CHILD DEVELOPMENT

Child Development, July/August 2011, Volume 82, Number 4, Pages 1058–1075

Trajectories of the Home Learning Environment Across the First 5 Years: Associations With Children's Vocabulary and Literacy Skills at Prekindergarten

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Children's home learning environments were examined in a low-income sample of 1,852 children and families when children were 15, 25, 37, and 63 months. During home visits, children's participation in literacy activities, the quality of mothers' engagements with their children, and the availability of learning materials were assessed, yielding a total learning environment score at each age. At 63 months, children's vocabulary and literacy skills were assessed. Six learning environment trajectories were identified, including environments that were consistently low, environments that were consistently high, and environments characterized by varying patterns of change. The skills of children at the extremes of learning environment trajectories differed by more than 1 *SD* and the timing of learning experiences related to specific emerging skills.

Poverty places children at risk for delays in language development, learning, school readiness, and academic achievement. Already by 3 years of age, children living in low-income households have smaller vocabularies and delayed language skills when compared to their more advantaged peers (Hart & Risley, 1995). Moreover, 3- to 5-year-old children living in poverty are less likely

This work was conducted at New York University's Steinhardt School of Culture, Education, and Human Development and reflects the doctoral dissertation of Eileen T. Rodriguez. The findings reported here are based on research conducted as part of the national Early Head Start Research and Evaluation Project funded by the Administration for Children and Families (ACF), U.S. Department of Health and Human Services under Contract 105-95-1936 to Mathematica Policy Research Inc., Princeton, NJ, and Columbia University's Center for Children and Families, Teachers College, in conjunction with the Early Head Start Research Consortium. The Consortium consists of representatives from 17 programs participating in the evaluation, 15 local research teams, the evaluation contractors, and ACF. Research institutions in the Consortium (and principal researchers) include ACF (Rachel Chazan Cohen, Judith Jerald, Esther Kresh, Helen Raikes, and Louisa Tarullo); Catholic University of America (Michaela Farber, Harriet Liebow, Nancy Taylor, Elizabeth Timberlake, and Shavaun Wall); Columbia University (Lisa Berlin, Christy Brady-Smith, Jeanne Brooks-Gunn, and Allison Sidle Fuligni); Harvard University (Catherine Ayoub, Barbara Alexander Pan, and Catherine Snow); Iowa State University (Dee Draper, Gayle Luze, Susan McBride, and Carla Peterson); Mathematica Policy Research (Kimberly Boller, Jill Constantine, Ellen Eliason Kisker, John M. Love, Diane Paulsell, Christine Ross, Peter Schochet, Cheri Vogel, and Welmoet van Kammen); Medical University of South Carolina (Richard Faldowski, Gui-Young Hong, and Susan Pickrel); Michigan State University (Hiram Fitzgerald, Tom Reischl, and Rachel Schiffman); New York University (Mark Spellmann and Catherine Tamis-LeMonda); University of Arkansas (Robert Bradley, Richard Clubb, Andrea Hart, Mark Swanson, and Leanne Whiteside-Mansell); University of California, Los Angeles (Carollee Howes and Claire Hamilton); University of Colorado Health Sciences Center (Robert Emde, Jon Korfmacher, JoAnn Robinson, Paul Spicer, and Norman Watt); University of Kansas (Jane Atwater, Judith Carta; and Jean Ann Summers); University of Missouri-Columbia (Mark Fine, Jean Ispa, and Kathy Thornburg); University of Pittsburgh (Beth Green, Carol McAllister, and Robert McCall); University of Washington School of Education (Eduardo Armijo and Joseph Stowitschek); University of Washington School of Nursing (Kathryn Barnard and Susan Spieker), and Utah State University (Lisa Boyce, Gina Cook, Catherine Callow-Heusser, and Lori Roggman). The content of this publication does not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. government. We extend our gratitude to Erin E. O'Connor and Mark E. Spellmann for their feedback and support during the preparation of this manuscript. Catherine S. Tamis-LeMonda also acknowledges funding from the National Science Foundation (Grants 0218159 and 0721383), which supports NYU's Center for Research on Culture, Development, and Education.

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 0009-3920/2011/8204-0004
DOI: 10.1111/j.1467-8624.2011.01614.x

to recognize the letters of the alphabet, count to 20, write their names, or read or pretend to read a storybook compared to peers in more resourced families (Nord, Lennon, Liu, & Chandler, 2000). These early differences portend disparities in children's subsequent language growth, cognitive development, school readiness, and academic achievement (Denton & West, 2002; Gershoff, 2003; Rodriguez et al., 2009; Snow, Porche, Tabors, & Harris, 2007). One meta-analytic review indicated effect sizes of .49 and .51 for prediction from children's cognitive and academic skills in preschool and kindergarten to later school outcomes (La Paro & Pianta, 2000). Moreover, children's math, reading, language, and attention skills at kindergarten entry predict measures of academic performance through middle childhood and adolescence (Claessens, Duncan, & Engel, 2009; Duncan et al., 2007; Snow et al., 2007). However, despite lower average performance, children from low-income families display substantial variation in their language and cognitive competencies (Pan, Rowe, Singer, & Snow, 2005; Roberts, Burchinal, & Durham, 1999; Snow, Barnes, Chandler, Goodman, & Hemphill, 1991; Snow et al., 2007), warranting research into the role of early home experiences in children's developing skills.

Children's Early Learning Environment

Bronfenbrenner's (1986) bioecological systems theory emphasizes the interplay of multiple contexts in shaping children's development. At a proximal level, parents are children's first and most important teachers. They promote children's learning and development by structuring multiple aspects of the environment, including: (a) participation in routine literacy activities, (b) supportive parent engagements, and (c) availability of age-appropriate learning materials (Bradley, 2006; Rodriguez et al., 2009).

Participation in *literacy activities* (e.g., bookreading and storytelling) is foundational to children's language growth and emergent literacy. Shared bookreading and exposure to print relate to children's vocabulary size, phonemic awareness, print concept knowledge, and positive attitudes toward literacy (Bus, van IJzendoorn, & Pellegrini, 1995; Dickinson & Tabors, 1991; Raikes et al., 2006; Sénéchal, LeFevre, Hudson, & Lawson, 1996; Snow & Dickinson, 1990). Other supportive literacy activities include reciting nursery rhymes (Baker, Serpell, & Sonnenschein, 1995), participating in activities that facilitate learning of the alphabet, numbers, and letters (Parker, Boak, Griffin, Ripple, & Peay, 1999), and outings to learning venues such as libraries or museums (Payne, Whitehurst, & Angell, 1994; Sénéchal et al., 1996).

The *quality of parents' engagements* with children promotes children's language and cognitive development in a number of ways. Children benefit from exposure to adult speech that is frequent, varied and complex (Dickinson & Tabors, 1991; Hart & Risley, 1995; Weizman & Snow, 2001) and responsive to children's initiatives (Tamis-LeMonda, Bornstein, & Baumwell, 2001; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004). Mothers' sensitivity and stimulation in the first years of life predict children's receptive language (Hann, Osofsky, & Culp, 1996), phonological awareness (Silven, Niemi, & Voeten, 2002), productive language (Beals & DeTemple, 1993; Hart & Risley, 1995), and story comprehension (Beals & DeTemple, 1993).

