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The literacy environment of preschool classrooms: contributions to children's emergent literacy growth

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This study examined the relations among features of the classroom physical literacy environment (book materials, literacy area and writing materials) and psychological literacy environment (instructional support), and preschool children's gains in two areas of emergent literacy over an academic year. Results showed that features of the physical literacy environment had little direct association with children's gains in emergent literacy, with the exception of quality of literacy area being a positive and significant predictor of children's gains in alphabet knowledge (but not name-writing ability). Rather, the physical and psychological literacy environment seem to be interdependent, particularly with respect to provision of writing materials. Specifically, presence of writing materials is positively and significantly associated with children's growth in alphabet knowledge and name-writing ability only within the context of high-quality, instructionally supportive classrooms. Educational implications are discussed.

The increasing emphasis on improving language and literacy academic outcomes for young children has led to an elevated focus on the quality of preschool classroom literacy environments (e.g. Barnett, Frede, Mobasher & Mohr, 1988; Dickinson & Smith, 1994; Ripple, Gilliam, Chanana & Zigler, 1999; Roskos & Neuman, 2001). Over the last decade, researchers have identified specific features of the classroom literacy environment that appear particularly influential to young children's literacy development (Neuman & Roskos, 1992; Roskos & Neuman, 2001), and these include aspects of the *physical environment* (e.g. classroom layout, access to literacy materials, range of literacy resources) as well as the *psychological environment* (e.g. the literacy-focused interactions between teachers and children).

For the most part, research on the early literacy development of children within preschool settings has focused on the influence of the physical literacy environment (Elley, 1992; Goodman, 1986; Morrow & Weinstein, 1982; Neuman, 1999; Neuman & Roskos, 1992, 1993; Postlethwaite & Ross, 1992; Roskos & Neuman, 2001; Taylor, Blum & Logsdon, 1986), with much less attention focused on the psychological literacy environment (Justice, Mashburn, Hamre & Pianta, 2008; Neuman, 1999). In the present study, we examined the differential and interactive effects of the physical and psychological literacy environment on children's literacy growth within preschool classroom settings, with a particular focus on children considered to be at risk of future learning difficulties due to socioeconomic disadvantage.

The classroom literacy environment

The global quality of classroom environments is typically differentiated in terms of structural (i.e. teacher–child ratio) versus process features (teacher–child interactions; Mashburn et al., 2008), alternatively referred to as the physical and psychological environment. In the present research, we concern ourselves with features of the classroom environment most proximal to supporting young children's literacy development; consequently, our concern is directed towards the physical and psychological *literacy* environments. Concerning the former, the physical literacy environment refers to the design, arrangement and display of various literacy materials within the classroom (Makin, 2003; Wolfersberger, Reutzel, Sudweeks & Fawson, 2004). This dimension largely concerns the organisational structure of the classroom (e.g. presence and location of a classroom library and writing centre) and material resources accessible to children throughout the classroom setting (Wilson, 1987). Within typical preschool classrooms, the physical literacy environment would include storybooks, writing materials, signs and labels and literacy-related play props (e.g. shopping lists, telephone books) that may be available in certain activity contexts (Ingham, 1981; Neuman, 1999; Pumfrey, 1988; Wolfersberger et al., 2004).

Numerous textbooks (e.g. Ingham, 1981; Neuman, 1999) and scholarly articles (e.g. Katim, 1991; Reutzel & Morrow, 2007) provide an abundance of descriptions of exemplary physically rich classroom literacy environments, to include availability of an attractive book centre containing a variety of comfortable seating options (Neuman, 1999; Wolfersberger et al., 2004). According to such descriptions, high-quality classroom libraries contain books that range in difficulty from simple to more complex text, include both expository and narrative texts, have books relating to the current classroom theme and contain a variety of book genres including rhyming texts, alphabet books and 'flap books' (books with flaps that children can manipulate) (Justice, 2006). Print-rich classrooms also have books available throughout the classroom, including dramatic play areas, the block centre and the science table. Books are connected to the ongoing tasks and learning activities that take place in the classroom routine (Reutzel & Morrow, 2007).

Physically rich classroom literacy environments additionally include an appealing writing centre that is reserved for 'young authors' (Phillips, Clancy-Menchetti & Lonigan, 2008). The writing centre contains many different writing tools and materials to promote a variety of writing experiences. Print materials around the writing centre are designed to evoke children's production of functional writing products (e.g. a party invitation, a map, a letter, a newspaper or magazine). Moreover, print-rich classrooms

have print available throughout the environs (e.g. posters, signs, teacher and child writing samples), and these materials are meaningful, related to the classroom theme, and are used throughout the day to enrich children's learning experiences. Several federal funding initiatives have strongly endorsed the strengthening of the physical literacy environment within preschool classrooms, such as Early Reading First (see Justice & Vukelich, 2008).

