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Family Socioeconomic Status and Consistent Environmental Stimulation in Early Childhood

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Abstract

The transition into school occurs at the intersection of multiple environmental settings. This study applied growth curve modeling to a sample of 1,364 American children, followed from birth through age six, who had been categorized by their exposure to cognitive stimulation at home and in preschool child care and first grade classrooms. Of special interest was the unique and combined contribution to early learning of these three settings. Net of socioeconomic selection into different settings, children had higher math achievement when they were consistently stimulated in all three, and they had higher reading achievement when consistently stimulated at home and in child care. The observed benefits of consistent environmental stimulation tended to be more pronounced for low-income children.

Ecological perspectives, which emphasize connections among multiple settings of children's lives, are highly relevant to education (Bronfenbrenner, 1979; Elder, 1998). For example, efforts to elucidate the ways in which families and schools come together to create unique spaces for children's development of cognitive and academic skills have informed not only theory but also policy, including No Child Left Behind (Epstein, 2005). This appreciation of multiple settings of development should be expanded to recognize the ways in which experiences in child care come together with experiences at home and in school to influence children's transitions into elementary school. Yet, any associations of proximal experiences in these settings with early learning must be parsed in relation to the larger system of socioeconomic stratification in the U.S. The need to do so is driven by the possibility of spuriousness in observed environmental effects on children (Duncan, Magnuson, & Ludwig, 2004), the important role of the transition into school in the intergenerational transmission of socioeconomic inequality (Brooks-Gunn & Duncan, 1997), and the long tradition of viewing both family-school connections and preschool as policy levers to reduce socioeconomic (and related) disparities among children (Epstein et al., 2002; Winsler et al., 2008).

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This study, therefore, traces the reading/math trajectories of children who have experienced consistency or inconsistency in cognitive stimulation across family, child care, and classrooms settings during their entry into formal education. This investigation will also address the potential for the number and type of early sources of stimulation to contribute to socioeconomic disparities in learning as well as assess the potential for the socioeconomic advantages of parents (e.g., income, education, marital status, neighborhood composition) to explain and/or condition any observed effects of various configurations of early stimulation. These aims will be pursued by applying growth curve techniques to multi-setting data from the NICHD Study of Early Child Care and Youth Development (SECCYD). The general goal is to advance understanding of child development, education, and inequality by treating schools as one piece of a web of overlapping contexts contributing to the learning of children from different backgrounds and assessing the give and take between selection and socialization in this web.

The Transition into Elementary School and Socioeconomic Inequality

The transition into elementary school is a vehicle for socioeconomic stratification in the U.S. (Winsler et al., 2008). At this point, the educational system magnifies existing disparities in cognitive and academic skills. Because perceived skills set class placements and performance expectations that then build on each other, even small early differences between child groups can expand into large end-of-school outcomes, such as dropout rates (Entwisle, Alexander, & Olson, 1997; Raver, Gershoff, & Aber, 2007). These findings are part of the rationale that early investments provide the greatest long-term payoff and support policy efforts targeting preschool and primary education (Fuller, 2007; Heckman, 2006; Takanishi & Bogard, 2007).

Ecological and life course perspectives elucidate the role of the transition into school in socioeconomic inequality by emphasizing how it is situated in the multi-faceted ecology of early childhood (Alexander & Entwisle, 1988; Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997; Crosnoe, 2006b; Raver et al., 2007). One example of this approach is contextual systems theory (Pianta & Kraft-Sayre, 2003), which contends that learning during the transition into elementary school is best understood as either supported or disrupted by transactions among environmental settings. Learning proceeds more smoothly when these settings provide positive resources in a parallel or linked manner, less so when they are disorganized and/or misaligned. Importantly, the theory also asserts that differences in such transactions help to explain why some children, such as those from families of low socioeconomic status (SES), are at risk for poor transitions.

For the most part, the ecological settings studied in relation to the transition into elementary school are families and schools (Christenson & Sheridan, 2001; Epstein et al., 2002; Patrikakou, Weisberg, Redding, & Walberg, 2005). Contextual systems theory emphasizes multiple forms of transaction between the two. One form is direct and interactional, with parents and school personnel engaging each other; for example, through a regular pattern of mutually respectful parent-teacher meetings or when parents volunteer at schools and schools offer services to parents. Another form is less coordinated; for example, parents and school personnel cultivating children's skills in similar, mutually reinforcing ways (e.g., both reading to child) whether they know that they are doing so or not. A child experiencing this type of transaction is growing up in a system of *consistently* enriching settings. Evidence from the Early Childhood Longitudinal Study indicates that both family-school transactions are associated with learning gains in early childhood but that the presence of environmental consistency (even when not coordinated) is more closely related to socioeconomic disparities in early learning (Crosnoe, 2006a). This study, therefore, focuses on consistency in learning environments around the transition into school and addresses two potential areas of expansion in this line of research: including child care and unpacking the role of family SES.