Finally, the *availability of learning materials* in the home supports children's language and literacy skills (Purcell-Gates, 1996; Sénéchal, LeFevre, Thomas, & Daley, 1998; Tabors, Roach, & Snow, 2001). The number of picture books in the home predicts children's receptive language skills and expressive vocabulary (Payne et al., 1994), and familiarity with books relates to preschoolers' subsequent vocabulary and early reading abilities (Sénéchal et al., 1996). Furthermore, early exposure to toys that promote symbolic play (e.g., cooking sets) and fine motor skills (e.g., blocks) relates to children's early receptive language skills (Tomopoulos et al., 2006), intrinsic motivation, and approaches to learning (Gottfried, Fleming, & Gottfried, 1998).

In a prior report, we examined the unique and combined influences of these three core components of the learning environment on children's language and cognitive skills at and across the ages of 14, 24, and 36 months (Rodriguez et al., 2009). *Each component* contributed uniquely to children's concurrent skills. When considered jointly, experiences at *each age* explained unique variance in children's language and cognitive skills at age 3 years, and predictive associations maintained after controlling for child and family characteristics.

Children's Learning Experiences Across the First 5 Years

Historically, developmental scholars have debated the malleability of human development: How susceptible are specific structures and functions to the influence of particular experiences at

specific periods in the life course? Such questions are core to theories of sensitive periods in development (Bornstein, 1989; Sameroff & Fiese, 2005; Shonkoff & Phillips, 2000).

Specific to the domain of language and cognition, countless studies indicate that children's experiences during the preschool years contribute to their emerging language and cognitive competencies; however, the role of timing in these associations is not entirely clear (e.g., Bruer, 1999; Herrnstein & Murray, 1994). Do the influences of experiences in infancy and toddlerhood endure above those at preschool? Do learning experiences during the preschool years relate to measures of children's school readiness, after controlling for early influences? How do experiences spanning infancy through preschool accumulate in their influences on children's readiness skills? By examining children's learning experiences across a span of 5 years, we ask whether trajectories characterized by peaks and/or declines at different ages differentially predict specific cognitive and language achievements at prekindergarten.

Experiences in the First 3 years

Children's home learning environment may be especially important during the early years—when various language skills are emerging. The amount of speech parents direct to their children before the age of 3 years accounts for over half of the variance in children's cognitive performance and vocabulary at 3 and 9 years of age (Hart & Risley, 1995). Relatedly, a longitudinal study of the home environments of U.S. children revealed stronger associations between learning experiences and language skills in early development (birth to 2 years, 3–5 years) than at later periods (Bradley, Corwyn, Burchinal, McAdoo, & Garcia Coll, 2001).

Experiences During the Prekindergarten Years

In light of the accelerated growth that occurs in children's language skills at prekindergarten (Bates, Bretherton, & Snyder, 1988; Bloom, 1998; Tamis-LeMonda, Cristofaro, Rodriguez, & Bornstein, 2006), experiences beyond the first 3 years are also important to children's emerging skills. Children from low-income backgrounds who experience enriched learning environments during kindergarten learn at rates comparable to their more advantaged peers, even if they displayed delays earlier in development (e.g., Ramey & Ramey, 2004). Similarly, the Head Start Family and Child Experiences Survey found that children with delays at age 3 years showed considerable gains in reading and writing at kindergarten when exposed to enriched environments between 3 and 5 years (Administration for Children and Families, 2003).

Additionally, analyses of the Infant Health and Development Program (IHDP), a multisite randomized early intervention for low birth weight and premature infants (Gross, Spiker, & Haynes, 1997; The Infant Health and Development Program Staff, 1990), revealed that although the effects of the birth to 3-year intervention on children's language and cognitive skills continued to be significant at age 8 years, the magnitude of early effects diminished over time (McCarton et al., 1997). The Early Head Start Research and Evaluation Project (EHSREP) found that children who experienced both Early Head Start (EHS) *and* center-based programs from ages 3 to 5 years fared better than children who received EHS services alone (Administration for Children and Families [ACF], 2006).

Current Study and Analytic Approach

In the current study, we sought to describe distinct learning environment trajectories across children's first 5 years and to relate these patterns to children's vocabulary and emergent literacy skills at prekindergarten. We also asked whether prediction from learning environment trajectories to children's outcomes would maintain in the presence of sociodemographic characteristics of children and families. To these ends, a person-oriented, semiparametric, growth mixture distribution model (e.g., Muthén & Muthén, 2001; Nagin, 2005) was used to identify individual time-course variation in children's learning experiences based on data gathered during home visits when children were 15, 25, 37, and 63 months of age.

Person-oriented approaches assume considerable heterogeneity among individuals in the intercepts and rates of change over time, and in the direction (increasing or decreasing) and shape of change (e.g., linear or quadratic; Windle & Wiesner, 2004). Such models allow identification of population heterogeneity as parameters are free to vary across groups (Nagin & Tremblay, 1999). Thus, a central tenet of these models is that subpopulations of growth curves represent intraindividual trajectories, as such, between-group variation is highlighted (Burchinal & Appelbaum, 1991; McCartney, Burchinal,

& Bub, 2006; NICHD Early Child Care Research Network, 2004).

Person-centered approaches can be contrasted with parametric, variable-centered analyses such as hierarchical linear modeling (Bryk & Raudenbush, 1987; Goldstein, 1995) and latent curve analysis (McArdle & Epstein, 1987; Willet & Sayer, 1994). Variable-centered approaches estimate individual differences among children around a single growth curve thought to capture the developmental course of a nontrivial number of children, even if those children are not assumed to show the same pattern of change over time (Hirsh-Pasek & Burchinal, 2006; Magnusson & Bergman, 1988; Windle & Wiesner, 2004).

Here, we expected to identify qualitatively distinct learning environment trajectories, including trajectories that were consistently low, consistently moderate, and consistently high in quality over time; trajectories characterized by growth over time (shifts from low to high); and trajectories characterized by declines over time (shifts from high to low). We also anticipated that different trajectories might be identified based on the timing of growth or decline (early or later in development). Additionally, associations between children's learning environment trajectories and later skills were expected to shed light on questions about the timing of developmental experiences. If learning experiences early in development (i.e., infancy and toddlerhood) predict prekindergarten academic performance, children with environments characterized as high in quality during their first 3 years should fare better than children whose initial experiences are in the moderate to low range, even if the latter group of children experience growth in their environments by prekindergarten. If concurrent experiences are more influential, the performance of children whose environments are high in quality at prekindergarten should exceed that of children with lower quality environments at prekindergarten, beyond earlier experiences. In line with an additive model of prediction, children with stable high environments were expected to fare best. Finally, to the extent that early versus later experiences predict specific language and literacy skills, experiences during the first 3 years were expected to relate most strongly to children's later vocabulary, given the importance of parent support for children's lexical development during the early years. In contrast, experiences during the prekindergarten period were expected to more strongly predict children's emergent literacy skills, given the development of emergent literacy at the transition to schooling.

Method

Participants

Study participants were drawn from the EHS-REP, an experimental evaluation study conducted in 17 programs across the United States (ACF, 2002). From 1996 to 1999, 3,001 children and families who sought assistance from local community agencies were recruited to participate. EHS programs recruit families with incomes at or below the federal poverty level and are required to use at least 10% of available spaces to enroll families with incomes above the poverty level. Approximately one half of the families were randomly assigned to receive EHS services.