The above descriptions focus on features of the physical literacy environment, and imply their significance to supporting children's literacy development within preschool classroom settings. Yet, recent research indicates that children's dynamic experience in the classroom is distinct from the physical features of the classroom environment and is characterised primarily by the quality of teacher–student interactions as well as those transpiring among students (Justice et al., 2008; Mashburn et al., 2008; NICHD ECCRN, 2002). The psychological literacy environment, in particular, refers to how teachers interact with children to support their literacy development during classroom activities (Hamre & Pianta, 2005; Justice et al., 2008; Makin, 2003; Pianta & Hamre, 2009; Taylor, Pearson, Peterson & Rodriguez, 2003). In classrooms with psychologically rich literacy environments, teachers provide positive and supportive learning environments characterised by frequent conversations, modelling of complex concepts, process-oriented feedback and explicit discussion of literacy terms and uses (e.g. Hamre & Pianta, 2005; Justice et al., 2008; Makin, 2003; Meehan, Hughes & Cavell, 2003; Pianta & Hamre, 2009; Snow, Burns & Griffin, 1998; Taylor et al., 2003). Recent research has suggested that many preschool classrooms today offer inadequately developed psychological literacy environments. For instance, Justice et al.'s (2008) recent study presenting systematic observations of literacy-focused interactions in 135 pre-kindergarten classrooms showed that the majority could be characterised as offering very modest psychological literacy environments. These findings converge with findings presented by LoCasale-Crouch et al. (2007) showing that about two-thirds of preschool classrooms (from among 692 studied) are characterised by low levels of psychological literacy environment to students.

Such findings are concerning given that some researchers contend that it is the nature of interactions taking place within classrooms, that is, the psychological environment as opposed to the physical, that is most important to children's literacy growth over time (Burchinal et al., 2008; Howes et al., 2008; Mashburn et al., 2008; Neuman & Roskos, 1993; NICHD ECCRN, 2002; Vukelich, 1991). Indeed, recent research of more global features of the physical and psychological environments of preschool classrooms has shown these to be positively interrelated (e.g. teacher–child ratio and instructional support), although measures of the latter are consistently related to children's literacy growth during an academic year, whereas measures of the former are not (Mashburn et al., 2008).

Classroom literacy environment and children's literacy skills

Studies examining features of the classroom literacy environment build upon a growing body of ecologically oriented research showing that the classroom environment is a potential contributing factor for understanding individual differences in the academic achievement of young children (Entwistle, Alexander & Olson, 1997; Neuman, 1996). Ecological theory research defines the term 'environment' as the common contexts of

everyday life (i.e. a behaviour setting), such as shops, classrooms, offices and grocery stores (Baker, 1968). Bronfenbrenner (1999, p. 5) proposed that child development 'take place through process of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate external environment'. Therefore, the organisation, structure and complexity of ecological environment have been documented to have 'coercive power' on the participants within a setting (Gump, 1989). In this respect, the classroom literacy environment, as a specific ecological environment, has been suggested to elicit highly predictable patterns of student behaviour (Barker, Wright, Schoggen & Barker, 1978). Furthermore, it is also apparent that the classroom literacy environment influences children's interactions with literacy-related materials in preschools (Wolfersberger et al., 2004). In fact, what children learn and achieve may vary according to the classroom literacy environment in which they are nested (Neuman & Celano, 2001).

Aspects of both the physical and the psychological literacy environment appear to have behavioural consequences for young children's development of early literacy skills (Christie & Enz, 1992; DeTemple, 2001; Morrow, 1991; Morrow & Rand, 1991; Neuman, 1996, 1999; Neuman & Gallagher, 1994; Neuman & Roskos, 1990; Wasik & Bond, 2001; Whitehurst & Lonigan, 1998). Indeed, there are a number of examples in the literature of the influence that features of the classroom literacy environments can have on children's literacy development. For instance, participating in a print-rich physical literacy environment was found to increase primary-grade pupils' literacy behaviours, including the frequency of reading and writing, which, in turn, promote literacy acquisition (Morrow, 1991). Within the early childhood setting, infusing literacy materials within preschool settings influenced the frequency, duration and complexity of literacy-related play in preschool-aged children (Neuman, 1999; Neuman & Roskos, 1992). Findings such as these suggest that there may be direct linkages between features of the physical literacy environment and young children's literacy achievement.

The psychological literacy environment also influences children's literacy achievements. For example, Christie and Enz (1992) reported that children played more frequently with literacy tools during dramatic play when their teachers directly mediated children's incorporation of literacy tools into their play. Similarly, Vukelich (1991) showed that preschool-aged children spent time demonstrating literacy behaviours in the presence of teacher modelling of literacy-related play, but that children's literacy play decreased sharply when teacher modelling was absent. Considering the psychological environment more broadly, Mashburn and colleagues showed that preschool children within classrooms characterised by high levels of instructional support (e.g. concept development and feedback quality) experienced greater growth on two measures of literacy achievement for preschools, namely rhyme and alphabet knowledge. Such findings suggest that children's participation in frequent, positive teacher–child interactions is an important contributor to children's literacy achievement (Bohannon & Bonvillian, 1997; Justice et al., 2008; Meisels, 2006; NICHD ECCRN, 2000; Rivkin, Hanushek & Kain, 2000; Tannock & Girolametto, 1992).

Although in the previous sections we have considered the physical and psychological literacy environments separately, it is important to note that the coupling of a physically and psychologically rich literacy environment may provide the most optimal literacy-learning context for young children (Christie & Enz, 1992; Nye, Konstantopoulos & Hedges, 2004; Rivkin et al., 2000). Indeed, some studies of 'adult-mediated literacy-enriched play' have explicitly coupled provision of physical literacy resources within

children's classrooms (i.e. literacy props within dramatic play settings) with teacher modelling and scaffolding of children's use of such physical resources (i.e. adult mediation; Christie & Enz, 1992; Neuman & Roskos, 1993; Vukelich, 1991). Experimental studies explicitly comparing children's use of physical literacy resources as well as literacy gains over time show that coupling of physical and psychological literacy resources is more influential to children's literacy development than simply infusing physical literacy resources into children's classrooms. While such findings provide compelling evidence of the importance of both the psychological and physical literacy environment to young children's literacy growth, they do not provide guidance on the nature of the relationship between the physical and psychological environment. For example, the physical environment may be a variable that indirectly influences children's literacy development, whereas the psychological offers direct influence (NICHD ECCRN, 2002). In fact, instructional processes and structures (i.e. the psychological and physical classroom environments) may have very different patterns of predicting child outcomes (Neuman & Cunningham, 2009).

