual Ability	85.85	11.84	85.53	11.84	86.17	12.03	0.63
Child Sleep Patterns							
Duration	8.80	1.41	8.50	8.50	1.41	1.13	1.63
Rise time	7.12	0.64	7.03	0.69	7.20	0.58	0.96
Bedtime	8.75	0.89	8.70	0.95	8.80	1.25	0.49
Child Health	1.45	1.40	1.77	1.25	1.13	1.48	1.80
Child Behaviors	5.75	2.58	5.97	2.28	5.53	2.86	0.65

Note. Full group $N = 60$; Small gains $n = 30$; Big gains $n = 30$. DAS = Differential Ability Scales.
[a]*t* scores were not statistically significant, $p > .05$

Differences in sleep, behavioral and health characteristics between the two groups of children were explored using paired *t* tests and chi-square tests. As shown in Table 1, the differences between groups were in the expected direction on measures of sleep (sleep duration and rise time), number of health problems, and number of problem behaviors. The *big gain* group generally had more optimal sleep characteristics (longer sleep duration, later rise time), fewer health problems and problem behaviors, but these differences were not significant.

Group differences were explored further by analyzing group differences using risk cut-off scores. Risk cut-off scores were created for each measure based on research reports of studies from nonclinical samples of children. The no-risk indicators for sleep, taken from reports of sleep habits in early childhood, which are reported to be 10 hours or more for nighttime sleep duration, rise time at 7 a.m. or later, and bedtime at 9 p.m. or earlier (Bates et al. 2002; Tikotzky & Sadeh, 2001). Research reports, based on nonclinical samples of children, on the prevalence of chronic health problems were used to set the risk cut-off at two or more chronic health problems (Newacheck & Stoddard, 1994). For problem behaviors, the risk cut-off was set at the presence of two or more problem behaviors that parents rated as a *very true* characteristic of their child. In this nonclinical sample, the number of children who had problem behaviors with scores of 2 (*very true*) was expected to be low.

For sleep duration, the *small gain* and *big gain* children who slept 10 hours or more at night ($n = 9$ and 17, respectively) were compared with participants who slept less than 10 hours at night ($n = 21$ and 13 respectively). The difference was significant, $\chi^2(1, n = 60) = 3.32$, $p < .04$; Odds Ratio = 3.05. For health problems, the *small gain* and *big gain* participants with no chronic health problems ($n = 5$ and 16, respectively) were contrasted with participants with two or more health problems ($n = 25$ and 14,

respectively). The difference was significant, χ^2 (1, n = 60) = 8.86, p < .003; Odds Ratio = 5.71. For behavior problems, the *small gain* and *big gain* participants with scores of 2 (*very true*) on two or more problem behaviors (n = 20 and 11, respectively) were contrasted with participants who had scores of 2 on less than two problem behaviors (n = 8 and 17, respectively). The difference was significant, χ^2 (1, n = 60) = 5.85, p < .01; Odds Ratio = .25. Other analyses for rise time (7 a.m. or later = no risk)) and bedtime (9 p.m. or earlier = no risk) were not significant.

Finally, the number of children in each group meeting risk cut-off criteria for all three variables was compared to those who did not meet the risk cut-offs for any variable. The difference was significant, χ^2 (1, n = 56) = 9.11, p < .01; Odds Ratio = .09, with 13 of the 30 children (43%) in the *small gain* group meeting risk cut-off criteria for all three variables compared to 2 of the 30 (6%) in the *big gain* group.

Discussion

The present study investigated how sleep habits, learning-related problem behaviors, and health status reported by parents were related to gains in letter knowledge skills in pre-kindergarten. The results show that short nighttime sleep duration, multiple problem behaviors that parents regarded as very descriptive of their child, and the presence of more than one chronic health problem were characteristics of the children who made only small fall-to-spring gains in their abilities to name alphabetic letters. Of the children in the *small gain* group, 70% to 85% met risk cut-off criteria on one of the sleep, behavior or health variables, and 43% of the children met the risk cut-off criteria on all three variables. The sleep, behavior and health problems were also present in the group of children making larger gains in letter knowledge, but were below the risk cut-off criteria in number and/or magnitude of problems. Only 39% to 43% of these children met the risk criteria for any of the three variables and only 6% met the risk criteria on all three variables. The two groups differed significantly on the number of children characterized by these risk conditions.