The analysis sample consisted of 1,852 mothers and their children. These participants included those for whom data on home learning experiences were collected during at least one of the four assessment periods of approximately 14, 24, 36, and 60 months child age (i.e., prekindergarten) and for whom at least one outcome measure was obtained at the prekindergarten visit (i.e., Peabody Picture Vocabulary Test [PPVT] or WJ–R Letter-Word Identification). Notably, 90% of the analysis sample included families for whom data was available for at least two of the four data points. Children assessed in Spanish were excluded as the number of children ($N = 170$) assessed in Spanish on the TVIP (the Spanish counterpart of the PPVT) was too small for between-group comparisons.

Nearly two thirds of the children were firstborn (62%), and half were male (50%). Over one third (39%) of the mothers were teens when their children were born, and 25% were married and living with their spouse. Thirty-eight percent of mothers were White ($n = 705$), 34% were African American/Black ($n = 623$), 8% were Hispanic English speaking ($n = 138$), 17% were Hispanic Spanish speaking ($n = 316$), and 4% were from other races ($n = 69$). At the study onset, 53% of mothers had at least a general education diploma (GED) or high school degree, and 45% were employed.

As compared to participants not meeting criteria for inclusion in the current study ($n = 1,149$), the analysis sample ($n = 1,852$) included a slightly smaller proportion of low birth weight (11% vs. 8%, $\chi^2 = 4.21$, $p < .05$) and cognitively delayed children (10% vs. 7%, $\chi^2 = 5.21$, $p < .05$), fewer Hispanic English-speaking mothers (13% vs. 8%) and more Hispanic Spanish-speaking mothers (9% vs. 17%, $\chi^2 = 67.68$, $p < .001$), more mothers who were employed (32% vs. 45%, $\chi^2 = 50.25$, $p < .001$), and a slightly larger proportion of families who were

receiving EHS services (48% vs. 52%, $\chi^2 = 4.80$, $p < .05$). Despite differences between the samples, there was substantial representation of all major subgroups in the analysis sample.

Procedures

Program staff obtained baseline data from all families at enrollment using the Head Start Family Information System (HSFIS) program application and enrollment forms. At each age, data collection included a 45-min parent interview, direct assessments of children's language and cognitive abilities, and a 10-min videotaped session of mother–child play. Interviewers completed a checklist on observations of the home environment at the end of each visit.

For the play sessions at the first three waves, dyads were presented with three bags containing a book and a standard set of age-appropriate toys (i.e., children's book, a cooking set, and a Noah's Ark set with various animals at 15 and 25 months; children's book, a cash register and grocery items, and interlocking blocks at 37 months). Mothers were asked to begin with Bag 1 and to finish with Bag 3, and to divide the time spent on each bag as they chose. At the prekindergarten visit, dyads were presented with two cans of Play-Doh, a cookie cutter, a rolling pin, and a protective board; after 8 min of play, they were given 2 min to clean up.

Measures

Children's Learning Experiences at 15, 25, and 37 Months and Prekindergarten

At each age, assessments of children's early learning experiences were based on select items from maternal interviews, coding of videotaped mother–child play sessions, and the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984). The process of item selection involved review of the study protocols by a team of researchers from four EHSREP sites (see Rodriguez et al., 2009, for further discussion of variable selection).

Literacy activities. During 15-, 25-, and 37-month interviews, mothers were asked about the frequencies with which they engaged in each of three activities with their children: shared bookreading, storytelling, and singing nursery rhymes. The frequency of each activity was assessed on a 6-point Likert scale ranging from *not at all* to *more than once a day*. Mothers were also asked whether they engaged in shared bookreading or storytelling as part their children's regular bedtime routine. At 37 months, the set of literacy activities was expanded to include the frequencies that other family members read stories to the focus child, that mothers took the child to a children's museum, that other family members took the focus child to a children's museum, and whether mothers or other adults in the household helped the child learn: letters of the alphabet, numbers, shapes, and sizes, and colors. At the prekindergarten assessment, mothers were asked about the frequencies with which they or other family members engaged in each of three activities with their child: shared bookreading (ranging from *not at all* to *every day*), storytelling (ranging from *zero times* to *three or more times*), and teaching letters, words, or numbers (ranging from *zero times* to *three or more times*). Mothers were also asked whether they read anything other than books with their child, and whether they or other family members had taken their child to a children's museum in the past year.

Quality of maternal engagement. Assessments of maternal engagement were based on coding of videotaped mother–child play sessions, as well as selected observational items from the HOME (Caldwell & Bradley, 1984). HOME items included whether or not mothers vocalized to or conversed with their child, responded verbally to their child's vocalizations or requests, labeled objects or people in the environment (15 and 25 months only), acknowledged their child's vocalizations (37 months only), encouraged their child to talk (prekindergarten only), used speech that was clear and complex (15, 25, and 37 months only), and used complex sentence structure and long words in conversing (prekindergarten only).

The coding of mother–child play sessions at 15, 25, and 37 months was based on the Child–Parent Interaction Rating Scales for the Three-Bag Assessment (Brady-Smith, O'Brien, Berlin, Ware, & Fauth, 2000). The prekindergarten play session was coded using the Parent–Child Interaction Rating Scales for the Play-Doh Task (Fauth, Brady-Smith, & Brooks-Gunn, 2003). Collectively, the scales assess a number of mother and child behaviors. For purposes of the current study, two mother behaviors were used as indicators of the quality of maternal engagement: Sensitivity/Supportiveness and Stimulation of Cognitive Development.

Sensitivity/Supportiveness assessed the degree to which the mother contingently responded to her child's needs and cues (e.g., gestures, vocalizations).

Stimulation of Cognitive Development measured the quality and quantity of mother's effortful teaching aimed at enhancing the child's perceptual, cognitive, and language development. Items were rated on a 7-point Likert scale, ranging from *very low incidence* to *very high incidence*. Interrater reliabilities were established on the nine 7-point scales to a criterion of 85%, allowing for a 1-point difference in scores. Interclass correlation coefficients (ICC) were based on comparisons of each coder's ratings to a gold standard coder. The ICCs for Sensitivity/Supportiveness were .70, .72, .63, and .70 at the 15-, 25-, 37-month and prekindergarten visits, respectively. For Cognitive Stimulation, ICCs were .71, .68, .59, and .74, respectively (ACF, 2002; Ispa et al., 2004).

Provision of learning materials. The provision of learning materials was assessed using a combination of maternal reports and interviewer observations from the HOME (Caldwell & Bradley, 1984). At 15 and 25 months, learning materials included the availability of children's books, toys supporting complex eye–hand coordination (e.g., crayons, alphabet blocks), role-playing toys (e.g., teddy bear), and toys that allow the child to make music. Each item was assessed on a 4-point Likert scale ranging from *none* to *5 or more*. At 37 months, items included the availability of children's books (ranging from *none* to *10 or more*), materials for play and leisure, and access to various audio and video devices. At the prekindergarten visit, items included the availability of children's books (ranging from *one to ten* to *more than fifty*), toys or games permitting free expression (e.g., crayons, puppets), toys or games for fine motor skills (e.g., interlocking blocks), toys or games facilitating learning numbers, toys that teach the names of animals, and whether the child had access to various audio and video devices.