Goals of the present study

In the present study, our goal was to examine the independent and interactive relations of the physical and psychological literacy environment to children's literacy gains over an academic year of preschool. Dimensions of the classroom physical literacy environment studied included book selection (number of books), the book and writing area and availability and quantity of writing materials (Smith & Dickinson, 2002). All of these dimensions have been described as essential components of a high-quality physical literacy environment (Neuman, 1999; Pumfrey, 1988; Wolfersberger et al., 2004). With respect to the psychological literacy environment, we focused specifically on teacher–child interactions within the classroom, particularly teachers' promotion of children's higher-order thinking skills, provision of process-oriented feedback during learning activities and modelling of language forms and functions (Mashburn et al., 2008; Pianta, La Paro & Hamre, 2008). In total, three research questions were addressed:

1. To what extent are there positive associations between the physical and psychological literacy environment of preschool classrooms?
2. To what extent are the physical and psychological literacy environments of preschool classrooms associated with children's literacy gains over an academic year?
3. To what extent are the relations between the physical literacy environment and children's literacy gains moderated by the psychological literacy environment?

Method

Participants

Participants were 30 preschool teachers and children in 38 centres who were enrolled in a larger study of preschool instructional practices. The participants comprised those teachers from the larger study who had contributed data containing all relevant variables needed to address the research questions in this study. Centres were affiliated with Head

Start ($n = 27$) and state-funded Pre-k/Title I ($n = 11$). In terms of race and ethnicity, teachers were Caucasian (75%) and African-American/black (25%). Teachers' highest education level varied: 21% had a master's degree, 36% had a 4-year bachelor degree and 43% had a 2-year Associate's Degree. Teachers reported an average of 11.5 years of teaching experience ($SD = 6.7$, range 0–25 years).

A total of 209 children from these classrooms were randomly selected in the autumn of the year to participate in ongoing literacy assessment. Between five and eight children per classroom were randomly selected for assessments from among all of those for whom caregiver consent was provided. The centres in which children were enrolled all had targeted enrolment policies, in which enrolment was directed towards children (and families) exhibiting some sort of risk, typically based on household income but also presence of disability. Consequently, the majority of children (71%) resided in a household with an annual income $<$US$25,000; 24% resided in households with an annual income between US$25,000 and US$50,000; and 5% resided in households earning $>$US$50,000. At the beginning of the academic year, children's average age was 4 years ($SD = 5.4$ months, range 40–66). More than half of the children were male (54%). In terms of race/ethnicity, 40% of children were white, 42% were African-American/black, 9% were Hispanic/Spanish/Latino, 1% were Asian and 8% were multiracial.

As part of the larger study, teachers were randomly assigned to a treatment or a comparison condition. Teachers in the treatment condition were trained in language-facilitation strategies designed to promote children's engagement and participation in extended conversational exchanges, whereas teachers in the comparison condition received similar amounts of training on a diverse range of topics (e.g. behaviour management). In the present study, our interest was examining the relations among the physical literacy environment, the psychological literacy environment and children's gains above and beyond any effects attributable to treatment conditions. Thus, we included all of the teachers across both the treatment and control conditions, expecting that these relations would not differ across two conditions. However, given the main effects of the treatment condition on children's literacy gains (see Cabell et al., forthcoming), we included treatment condition as a covariate to control for any effects on children's literacy outcomes attributable to teachers' condition assignment.

Measures

Teachers and children participated in a series of activities over the entire academic year to achieve the purposes of the larger study. We describe the procedures relevant to the current study. In the autumn and spring of the year, members of the research team conducted a systematic observation to assess each teacher's classroom literacy environment. Also in the autumn and spring of the year, trained research assistants individually assessed each child's literacy skills.

Literacy environment measures

Physical literacy environment. The Early Language and Literacy Classroom Observation (ELLCO; Smith & Dickinson, 2002) instrument was used to assess the preschool classrooms' physical literacy environment. The ELLCO consists of three parts: (a) literacy environment checklist; (b) classroom observation; and (c) literacy activities rating scale. In the current study, we implemented only the literacy environment checklist to provide an index of each classroom's physical literacy environment. In line with

administration protocols, the literacy environment checklist was completed when the classroom was not in use (Smith & Dickinson, 2002). The observers moved about the classroom, surveyed the general elements of literacy environment and completed the checklist in 15–20 minutes.