The definitions of risk used in the present study associated with sleep duration, problem behaviors and chronic health condition were based on previous research findings concerning typical sleep habits or rates of occurrence in community samples of children, such as those children participating in the present study, rather than in clinical populations. This is an important distinction since many studies use the characteristics of clinical samples in investigating academic outcomes. For example, Taras and Potts-Datema (2005) have linked serious health conditions (AIDS, heart disease, diabetes, epilepsy and leukemia) to poor school achievement in kindergarteners and older children, and Gozal (1998) has demonstrated the impact of serious sleep disturbances, such as sleep disordered breathing, on school achievement in young children. While the risk conditions found to impact outcomes in clinical populations can be used to screen individuals in community samples for the presence of similar conditions, the occurrence rate of very serious problems is often too low to result in significant findings. Indeed, the findings of the present study showed that on average, there were no group differences on measures of sleep duration, problem behaviors and health status. All of the children had scores that were above the lowest score (least risk) on some sleep, behaviors and health items. However, by establishing risk criteria based on research

reports of typical sleep, behavior and health characteristics for young children, group differences were found.

The association between these risk conditions and changes in letter knowledge adds to the information from previous studies of preschool children about how children's characteristics impact learning in the classroom. Several studies have reported the impacts of age, general cognitive and/or sex differences on letter knowledge skills. Our previous research (Molfese et al., 2006) has shown that children making small gains were the younger children in the class (i.e., those who had just turned 4-years-old), children with lower DAS scores, and/or were male. These findings are consistent with those of Rock and Pollack (2002) who reported that fall-to-spring gains by kindergarten males in letter knowledge were significantly smaller than those of females. In that study, however, age was statistically controlled, so the role of age in letter knowledge skills was not analyzed separately. The effects of general cognitive abilities were not reported. Treiman, Tincoff, Rodriguez, Mouzaki, and Francis (1998) reported age effects in children's performance on different types of letter naming tasks, but effects due to general cognitive skills or gender were not explored. It would be helpful to the understanding of early literacy development if there were more consistency across studies in the types of child characteristics that are described and analyzed. Such consistency would be helpful in better identifying and validating which child characteristics impact what types of early learning in which children. Such information is also needed to better understand how the preparation, content knowledge and pedagogy of preschool teachers might be changed to incorporate information about a wider variety of characteristics that influence early learning and school achievement.

Parental reports can be a good source of information about a child's sleep patterns, behavior and health, especially for screening purposes. It is ideal if screening instruments are composed of a small number of items that request readily known information and require only a brief time for parents to complete. The screening instrument, such as that used here, containing questions about sleep patterns, behaviors and health status, is not intended to be a thorough assessment of these characteristics but is a means of determining if and to what extent individual children have characteristics that place them at risk. When such information is combined with other information, such as age, gender, and a school readiness assessment, a stronger picture of the child's status could be provided during an intake assessment. Such an approach has been used effectively by Glascoe (1997, 2000) who used parental reports and an assessment battery to identify children with learning disabilities and impairments, and by Hill (2001) who reported that including parenting practices, parental involvement in the school, and parental expectations along with other information provided by teachers resulted in accurate predictions of early reading and mathematics achievement in kindergarten. Interestingly, Cadman et al (1988) reported that a pre-kindergarten screening battery that used parental reports of health, developmental and behavior history was predictive of children's later academic problems (e.g., grade retention, need for special education, low achievement), but also reported that adding a developmental screening test did not improve predictive accuracy. These results suggest that parental reports about a range of their children's characteristic behaviors and habits at home can provide very useful information. By including parents as participants in evaluations of their children's

school readiness assessments, a relationship is established from which teachers and parents can work to optimize children's early learning.

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