Learning environment composite measures. Using these multiple items for each of the three components of the learning environment, composite scores ranging from 0 to 2 were created for literacy activities, the quality of maternal engagement, and provision of learning materials at each age (see Table 1). These were summed for a *total learning environment score* (range = 0–6) at each of the ages (see Rodriguez et al., 2009).

A number of steps were taken to support the measurement equivalence and validity of the component and total scores at each age. Confirmatory factor analysis on item-level data supported a unitary factor structure for variables comprising each of the three components of the environment, with all items demonstrating modest to strong loadings on their respective factors. Moreover, despite subtle variations in the item content across the four ages, the individual item loadings were comparable at the different ages. Individual item loadings for the set of indicators representing literacy activities ranged from .53 to .82 at 15 months, .56 to .83 at 25 months, .36 to .74 at 37 months, and .66 to .73 at 63 months. For maternal engagement, item loadings ranged from .47 to .74 at 15 months, .45 to .66 at 25 months, .44 to .78 at 37 months, and .44 to .76 at 63 months. For learning materials, item loadings ranged from .63 to .75 at 15 months, .64 to .75 at 25 months, .66 to .72 at 37 months, and .84 to .91 at 63 months. At each age, the three component scores were correlated (rs = .18–.24 at 15 months, .19–.23 at 25 months, .16–.25 at 37 months, and .14–.32 at prekindergarten, ps < .001). Across age, there was moderate to strong stability for each of the scores; cross-age correlations ranged from .32 to .39 for literacy activities, .28 to .41 for maternal engagement, and .33 to .41 for materials (ps < .001).

We also applied confirmatory factor analysis to the three component scores that comprised the total learning environment measure. This analysis supported a unitary factor structure at each age, with roughly equivalent loadings for each component on the total score over developmental time (loadings

Table 1
Descriptive Statistics for Learning Environment Component Indices and Child Cognitive and Language Abilities

	15 months	25 months	37 months	63 months
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Learning environment component indices				
Literacy activities	0.95 (0.58)	1.10 (0.60)	1.24 (0.62)	0.75 (0.81)
Maternal engagement	0.67 (0.72)	0.79 (0.76)	0.78 (0.79)	0.81 (0.76)
Learning materials	0.98 (0.64)	1.10 (0.62)	1.11 (0.65)	0.95 (0.83)
Child cognition and language				
Bayley MDI[a]	98.51 (9.87)			
PPVT				91.43 (15.27)
Letter-Word Identification				88.72 (14.63)

Note. MDI = Mental Development Index; PPVT = Peabody Picture Vocabulary Test.
[a]Children's 15-month Bayley MDI score was entered as a covariate in all models.

ranged from .68 to .72 for literacy activities, .60 to .67 for maternal engagement, and .70 to .78 for learning materials). This supports the validity of the component scores and suggests equivalent constructs across the four assessments. Cronbach's alphas for the total learning environment scales at each of the four ages were .70, .72, .73, and .80.

Dependent Measures: Children's Vocabulary and Emergent Literacy Skills at Prekindergarten

Children's performance on two standardized assessments of school readiness served as the outcome measures: the Peabody Picture Vocabulary Test–III (PPVT–III; Dunn & Dunn, 1997) and the Letter–Word Identification subtest of the Woodcock–Johnson Tests of Achievement (WJ–R; Woodcock & Johnson, 1989).

Peabody Picture Vocabulary Test, Third Edition. The PPVT–III (Dunn & Dunn, 1997) is a widely used measure of receptive vocabulary. Children are presented with a series of four illustrations and asked to point to the picture that best corresponds to the examiner's spoken word. Items are ordered by level of difficulty and testing continues until a ceiling is reached, as defined by 8 or more errors within a set of 12. The PPVT–III has good internal consistency reliability (Cronbach's αs = .92–.98) and correlates highly (rs = .80–.90) with measures of cognitive ability (WISC–III, K–BIT).

Woodcock–Johnson Revised Tests of Achievement, Form B. Children were administered the Letter–Word Identification subtest of the Woodcock–Johnson Revised Tests of Achievement, Form B (Woodcock & Johnson, 1989). This subtest yields a measure of children's emergent literacy skills. With children of this age, initial items tap letter knowledge and word recognition; as testing progresses, items increase in difficulty to yield a measure of children's early reading skills. Testing continues until children reach a ceiling, as defined by six consecutive errors or nonresponses. The WJ–R has good internal consistency reliability (Cronbach's αs = .80–.90).

Control Variables

A set of 10 child and family controls were included in models that examined associations between learning environment trajectories and children's performance at prekindergarten (see below). The inclusion of controls in models addressed potential endogeneity, or the possibility that associations from learning environment trajectories to children's readiness might be explained by third variables or unobserved characteristics of children and families. It also addressed the robustness of the learning environment effects in the face of potentially meaningful predictors (Lugo-Gil & Tamis-LeMonda, 2008; NICHD Early Child Care Research Network & Duncan, 2003).

Demographic data. Information on child gender, birth order and birth weight, mothers' age at focus child's birth (i.e., teen status), maternal race/ethnicity, education and marital status (i.e., whether the mother was married and living with a spouse), and household income were collected at baseline. Data on mothers' employment status (i.e., employed vs. not employed) was obtained during the 15-month visit. Race/ethnicity categories included a breakdown of Hispanic primary caregivers into English-speaking versus Spanish-speaking subgroups. We distinguished between English-speaking and Spanish-speaking Hispanic mothers so as to better interpret children's vocabulary and emergent literacy outcomes.

Bayley Mental Development Index. The Bayley Mental Development Index (MDI) is one of three component scales of the Bayley Scales of Infant Development–Second Edition (BSID–II; Bayley, 1993). The MDI was administered to children at 15 months of age for control in regressions. It includes items that assess memory, problem solving, generalization skills, classification abilities, early number concepts, and emerging language. The MDI is associated with other observational measures of children's language (e.g., word types and tokens) in low-income EHS populations (Pan, Rowe, Spier, & Tamis-LeMonda, 2004) and correlates with other cognitive tests including the McCarthy Scales of Children's Abilities (r = .79) and the Wechsler Preschool and Primary Scale of Intelligence–Revised (r = .73).

Results

Results are organized around the goals of: (a) identifying qualitatively distinct trajectories of children's learning environments and (b) relating those trajectories to children's vocabulary and emergent literacy skills at age 5.

Variation in Children's Learning Experiences Over Time

A semiparametric, group-based modeling approach (Jones, Nagin, & Roeder, 2001; Nagin, 1999, 2005; Nagin & Tremblay, 1999) was used to identify learning environment trajectories. Modeling proce-

dures involve estimating growth curves for each individual, and then identifying prototypic group curves based on the individual trajectories estimated for each population member. The degree to which each individual's growth curve resembles each of the prototypic group curves is estimated by posterior probabilities (ranging from 0 to 1); individuals are classified into the trajectory group for which they have the highest probability of membership. Model parameters are estimated using a maximum likelihood approach that permits for missing values (Jones et al., 2001; Nagin, 2005). Thus, model outputs include the shape of each trajectory (patterns of stability and change), the estimated proportion of the population belonging to each trajectory, and the probability that each individual belongs to each group.