The literacy environment checklist consists of 24 variables, which are subdivided into five areas: book area, book selection, book use, writing materials and writing around the room. The administration guide of the ELLCO does not provide evidence of the factor structure of this organisational scheme; therefore, for our purposes, we used an exploratory factor analysis that sorted the 24 items on the literacy environment checklist reliably into three clusters: *Book materials*, which described the number, variety, placement and accessibility of books (cluster 1); *Literacy area*, which addressed the arrangement of the classroom's book and writing area (cluster 2); and *Writing materials* which focused on the variety of writing materials or tools available for children's use (cluster 3). Nine variables showed low communality loading (.002–.499); this level of communality loading (<0.5) suggested a poor fit with the factors. In keeping with standard practice, we eliminated the factors with low communality loading. (A list of deleted variables is available from the first author.) A subsequent exploratory factor analysis using principal factoring and oblique rotation confirmed the three-factor structure. Results showed that internal consistency for each factor was adequate (Book materials: $\alpha = .84$; Literacy area: $\alpha = .80$; Writing materials: $\alpha = .65$). The scores for each variable were summed to create a total score for each factor. Descriptive statistics for classrooms' physical literacy environment are shown in Table 1.

Psychological literacy environment. The Classroom Assessment Scoring System-Pre-k (CLASS; Pianta et al., 2008) was used to assess the psychological literacy environment, specifically the quality of interactions between teachers and children. The CLASS is an observational measure that examines three global domains of teacher–child interactions. Specifically, it comprises nine items measuring three global domains: instructional support, emotional support and classroom organisation. Each is rated along a 1–7 scale, with 1 or 2 representing low-level quality; 3, 4 or 5 representing mid-level quality; and 6 or 7 indicating high-level quality. Prior research has shown that classroom quality captured by the instructional support domain is associated with children's literacy growth (Mashburn et al., 2008). Therefore, in this study, we used the instructional support domain as the index of the psychological literacy environment. This domain is a composite of three separate rating scales: concept development, quality of feedback and language modelling. The concept development scale assesses the teacher's use of instructional strategies to promote children's higher-order thinking and cognitive skills. The quality of feedback scale measures the extent to which the feedback provided by the

Table 1. Descriptive statistics for classroom literacy environment.

Literacy environment feature (maximum score)	*M*	*SD*	Range
Book materials (14)	6.48	3.15	0.5–5.0
Literacy area (5)	3.15	1.50	1.5–12.5
Writing materials (6)	3.63	1.14	1.5–5.5
Instructional support (7)	3.46	0.87	1.8–5.1

Note: Book materials, literacy area and writing material scores from The Early Language and Literacy Classroom Observation (Smith & Dickinson, 2002); instructional support score from Classroom Assessment Scoring System (Pianta et al., 2008).

teacher expands child learning and understanding. The language modelling scale assesses the quality and quantity of teachers' use of language-stimulation techniques. For each scale, there are multiple indicators that define the scale. For example, the indicators for the concept development scale include observing for instances in which the teacher engages children in analysis, reasoning, creating, integrating ideas and making connections to the real world. The CLASS coders used these indicators to score the item along the 7-point scale.

The CLASS observational tool can be used in live observation as well as in videotaped observations. In the current study, we used the videotaped observation approach. Specifically, approximately 2-hour videotapes of the classroom were collected by research assistants in both the autumn and spring of the year. Scoring CLASS from videotapes was conducted in a lab-based setting by research assistants who had completed CLASS training at the University of Virginia (the CLASS development site) to a reliability criterion established by the tool's authors (see Pianta et al., 2008). Specifically, research assistants had to attend a 2-day training workshop conducted by a certified CLASS master coder and achieve 80% coding reliability with six 'gold standard' classroom videotaped examples. The gold standard videotape examples were similar to classrooms participating in this study (i.e. similar teacher–child ratios and pupil demographic characteristics). To minimise the coder bias in CLASS scores for any teacher, about four research assistants were randomly assigned to code 30 teachers.

For the present purposes, the CLASS scores for the domain of instructional support were the averaged scores across the two observation points (autumn, spring). The difference between the mean spring score ($M = 3.40$) and the mean autumn score ($M = 3.51$) was not significantly different ($p = .48$). The internal consistencies for the instructional support domain in our sample were .70. Table 1 presents mean scores and standard deviation for instructional support.

Children's literacy outcomes

Children completed individual assessments of literacy skills in the autumn (Time 1) and spring (Time 2) of the year. Among a larger battery of measures, designed to examine a broad array of developmental outcomes (e.g. vocabulary, phonological awareness, social skills), for the present purposes we included two measures of early literacy skill (alphabet knowledge, name-writing ability) that have been linked to the physical and/or psychological literacy environment. Children's abilities to identify the lower-case letters of the alphabet and to write their own names were assessed using the alphabet knowledge and name-writing subtests, respectively, of the *Phonological Awareness And Literacy Screening-Pre-k* (PALS-Pre-k; Invernizzi, Meier & Sullivan, 2004). For the purpose of this study, we did not use a measure of upper-case letter knowledge as children often achieve ceiling levels on this measure by spring of preschool (just short of transition to kindergarten). For example, the mean of children's upper-case letter scores in spring was 18 letters, corresponding to 70% accuracy in a previous study (Guo, Piasta, Justice & Kaderavek, 2010). For the present study, the mean number of upper-case letters known was 14. The PALS-Pre-k (Invernizzi et al., 2004) has been widely used in previous empirical studies (e.g. Guo et al., 2010; Justice, Kaderavek, Fan, Sofka & Hunt, 2009; Victoria, 2009). Invernizzi et al. (2004) reported that the concurrent validity of the PALS-Pre-k ranged from .41 to .71 with other phonological awareness measures; the predictive validity was from .53 to .56. Children's performance on PALS-Pre-k subtests has been

Table 2. Descriptive statistics (raw scores) for child participants.

Variable	Time 1			Time 2		
	M	*SD*	Range	*M*	*SD*	Range
Lower case alphabet knowledge	4.79	6.78	0–26	12.13	9.47	0–26
Name-writing ability	3.53	2.04	0–7	5.33	1.67	0–7

Note: Alphabet knowledge scores represents number of letters correctly named (out of 26); name-writing ability scored on 7-point score (7 = *accurate representation of name*).

used to create reliable portraits of children's emergent literacy development using cluster analyses (e.g. Cabell et al., 2010).

The PALS-Pre-k alphabet knowledge subtest is a measure of children's knowledge of the 26 lower-case letters of the alphabet. The child is required to name each individual letter within a randomly ordered array; Invernizzi et al. (2004) reported that the inter-rater reliability for this subtest is .99. The PALS name-writing subtest is a measure of children's emergent writing skills; the child is required to draw a portrait of him/herself and then sign it. The child's signature is scored on a 7-point scale. Invernizzi et al. (2004) reported that the inter-rater reliability for name-writing subtest is .99. Table 2 presents children's scores on these two measures at the two time points; for analyses, raw scores were used.

Analytic strategy

For research question 1, which examined the relations between the physical and psychological literacy environments, we used correlation analysis. For the remaining questions (examining the relations among the physical and psychological literacy environment and children's literacy gains), we used hierarchical linear modelling (HLM) to account for the nested nature of the data (children were nested within classrooms, which were nested within preschool centres). Three-level HLM was used to examine the child (level 1), classroom (level 2) and centre (level 3) components.

First, unconditional (i.e. without predictors) for each outcome (i.e. alphabet knowledge, name-writing ability) models were tested to compute the intra-class correlation coefficient (ICC). The unconditional model predicting alphabet knowledge yielded an ICC of .310 at the centre level and .005 at the classroom level, indicating that 68.5% variance in Time 2 alphabet knowledge scores resided between children in the same classroom and the centre; about 0.5% of variance resided systematically between classrooms within the same centre, whereas 31% of the variance resided between centres. Similarly, the ICC (.160 at the centre level and .018 at the classroom level) obtained from the unconditional model predicting name-writing ability indicated that 82% of variance in Time 2 name-writing ability scores was attributable to the difference between children within the same classroom and centre; 1.8% of the variance was attributable to the difference between classrooms within the same centre, whereas 16% of variance was attributable to the difference between centres. Therefore, three-level HLM was used in the present study instead of two-level HLM, given that variance for each outcome (i.e. alphabet knowledge, name writing) at level 3 was significant, but not significant at level 2 from our unconditional models.

Following the first step, we entered child variables at level 1, teacher variables at level 2 and centre variables at level 3. The HLM models included Time 1 scores entered as a

predictor and grand mean centred at the child level (level 1). In this way, residualised gain (Zumbo, 1999) in literacy outcomes was examined. For all HLMs, the level 1 model (equation (1)) predicted the Time 2 scores (Y) of child (i) in classroom (j) in centre (k) as a function of Time 1 scores centred at the grand mean (π_{1j}). In this model, π_{0jk} is the mean of Time 2 scores in classroom j and centre k and e_{ijk} is the child-level error.

$$Y_{ijk} = \pi_{0jk} + \pi_{1j}(T1\ \text{score}) + e_{ijk}. \tag{1}$$

The level 2 models examined changes in child scores (from Time 1 to Time 2) as a function of the physical (i.e. book materials, literacy area and writing materials as measured by the ELLCO) and psychological (i.e. instructional support as measured by the CLASS) literacy environments. All continuous variables were centred at grand means. Equation (2) presents the level 2 model used to measure the direct effects of the physical environment (i.e. book materials [BM], literacy area [LA] and writing materials [WM]). In this model, the mean classroom Time 2 scores (π_{0jk}) are a function of the grand mean (β_{00k}) plus the effects of the physical environment (β_{0jk}) and classroom-level error (γ_{0jk}). Equation (2) represents the physical environment model specifically examining the effect of book materials (BM). We ran two additional versions of equation (2) to consider aspects of literacy area (LA) and writing materials (WM). Based on preliminary analyses showing Time 1 scores (π_{1jk}) as fixed effects, these were modelled simply as a function of the classroom mean (β_{10k}).

$$\begin{aligned} \pi_{0jk} &= \beta_{00k} + \beta_{01k}(\text{BM}) + \gamma_{0jk}, \\ \pi_{1jk} &= \beta_{10k}. \end{aligned} \tag{2}$$

Equation (3) represents the model concerning the direct effect of instructional support (IS).

$$\begin{aligned} \pi_{0jk} &= \beta_{00k} + \beta_{01k}(\text{IS}) + \gamma_{0jk}, \\ \pi_{1jk} &= \beta_{10k}. \end{aligned} \tag{3}$$

Final models included the interactions among book materials, literacy area, writing materials and instructional support. Equation (4) represents the model including the interaction between book materials (BM) and instructional support (IS).

$$\begin{aligned} \pi_{0jk} &= \beta_{00k} + \beta_{01k}(\text{BM}) + \beta_{02k}(\text{IS}) + \beta_{03k}(\text{BM} \times \text{IS})\gamma_{0jk}, \\ \pi_{1jk} &= \beta_{10k.} \end{aligned} \tag{4}$$

In this model, the main effects of book materials (β_{01k}) and instructional support (β_{02k}) are modified by the interaction between book materials and instructional support (β_{03k}). The identical models were run for the interaction between literacy area and instructional support and the interaction between writing materials and instructional support.