The model selection process involved estimating a series of models that specified varying numbers of trajectory groups (e.g., four-, five-, and six-group solutions). Decisions about the optimal number of groups, as well as their shape (linear or quadratic), were guided by the Bayesian information criterion (BIC); solutions across multiple models were examined and the model with the largest BIC (indicating better model fit) was selected. Specifically, a quadratic growth curve model was specified; that is, quadratic curves were specified for all the groups in the initial model being tested. If a group did not reach significance on a higher order term (quadratic), specifications were changed to a lower order term (linear). This procedure was repeated until parameter estimates for all of the trajectories in the model were significant. Given that nonlinear functions such as logistic growth curves or higher order polynomial functions (e.g., cubic growth curves that describe change that is S-shaped) require five or more repeated assessments, trajectories were not tested to this level of specificity (McCartney et al., 2006).

Using the above criteria, a six-group model was selected (BIC = −9,962.33). There were small differences in the BIC estimates of the five-, six-, seven- and eight-group solutions. However, upon closer examination of the trajectories, it was decided to err on the side of parsimony and to select the six-group model in order to retain power for the subsequent analyses. Moreover, the six-group solution was favored over the five-group solution because it yielded an additional trajectory group of theoretical interest: children whose learning environments were relatively high at 15 months but declined thereafter (Group 5). The posterior probabilities of group membership for the six-group model were also superior to those for competing models.

Parameter and group membership estimates for trajectories in the selected model were all significant at the $p < .01$ level. Model fit was also indexed using posterior probability estimates, which as previously noted, provide an indicator of how well individuals' growth curves resemble each of the identified trajectories. The mean posterior probability scores for each of the six trajectory groups were: $M = 0.69$ for Group 1, $M = 0.68$ for Group 2, $M = 0.80$ for Group 3, $M = 0.70$ for Group 4, $M = 0.64$ for Group 5, and $M = 0.78$ for Group 6. These probabilities are acceptable, although lower than desired, perhaps reflecting the truncated variation in the clustering variables of the total learning environment at each age.

Descriptive statistics on children's learning environment scores at each age by trajectory group are presented in Table 2. Overall means and standard deviations of children's learning environment composite scores across all groups, based on a possible

Table 2
Means and Standard Deviations of Learning Environment Composite Scores at Each Age by Trajectory Group

		Learning environment composite score			
	n	15 months *M* (*SD*)	25 months *M* (*SD*)	37 months *M* (*SD*)	63 months *M* (*SD*)
Learning environment trajectory group					
1. Low rise	61	0.72 (0.51)	0.98 (0.63)	1.31 (0.81)	1.63 (0.94)
2. Low decline	143	1.30 (0.80)	1.28 (0.80)	1.11 (0.68)	0.11 (0.09)
3. Moderate decline	845	2.10 (0.93)	2.62 (0.98)	2.72 (1.03)	1.50 (0.88)
4. Moderate rise	578	3.02 (0.90)	3.39 (0.96)	3.57 (1.04)	3.67 (0.89)
5. High decline	48	4.34 (0.76)	4.26 (0.79)	3.86 (0.88)	2.51 (0.81)
6. High stable	177	4.19 (0.91)	4.63 (0.83)	5.01 (0.83)	4.61 (0.97)

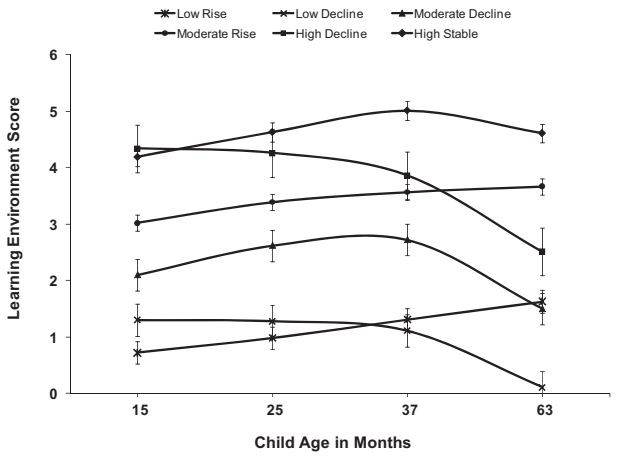

Figure 1. Trajectories of children's learning environments from 15 months to 63 months.

range of 0 to 6, averaged: $M = 2.63$ ($SD = 1.35$) at 15 months, $M = 3.00$ ($SD = 1.37$) at 25 months, $M = 3.14$ ($SD = 1.42$) at 37 months, and $M = 2.42$ ($SD = 1.65$) at prekindergarten.

However, these overall mean scores mask the variation in patterns of learning environments across the six groups. The six trajectory groups revealed differences in their intercepts, shapes, and rates of change over time. Each group was labeled based on initial intercept level and general pattern of change over time. As Figure 1 illustrates, Groups 1 and 2 were characterized by overall average scores in the low range. Children in Group 1, *low rise* ($n = 61$), experienced environments that were low in quality at 15 months and showed a pattern of consistent yet small increases over consecutive assessments. Children in Group 2, *low decline* ($n = 143$), experienced environments characterized by similarly low mean scores at 15 months (albeit slightly higher than those of Group 1) that were sustained through 37 months and then declined to even lower levels by 63 months. Approximately half ($n = 845$) of the children were clustered in Group 3, *moderate decline*, a quadratic pattern characterized by moderate levels that were stable through 37 months and declined thereafter. One third ($n = 578$) of the children experienced environments that were moderate in quality across the four ages, with a pattern of consistent growth across assessments (Group 4, *moderate rise*). Children in Group 5, *high decline* ($n = 48$), experienced high-quality environments at 15 months that showed a downward trajectory over time, with scores reaching moderate levels by 63 months. Finally, approximately 10% of the children ($n = 177$) were clustered in Group 6, *high stable*. These children experienced the most optimal environments—a quadratic pattern characterized by average scores in the high range that increased slightly from 15 months to 37 months and were sustained thereafter.

Subscores of the Learning Environment by Trajectory Group

Children experienced qualitatively distinct trajectories when considering their *total* learning environment scores across the four ages. Notably, children of the six trajectory groups also diverged on virtually all the *subscores* that comprised these total scores (literacy activities, maternal engagement, and learning materials) at every age, based on post hoc comparisons of component scores. Specifically, we conducted a set of one-way analyses of variance (ANOVAs; with trajectory group as the between-subjects factor) with Bonferroni correction for chance. This yielded a total of 180 post hoc comparisons—4 ages × 3 components × 15 trajectory group comparisons (Group 1 vs. 2, 3, 4, 5, 6; Group 2 vs. 3, 4, 5, 6; and so on)—156 (87%) of which were significant. The exceptions paralleled patterns found among the trajectory groups illustrated in Figure 1. For example, children in the high decline and high stable groups did not differ significantly on their total learning environment scores at 15 and 25 months, nor on any of the three component scores at these ages; by 37 months, they differed on maternal engagement and learning materials, which was likewise reflected in a significant difference on their total learning environment score; by 63 months they differed on all three components and on their total scores. This pattern mirrors that for the trajectories of the two groups of children, which shows increasing divergence in total learning environments over time.