At level 3, we included treatment effect (γ_{001}). Treatment status was modelled to control for its potential effects on children outcomes. u_{00k} refers to the school-level error

$$\beta_{00k} = \gamma_{000} + \gamma_{001}(\text{Treatment}) + u_{00k}.$$

Table 3. Correlations between features of physical and psychological literacy environment.

Variable	1	2	3	4
1. Book materials	–	.206	.030	.032
2. Literacy area		–	– .037	.434*
3. Writing materials			–	.179
4. Instructional support				–

*$p < .05$.

Results

Relations between physical and psychological classroom literacy environment

Addressing the first research question, Table 3 presents the bivariate correlations among the dimensions of the physical and psychological literacy environment. Note that the three features of the physical environment were not interrelated. There was a significant association between one aspect of the physical environment – namely the literacy area – and teachers' instructional support, $r = .434$, $p < .05$. However, neither book materials nor writing materials available in the classroom were significantly related to instructional support. Considered together, these findings suggest that the physical and psychological literacy environment of preschool classrooms may be considered somewhat distinct entities.

Physical and psychological literacy environment and children's literacy growth

The second research question investigated the relations among the physical and psychological literacy environment and children's literacy gains over an academic year when accounting for children's incoming performance and teacher's nesting within treatment (treatment was assigned to centres). HLM results demonstrated that the classroom literacy area, one dimension of the physical literacy environment, was a significant predictor of children's alphabet knowledge (residualised change) ($\beta_{01k} = 1.325$, $p = .018$), after controlling for treatment condition. However, neither book materials ($\beta_{01k} = -0.176$, $p = .525$) nor writing materials ($\beta_{01k} = -0.804$, $p = .238$) significantly predicted the residualised change in children's alphabet knowledge, after controlling for treatment condition. In addition, none of the three dimensions of physical literacy environment, book materials ($\beta_{01k} = 0.028$, $p = .640$), literacy area ($\beta_{01k} = 0.176$, $p = .102$) or writing materials ($\beta_{01k} = 0.076$, $p = .539$), significantly predicted residualised change in children's name-writing ability, after controlling for treatment condition.

We also examined the relation between the psychological literacy environment and children's literacy gains. HLM results showed that psychological literacy environment as represented by instructional support did not significantly predict children's gains in alphabet knowledge ($\beta_{01k} = 0.185$, $p = .851$) or name-writing ability ($\beta_{01k} = 0.195$, $p = .297$), after controlling for treatment status.

In sum, these results demonstrated that one dimension of physical literacy environment – literacy area in the classroom – had a significant and positive main effect on children's alphabet knowledge gains; the other two dimensions – book materials and literacy materials – were not associated with children's gains in alphabet knowledge, and no physical dimension was a positive predictor of name-writing ability gains. Finally, there

Table 4. Hierarchical linear modelling results: relations among writing materials, instructional support and children's literacy gains.

Variable	Alphabet knowledge				Name-writing ability			
	Coefficient	*SE*	*df*	*p*-value	Coefficient	*SE*	*df*	*p*-value
Time 2 scores (intercept β_{00k})	12.457	0.877	21	$<.001$	5.528	.131	21	$<.001$
Child-level variable								
Time 1 scores (β_{10k})	0.679	0.111	136	$<.001$	0.331	.054	140	$<.001$
Classroom-level variables								
Writing materials (β_{01k})	-0.876	0.555	26	.126	0.047	.097	26	.632
Instructional support (β_{02k})	0.640	0.645	26	.330	0.205	.133	26	.135
Writing material × instructional support (β_{03k})	1.519	0.303	26	$<.001$	0.283	.077	26	.001
Centre-level variable								
Treatment (γ_{001})	2.487	1.979	21	.223	0.316	.307	21	.315
	Variance	X^2	*df*	*p*-value	Variance	X^2	*df*	*p*-value
Random effects								
Centre level (U_{00})	10.741	67.930	21	$<.001$	0.113	30.960	21	.074
Classroom level (R_0)	0.021	1.801	4	$>.500$	0.001	4.738	4	.315
Child level (E)	41.901				1.674			

Note: Results with robust standard errors reported. Time 2 = spring; alphabet knowledge = scores of alphabet knowledge subtest of Phonological Awareness and Literacy Screening-Pre-k (PALS-Pre-k); name-writing ability = scores of name-writing subtest of PALS-Pre-k.

was no significant main effect of instructional support representing the psychological literacy environment on children's gains in alphabet knowledge and name-writing ability.

Interactions among the physical and psychological literacy environment

The third research question considered the extent to which the relation between the physical literacy environment and children's literacy gains may be moderated by (or dependent upon) the psychological literacy environment. More specifically, we examined whether the association between each of the three dimensions of the physical literacy environment (book materials, literacy area and writing materials) and children's literacy gains was moderated by the instructional support index. For children's alphabet knowledge gains, HLM results showed that the interaction between book materials and instructional support was not significant ($\beta_{03k} = -0.008$, $p = .975$), nor was the interaction between literacy area and instructional support ($\beta_{03k} = -0.080$, $p = .927$). However, the interaction between writing materials and instructional support significantly predicted children's alphabet knowledge ($\beta_{03k} = 1.519$, $p < .001$), see Table 4. Figure 1 depicts this moderating effect. As shown, higher quality of writing materials within classrooms was related to higher alphabet knowledge scores in classrooms where teachers provided high levels of instructional support.

Next, we considered interaction effects associated with children's name-writing ability. Results showed that (a) neither book materials nor literacy area exhibited a significant interaction with instructional support to predict children's name-writing ability gains ($\beta_{03k} = 0.026$, $p = .571$ and $\beta_{03k} = -0.024$, $p = .864$, respectively). However, a positive interaction occurred between writing materials and instructional support ($\beta_{03k} = 0.283$,

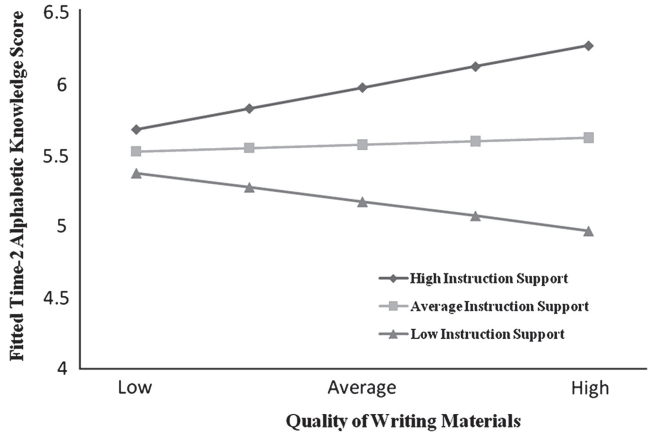

Figure 1. Interaction between writing materials × instructional support on fitted spring alphabet knowledge scores, adjusting for autumn alphabet knowledge scores and treatment status. Instructional support scores fall at the 25th (low), 50th (average) and 75th (high) percentiles. Time 2 = spring.

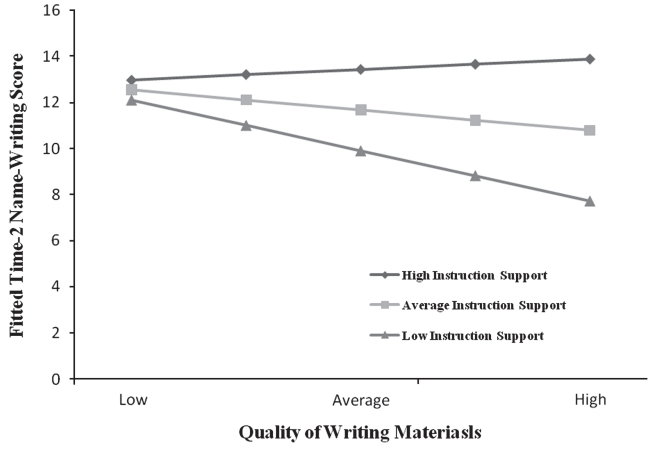

Figure 2. Interaction between writing materials × instructional support on fitted spring name-writing scores, adjusting for autumn name-writing scores and treatment status. Instructional support scores fall at the 25th (low), 50th (average) and 75th (high) percentiles. Time 2 = spring.

$p = .001$, see Table 4), as depicted in Figure 2. This interaction indicates that a higher quality of writing materials was associated with higher name-writing ability gains in classrooms with high levels of instructional support, similar to the finding for alphabet knowledge.

Discussion

The purpose of this study was to investigate relations among the physical and psychological classroom literacy environment and children's literacy gains during preschool. Three major findings emerged from this study. First, the material dimensions

of the physical literacy environment were only weakly associated with the classroom psychological environment (i.e. instructional support); however, organisational dimensions of the physical literacy environment were correlated to the psychological environment. Second, organisational dimensions of the physical literacy environment, rather than material dimensions, were related to children's literacy gains, specifically alphabet knowledge. Third, the psychological literacy environment had little association with children's gains in alphabet knowledge and name-writing ability, unless paired with the presence of a strong literacy environment. We shall discuss each finding in the remainder of this discussion.

Concerning the initial finding, the modest correlations between classroom literacy materials (i.e. presence of reading and writing materials) and the psychological literacy environment suggest that structural features of classrooms may be largely distinct from the dynamic processes that characterise the quality of literacy instruction (see Mashburn et al., 2008). This is consistent with prior research examining the distinction between classroom structural and process features, more globally (Mashburn et al., 2008), and indicates this structure–process distinction extends to the literacy environment, specifically. This finding, however, is somewhat contradictory to the theorised view that a rich physical literacy environment may foster rich and progressive *interactions* with literacy and, thereby, support young children's literacy growth (Bodrova & Leong, 2006; Howes et al., 2008; NICHD ECCRN, 2002). Instead, our findings suggest that a materially rich physical environment may be a necessary but not sufficient condition for creating high-quality, literacy-promoting interactions in the classroom (i.e. creating a rich psychological literacy environment). Indeed research shows that high-quality literacy interactions between teachers and children may be dependent upon teachers' knowledge of language and literacy development, rather than access to material supports (Dickinson & Caswell, 2007; for a discussion see Roskos, Rosemary & Varner, 2006). In fact, even when teachers are using available and structured literacy materials, such as a literacy curriculum, they generally fail to demonstrate high-quality literacy interactions with the children in their classroom (Justice et al., 2008). Our findings further support the field's growing interest in fostering high-quality language and literacy interactions in the preschool classroom and the recognition that such quality improvements may require support beyond that of a rich physical environment.