Sociodemographic Correlates of Learning Environment Trajectories

The sociodemographic characteristics of children and families by group membership were next examined (Table 3). As shown, chi-square analyses revealed significant overall group differences in children's general cognitive ability, with children delayed on the Bayley MDI (scores below 85) being overrepresented in trajectories characterized by low average scores (low rise and low decline). Children of mothers who were teens at the time of the focus child's birth were more likely to experience learning environments in the low to moderate range. Differences were also

Table 3
Sample Characteristics and Child Outcomes by Trajectory Group Membership

	Learning environment trajectory group						
	Low rise	Low decline	Moderate decline	Moderate rise	High decline	High stable	$\chi^2/F(df)$
N	61	143	845	578	48	177	
Sample characteristic							
Gender = male	57.4%	49.7%	53.1%	46.4%	52.1%	48.6%	7.69
Birth order = firstborn	59.0%	53.5%	62.9%	62.8%	62.5%	62.9%	5.09
Birth weight < 5 lb. 8 oz.	8.6%	8.7%	8.0%	9.2%	6.8%	4.1%	4.27
15-month MDI < 85	16.4%	13.3%	7.6%	6.3%	2.1%	3.5%	20.37***
Maternal age < 20 years	37.3%	41.8%	43.5%	36.9%	25.5%	29.4%	18.65**
Race/language							222.52***
White	8.3%	12.1%	32.6%	51.2%	54.3%	66.1%	
African American	33.3%	56.0%	40.1%	28.2%	26.1%	17.3%	
Hispanic/English	3.3%	5.7%	8.5%	7.3%	8.7%	8.3%	
Hispanic/Spanish	55.0%	26.2%	18.8%	13.3%	10.9%	8.3%	
Maternal education							187.32***
Less than HS/GED	78.9%	70.6%	52.6%	39.5%	27.3%	19.8%	
HS/GED	12.3%	22.6%	31.1%	31.2%	31.8%	29.3%	
More than HS/GED	8.8%	6.8%	16.3%	29.4%	40.9%	50.9%	
Mother is employed	36.1%	36.7%	42.7%	44.4%	60.4%	59.9%	28.15***
Mother lives with husband	32.8%	19.9%	20.2%	29.1%	25.0%	34.5%	27.99***
Income (% of poverty)							40.21***
< 33%	34.0%	47.5%	31.7%	28.2%	22.7%	18.7%	
33%–67%	25.5%	23.7%	30.4%	31.1%	34.1%	29.3%	
67%–99%	27.7%	25.4%	24.5%	26.9%	22.7%	34.0%	
100% or more	12.8%	3.4%	13.4%	13.9%	20.5%	18.0%	
Child Pre-K Outcomes							
PPVT	78.38_{a}	81.51_{a}	87.91	94.60_{b}	100.42_{bc}	104.59_{c}	68.64 (5, 1667)***
Letter–Word Identification	81.38_{ab}	82.03_{a}	86.58_{bc}	91.70_{d}	89.69_{cd}	96.95	30.99 (5, 1839)***

Note. Means in the same row that share subscripts do not significantly differ at $p < .05$ based on Bonferroni difference comparisons. MDI = Mental Development Index; GED = general education diploma; PPVT = Peabody Picture Vocabulary Test.
**$p < .01$. ***$p < .001$.

observed by mothers' race/ethnicity: Children of White mothers were more likely to experience moderate rise, high decline, and high stable environments; children of African American mothers were more likely to experience low rise and low decline environments; and children of Hispanic Spanish-speaking mothers were overrepresented in low rise trajectories.

Measures of family human capital were also associated with trajectory group membership. Children of mothers with fewer than 12 years of education were disproportionately represented in the low rise and low decline groups, as well as in moderate decline environments. Conversely, children of mothers with more than 12 years of education were more likely to experience moderate rise, high decline and high stable environments. Maternal employment was associated with high decline and high stable environments. Differences among groups were also observed for marital status, with children of married mothers being more likely to experience environments at the two extremes, low rise and high stable. Finally, children living in families with incomes below 33% of the poverty level were overrepresented in the low decline group.

Learning Environment Trajectories and Language and Literacy Skills

The second research goal was focused on associations between children's learning environment trajectories and performance on standardized measures of vocabulary and emergent literacy prior to kindergarten entry. At the bivariate level, total learning environment scores at each of the four ages were significantly associated with all prekindergarten measures (*r*s = .35–.38 for the PPVT, .24–.29 for Letter–Word Identification, *p*s < .001).

Outcomes in Children With Different Trajectories

In terms of learning environment trajectories, a one-way ANOVA with trajectory group as a between-subjects factor was conducted for each of the child prekindergarten outcomes separately (see bottom of Table 3). Children at the extremes of learning environments displayed differences in standardized scores of nearly 30 points. The majority (71%) of children in the low rise group and 56% of children in the low decline group performed in the delayed range on the PPVT (scores < 85), and only 7% of children in the low rise group and 6% of children in the low decline group scored in the normal range on the PPVT (i.e., ≥ 100). In contrast, only 8% of children in the high stable group performed in the delayed range on the PPVT, with 70% achieving scores ≥ 100. A similar pattern was observed for children's performance on the Letter–Word Identification subtest of the WJ–R.

The adjusted means for these analyses are illustrated in Figure 2. Covariates included whether the child was male, whether the child was firstborn, whether the child was of low birth weight status (< 5 lb 8 oz), mother's teen status at birth of child, mother's race/ethnicity (African American, Hispanic English speaking, Hispanic Spanish speaking, with White as the omitted reference group), mother's highest level of education (high school or GED diploma, greater than high school or GED diploma, with fewer than 12 years of education as the omitted reference group), whether the mother was employed, whether the mother was married to and living with a spouse, and household income. Models also controlled for children's cognitive ability at 15 months, program status (family received EHS services), and program site (inclusion of 16 dummy variables, with one site serving as the excluded reference group). As shown, children's prekindergarten vocabulary and emergent literacy skills were still strongly predicted by their learning environment trajectories. However, as might be expected, associations to children's outcomes slightly attenuate with the inclusion of controls in the model. For example, when no controls were included in the model, the PPVT scores of children in the low rise and high stable groups were 78 and 104, respectively—a difference of 26 points. When the characteristics of children and families were likewise considered, the PPVT scores of children in the low rise (M = 83) and high stable (M = 101) groups differed by 18 points.

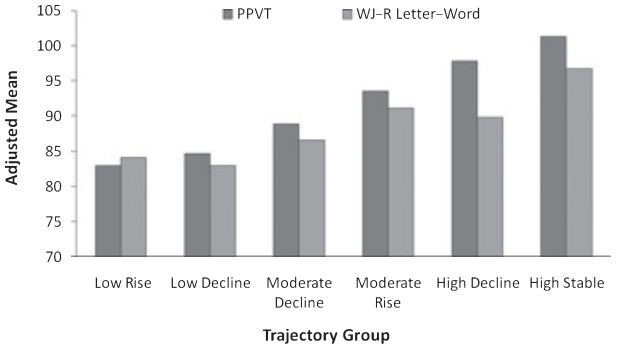

Figure 2. Adjusted means for children's prekindergarten vocabulary and emergent literacy skills by trajectory group. *Note.* PPVT = Peabody Picture Vocabulary Test; WJ = Woodcock–Johnson Revised Test.