In contrast to the findings regarding literacy materials in the classroom, the organisational dimensions of the physical literacy environment (i.e. literacy area score) did relate moderately but significantly to quality of instruction (i.e. the psychological literacy environment). Further, this was the only dimension of the physical literacy environment to relate to children's literacy development. Links between the organisation of literacy materials in the classroom and child outcomes have been noted in previous research (Elley, 1992; Goodman, 1986; Morrow & Weinstein, 1982, 1986; Neuman, 1999; Neuman & Roskos, 1992, 1993; Postlethwaite & Ross, 1992; Roskos & Neuman, 2001; Taylor et al., 1986); however, the reasons are not well understood. It may be that in classrooms with well-organised literacy materials, young children are motivated to use these materials, thus exploring and learning about literacy. However, this interpretation does not explain the observed connection of the literacy area score to the quality of literacy instruction (i.e. psychological literacy environment). To understand why the literacy area score related to quality of literacy instruction *and* children's alphabet knowledge gains, it may be important to first consider the items comprising the literacy area score. The literacy area score does not simply represent the volume of reading and

writing materials in the classroom, but rather the extent to which teachers intentionally promote children's literacy exploration through their organisation of materials. For a classroom to receive a high 'literacy area' score, there must be a warm and inviting area for children to explore literacy and the classroom theme must be integrated into these child-centred environmental components. Thus, the literacy area score may represent a type of dynamic process of the classroom important to children's learning and reflective of high-quality teaching. Indeed, this view is consistent with perspectives that see classroom organisation as a dynamic teacher–child process relevant to the construct of classroom quality (Pianta et al., 2008), and important to children's development (Curby, Rimm-Kaufman & Ponitz, 2009; Ponitz, Rimm-Kaufman, Brock & Nathanson, 2008). Although the literacy area score does not measure the interactions between children and teachers directly, it does reflect teacher's *use* of materials in a way that is focused on children's learning. Thus, the literacy area score may reflect a merging of the physical literacy environment and the psychological literacy environment, albeit it in a somewhat passive way (as opposed to direct teacher–child interactional processes). This is possibly the reason why the effects of literacy area on children's alphabetic knowledge are modest albeit significant.

Our third finding indicated that the psychological literacy environment, considered alone, did not predict children's literacy development, but that the interaction of the physical and psychological environment was important to children's alphabet and name-writing gains. Specifically, our findings demonstrated that a combination of higher-quality writing materials in concert with high positive instructional support was associated with children's gains in both alphabet knowledge and name-writing ability. Conversely, children exhibited *less* literacy growth in classrooms with low quality of instructional support, even when there was a high quality of writing materials available in the classroom. This finding extends support to the view that children's literacy development may require a strong physical and psychological literacy environment implemented in concert, which is in line with previous research (Christie & Enz, 1992; Neuman, 1999; Nye et al., 2004; Rivkin et al., 2000). We hypothesise that high-quality instructional support provides a powerful incentive for children to use the available literacy resources and improve their literacy ability (Harms & Clifford, 1980; Neuman & Roskos, 1993). In keeping with a social-interaction perspective, children achieve more when a more capable adult helps negotiate difficult tasks (Vygotsky, 1978). The fact that the interaction of high-quality instruction with *writing materials* rather than reading materials as related to children's outcomes is also interesting. This finding is consistent with recent research showing the value of mediated writing activities to children's literacy-specific accomplishments (Aram & Biron, 2004).

Limitations

To fully situate this work within the extant literature requires recognition of its limitations. First, since our analyses are correlational, we cannot make any causal assumptions. Experimental studies in the future are needed to examine the long-term effects of manipulations to the classroom literacy environment on children's literacy growth.

Second, the preschool classrooms enrolled in the current study served children primarily from low-income families. Evidence suggests that the language skills of low-income children can be quite divergent in comparison with the language abilities of

children from high-income homes (Neuman & Celano, 2006). Thus, the results of these data may not generalise to literacy growth in children from high-income homes. Future research should examine comparative gains in high- versus low-income children in response to preschool literacy environments.

Finally, we did not capture differences in children's home versus school literacy environments. Children's home literacy experiences can exert significant influence on their literacy development (Neuman & Celano, 2001). Future studies should examine the relationship between physical and psychological literacy environment across the home and school contexts.

Implications and conclusions

A goal of federally funded and state early education programmes is to promote emergent literacy skills as an essential component of children's school readiness and later academic success. Research has supported varied routes towards supporting children's emergent literacy skill development, to include the importance of high-quality teaching (e.g. Mashburn et al., 2008) and the availability of literacy materials in the classroom (e.g. Neuman & Roskos, 1992; Roskos & Neuman, 2001). This study highlights the dependency between these two dimensions of preschool classrooms and underscores the need for both high-quality physical and psychological environments as an integrated pathway towards children's literacy development. Stated another way, the role of the preschool teachers is critical to ensuring that literacy-enriched environments succeed in promoting young children's literacy development (Kagan & Cohen, 1997). Although this finding may not be surprising, it suggests that teacher professional development and support needs to be at the forefront of early education policies designed to enhance the quality of classroom support to children's literacy development. This is especially true, given that only one in seven early childcare settings provides high-quality instructional support (Howes et al., 2008). Unlike studies that seek to contrast the contribution of the physical and psychological environmental contributions to children's development, this paper emphasised the interdependent nature of these two classroom dimensions. As such, this paper points to the importance of defining the quality of classroom literacy support as a combination of the physical environment, the psychological environment *and their active integration* for a comprehensive view of classroom quality.

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