The Timing of Children's Learning Experiences

The final set of analyses addressed more specific questions regarding the *timing* of learning experiences on children's vocabulary and emergent literacy skills. These questions were addressed using analysis of covariance (ANCOVA) models with planned contrasts, as well as regression analyses. The covariates noted above were included in both sets of analyses. Thus, the tested models present an extremely conservative test of the influence of learning environments on children's prekindergarten skills, especially by covarying early child measures already associated with and likely shaped by children's home experiences up to and at that point in time.

Planned contrasts

ANCOVA models using two planned contrasts (i.e., low rise vs. moderate decline, high decline vs. high stable) were conducted for each of the dependent measures. For significant contrasts, effect sizes (d) were computed as the difference between the adjusted group means divided by the estimated standard deviation under the analysis model. Using Cohen's (1988) recommendations, differences of 0.70 or greater were considered large, 0.40–0.70 were considered moderate, and less than 0.40 were considered small.

To explore the role of children's *early learning experiences*, the skills of children in the low rise and moderate decline groups were contrasted. Children in the moderate decline group experienced higher quality environments at 15 months (M = 2.10) as compared to children in the low rise group (M = 0.72). However, the average prekindergarten learning environment scores for children in these two groups were virtually identical (Ms = 1.63 and 1.50,

respectively). Thus, if experiences during the first 3 years are foundational to children's school readiness skills, children in the moderate decline group should outperform those in the low rise group.

These analyses yielded a moderate effect size when the receptive language skills of children in these two groups were compared. Specifically, children in the moderate decline group scored significantly higher on the PPVT at prekindergarten than did children in the low rise group, contrast estimate = 5.89, SE = 2.10, $F(1, 1637) = 7.86$, d = 0.41, $p < .01$. No significant group differences were found on the Letter–Word Identification subtest of the WJ–R.

To test the role of *experiences at prekindergarten*, the scores of children in the high decline and high stable groups were contrasted. Children in these two groups experienced similar learning environments at 15 months (Ms = 4.34 and 4.19, respectively); however, unlike children in the high stable group, the learning environments of children in the high decline group were not sustained over time, with average scores showing considerable decline by prekindergarten (Ms = 2.51 vs. 4.61, respectively). If experiences during the preschool years provide added benefits beyond those of earlier experiences, children in the high stable group should outperform those in the high decline group on prekindergarten measures of school readiness.

Findings of this analysis highlight the importance of contemporaneous learning experiences for children's prekindergarten letter–word identification skills. A moderate effect size emerged when comparing the skills of children in the high stable group to those in the high decline group. Specifically, the average scores of children in the high stable group were significantly higher than those of children in the high decline group on the WJ–R Letter–Word Identification subtest, contrast estimate = 6.95, SE = 2.18, $F(1, 1809) = 10.15$, d = 0.52, $p < .001$. No significant group differences emerged on the PPVT.

Regression Models

The above planned contrasts were based on the subset of children who experienced select trajectories, with certain subgroups relying on relatively small samples. We therefore sought to confirm these patterns in the entire sample of children (n = 1,852) using regression analyses. Specifically, we examined the unique and combined contributions of the *early* and *later* learning environment on children's vocabulary and emergent literacy skills. In these analyses, child and family sociodemographic characteristics were entered in the first step of models. The second step of models included the early learning environment score (based on averaging of the total learning environment scores at 15, 25, and 37 months), the later learning environment score (i.e., the total score at 63 months), and the interaction between the two.

Findings paralleled those of the person-centered approach. Specifically, only the early learning environment predicted children's PPVT scores at prekindergarten (β = .109, p = .004); neither the later environment (β = .069, p = .184) nor the interaction between the two (β = .108, p = .112) was significant for this dependent measure, $F(33, 1639) = 23.63$, $p < .001$. Inclusive of all covariates, the final model explained 32% of the variance in children's prekindergarten PPVT scores. In contrast, when considering children's letter–word identification skills, the later learning environment (β = .130, p = .012) was now predictive, $F(33, 1811) = 16.71$, $p < .001$; the early learning environment also predicted children's letter–word identification skills, although not as strongly (β = .109, p = .005); and the interaction term was not significant (β = .021, p = .756). The final model accounted for 23% of the variance in children's letter–word identification scores. These regressions augment trajectory analyses by suggesting temporal specificity in the prediction of different child outcomes for the analysis sample at large.

Discussion

The current findings highlight variability in the early learning environments of children from ethnically diverse, economically disadvantaged families, and reveal strong associations between learning environments and children's prekindergarten vocabulary and emergent literacy skills. Both early and later experiences uniquely predict children's skills, and together explain over 1 SD in children's performance at prekindergarten (after controlling for characteristics of children and families). Nonetheless, the influence of children's learning experiences are specific to the timing of supports as well as the outcome being examined: learning experiences in the first years relate to later receptive language skills, whereas experiences at prekindergarten support letter–word identification.

The Course of Children's Early Learning Environments

Enormous variation exists in the learning environment trajectories of children across their first

5 years. The six trajectories that were identified differed in their initial intercept levels and patterns of change over time. Already by 15 months, children from the six trajectory groups experienced learning environments that spanned the full range of 0–6 scores. Over time, children's trajectories differed in terms of whether they increased, decreased, or remained stable. The largest group of children (45%) experienced environments characterized by moderate overall levels that were stable through 37 months and declined thereafter (moderate decline). Another one third of children experienced environments in the moderate range that showed a pattern of consistent growth over time (moderate rise).

Although less prevalent, 10% of children experienced environments characterized by overall scores in the low range. Children in the low rise group experienced environments that were low in quality at 15 months and increased across the assessments, yet still remained at relatively low levels. The environments of children in the low decline group were characterized by similarly low mean scores at 15 months; however, these environments remained at low levels through 37 months, and declined even further by the age of 5 years.

At the other extreme were children who experienced environments in the high range, which constituted roughly 15% of the overall sample. Children in the high decline group experienced high-quality environments at 15 months that showed a marked decline over time, with scores reaching moderate levels by age 5. Children in the high stable group experienced the highest scores on measures of the learning environment—a pattern characterized by scores in the high range that increased from 15 to 37 months and remained relatively high thereafter.

These findings indicate that some children are already at risk by 15 months, and despite a common view that many parents will ''catch up'' in the learning experiences they provide children as their children approach school age, this does not appear to be the case. That is, *there was no learning environment trajectory group that started out low and increased to moderate levels or beyond by the time children entered prekindergarten*. Similarly, children who experienced supportive learning environments at 15 months were likely to continue to experience such environments through the age of 5. Thus, the quality of learning environments at the start of infants' 2nd year may foretell their later experiences.

Of note is the fact that three of the six trajectory groups were characterized by declines by the prekindergarten assessment. Notably, the time frame between the 37-month and prekindergarten assessments was approximately twice as long as the prior intervals. One reason for this decline might be in the criteria used to credit mothers with providing high learning environments at the different assessments. For example, at 15-months, mothers' use of didactic language was considered supportive of children's language growth; however, by prekindergarten, mothers had to engage in activities that intentionally taught children skills (e.g., learning letters, numbers) to be credited with providing a high-quality learning environment. Similarly, as children developed, the number of books in the home required for a high score shifted from 5 books (15 and 25 months), to 10 books (37 months), to 25 books (prekindergarten). Thus, learning environments characterized by declines at prekindergarten might be those in which mothers did not yet engage in formal learning activities with their children.

Predictions to Language and Literacy Skills at Prekindergarten

This study also documents substantial variation in the vocabulary and emergent literacy skills of prekindergarten children from low-income families. These skills were strongly predicted by children's learning environment trajectories. Overall, children in the low rise and low decline groups fared the worst, children who experienced environments characterized as high decline and high stable fared the best, and children who experienced moderate environments (moderate decline and moderate rise) performed somewhere in between. These differences meant that across the six groups, children showed disproportionate likelihoods of being delayed versus on par with national norms. Notably, 70% of children experiencing high stable environments performed at or above national norms, whereas only 7% of children with low rise environments performed in this range. Moreover, after controlling for a broad range of child and family demographic characteristics, children at the extremes of learning environments revealed enormous disparities in performance on standardized measures in the magnitude of 20 points. In accord with past studies, children who consistently experienced stimulating home environments across early childhood were at an advantage when compared to children with less supportive environments on measures of later language, literacy, and cognitive skills (Hirsh-Pasek & Burchinal, 2006; Landry,

Smith, Swank, Assel, & Vellet, 2001; Rodriguez et al., 2009).

Beyond highlighting the central role of learning environments in the developmental outcomes of children at prekindergarten, select contrasts underscore the importance of *timing* in the development of specific literacy skills. Learning experiences at different ages exerted greater influence on the skills that were emerging during that period in development. Children with more supportive learning environments *early on* had higher scores on the PPVT by prekindergarten. The provision of language and literacy experiences as early as the 1st year of life promotes children's vocabulary growth, which in turn is foundational to subsequent school success (Hart & Risley, 1995; Snow et al., 2007). In contrast, children who diverged in their later learning environments (yet experienced similar early learning environments) differed in their letter–word identification skills. Thus, learning experiences during the preschool years appear to build on children's earlier competencies and support more complex aspects of emergent literacy.

This specificity accords with studies on the differential effects of distinct types of home literacy activities on children's development (Sénéchal & LeFevre, 2002; Sénéchal et al., 1998). Specifically, parents' provision of *informal* literacy experiences exposes children to written language, as in the case of shared bookreading; these experiences promote children's receptive language and early vocabulary acquisition. In contrast, *formal* literacy experiences focus directly on written language, such as teaching a child letters of the alphabet or how to write their name; such experiences have been shown to relate to emergent literacy skills including alphabet knowledge, early reading, and invented spelling (Sénéchal et al., 1998).

The current study contains limitations at the levels of sampling, measurement, and analyses. First, sampling bias precludes generalizability to all low-income families, as participants self-selected into the study. The starting sample that was randomized into treatment versus control conditions included families who sought EHS services prior to infants' 1st year. Thus, they may have been especially concerned about promoting the healthy development of their young infants. From this larger cohort of 3,001, many families never participated further in the evaluation study, and others did not meet our criteria for study inclusion. Consequently, the families in our study were more advantaged compared to the overall EHS evaluation study sample. Nonetheless, we did not focus on more stringent analyses around impacts, and it is reasonable to expect that learning experiences matter for the larger population of young children.

At the level of measurement, we focused on a select and somewhat narrow set of indicators of the learning environment and children's preschool outcomes. Parenting measures focused on mothers' literacy practices specifically rather than the full range of social and emotional experiences that may equip children with the skills necessary for school success. In addition, focus was on the learning experiences that *mothers* provided their children; fathers, older siblings, grandparents, and extended family members are core participants in the learning experiences of infants, toddlers, and preschoolers alike (Tamis-LeMonda et al., 2004). Experiences in preschool also independently contribute to children's receptive vocabulary and emergent literacy skills in kindergarten beyond those encountered in the home environment. This limited focus might account for why certain effect sizes were relatively small in magnitude.

Measures of children's language and emergent literacy outcomes were limited to standardized assessments that may not capture the rich variation that exists in other aspects of children's developing literacy skills (e.g., narrative competencies, story comprehension, phonemic awareness). A number of researchers have pointed to children's executive functioning, social skills and emotion regulation as major indices of school readiness (Duncan et al., 2007; Shonkoff & Phillips, 2000). Moreover, standardized assessments of children from language minority households most likely provide an underestimation of children's performance.

Finally, at the level of analyses, we examined learning environment trajectories primarily through a person-centered modeling approach. While these approaches have notable strengths, several methodological concerns argue for caution in the interpretation of results (Bauer, 2007). Moreover, to assess trajectories over time, we created a single composite that was composed of three equally weighted components (i.e., literacy activities, maternal engagement, learning materials); thus, we did not examine patterns of stability and change in specific components—only change overall. Patterns of children's learning environment trajectories might differ for different components. However, exploratory analyses indicated that children of the six groups differed on virtually all components of the learning environment at all ages, with few exceptions.

The current study has important implications for policy and practice. The findings are central to the

design of effective interventions with young children and parents from economically disadvantaged backgrounds. First, the learning environment of children contains a number of important features, including the literacy activities in which parents and children engage, the quality of parents' interactions with children, and the materials that children have available for learning. Thus, practitioners should take a multipronged approach to supporting development in these areas. Moreover, as a part of these efforts, special attention should be given to the factors that might enable (or hinder) parents in their provision of supportive learning environments. For example, mothers' education, employment, marital status and household income were all associated with learning environment trajectories in the high range, whereas mothers' age (teen status), African American status, and Spanish-speaking status were associated with learning environments in the low range. Practitioners working with parents should thus be sensitive to the larger social and demographic contexts of children's early learning environment. The importance of maternal employment and household income underscores the financial benefits of mothers' working and challenges the notion that maternal work status in the early years is detrimental to children's development. Mothers who are employed might be better able to invest in stimulating learning materials and engage in educational activities that promote learning in their children. Therefore, practitioners should attend to not only supporting parents directly in their literacy-promoting behaviors, but also indirectly by targeting areas that might be associated with parents' abilities to provide such supports, including maternal education.

Second, this work highlights the importance of targeting children's learning environments early in development. By the start of the 2nd year (15 months), the experiences parents provide their children may be solidified into patterns of engagement that will either continue to support or impede children's emerging skills. Moreover, close inspection of the various patterns of change indicated that most learning environment trajectories were likely to be characterized by declines over time rather than increases. This may be due to the characteristics of the participating families, who were predominantly low-income and may have faced challenges in sustaining supportive environments over children's development. It also suggests that families may have difficulties transitioning from informal modes of supporting children's development early on, to more formal, intentional modes of teaching as children enter school. Interventions early on may set families on an altered trajectory of support, if families are assisted in efforts to engage children in routine practices, interact with children in supportive ways, and provide children with opportunities to learn about their worlds through educational materials.

Finally, patterns of decline were most likely to be observed starting at the 3-year assessment. This suggests a developmental period of potential concern and aligns with studies that stress the importance of continued investments in children beyond the 0–3 period. As noted earlier, the benefits of early interventions maintain when environments continue to support children's emerging competencies from age 3 to 5 years. Thus, parents should be supported in their efforts to provide their children with learning experiences that build on early abilities and further promote the skills foundational to children's school success.

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