Expanding the Scope

More fully recognizing the insights of ecological perspectives requires the consideration of more than just family-school connections. Given the aforementioned value of early educational investments (Heckman, 2006), early child care is a logical setting to examine. Today, most children transition into elementary school after spending time in nonparental child care, including formal center care. The calibration and assets provided by families, schools, and child care, then, create a web of possible support for children as they enter the educational system (Committee on Family and Work Policies, 2003). Just as research on family-school connections has yielded insight into the value of consistent learning supports across home and school (Epstein et al., 2002), both naturalistic and intervention studies have demonstrated the value to learning of positive transactions between home and child care/ preschool (NICHD ECCRN, 2005b; Wasik, Ramey, Bryant, & Sparling, 1990). What is lacking is information about coordination and/or consistency among all three pieces of the triangle.

Following contextual systems theory, the *accumulation* of cognitively stimulating settings should boost children's prospects for learning in elementary school. In other words, children who are stimulated at home, in child care, and then in elementary school would be expected to do better than children who are stimulated in only two of these settings, who would be expected to do better than children who are stimulated in only one of these settings. Beyond the accumulation of cognitively stimulating environmental settings, the *configuration* of exposures to cognitive stimulation matters. For example, children may not benefit equally from stimulation in two of three settings if the two settings in question differ between them (e.g., home and school for Child 1, child care and school for Child 2).

Given that parents are typically the most consistent agents of young children's learning and given the many ways that parents prepare children for school (Hart & Risley, 1995; Lareau, 2004), the absence of cognitive stimulation at home during early childhood should be especially problematic. Stimulation in *either* child care *or* school only, therefore, would be less beneficial than stimulation at home only. Furthermore, stimulation in *both* child care *and* school only would be less beneficial than stimulation in both home and child care only or in both home and school only. If stimulation at home is paired with stimulation in only one other setting, a case could be made that either school or child care will be more important. Of course, the school classroom is where formal instruction takes place, and, again, the demands of such instruction are what many parents are tailoring their in-home stimulation to eventually support (Entwisle et al., 1997). Yet, given the increasingly strong link between early child care and school readiness (NICHD ECCRN, 2005b), children may be less able to take advantage of stimulating school settings if they do not enter school with a strong foundation for learning developed during years of consistent stimulation at home and in child care (Walker, Greeenwood, Hart, & Carta, 1994).

The first aim of this study, therefore, is to identify configurations of cognitive stimulation across home, early child care, and school settings around the initial school transition. The second is to determine the degree to which these configurations are associated with children's learning trajectories during elementary school.

Elucidating the Role of Family SES

Given what is known about family SES and education (Entwisle et al., 1997; Walker et al., 1994), any assessment of consistent environmental stimulation during this transition would

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be incomplete without assessing how family SES fits into the puzzle. Theoretical perspectives on socioeconomic disparities in all stages of education have a basic underlying argument (Alexander & Entwisle, 1988; Lareau 2004). In short, because socioeconomic disparities in access to social resources for learning drive socioeconomic differences in learning, equal access to such resources across socioeconomic strata should narrow these differences. This argument connects to the aims of this study in two ways.

First, one arrangement of family SES, social resources for learning, and child learning is that social resources mediate the link between family SES and child learning. An alternate explanation, however, is that the association between resources and learning is spurious, with both produced by family SES. In this case, social resources for learning are merely proxies for families' socioeconomic circumstances. Of course, both arrangements could be at work. The degree to which both, either, or neither apply here, then, needs to be determined.

Second, the link between consistent environmental stimulation and learning may also be moderated by SES. Again, the working hypothesis has long been that reducing group differences in access to social resources will reduce disparities in child outcomes. Yet, universal interventions often reveal that equal access to resources can lead to greater disparities in outcomes when non-at-risk children are better able to capitalize on having that resource than at-risk children (Ceci & Papierno, 2005). Following this pattern of cumulative advantage, high-SES children might benefit more from having the same kind of environmental stimulation as low-SES children. If so, socioeconomic disparities in learning would increase even if the absolute levels of learning of low-SES children were raised. Another scenario is that access to any new resource will make more of a difference to the children for whom it is nonredundant. Thus, the impact of a resource has added value for at-risk children. Following this buffering pattern, making sure that high- and low-SES children have the same kind of environmental stimulation should reduce socioeconomic disparities (Winsler et al., 2008). Thus, two moderation patterns are plausible.

The final aim of this study, therefore, involves three related questions. Are relations between family SES and child learning mediated by consistent environmental stimulation? Does consistent stimulation proxy family SES? Does SES condition effects of consistent stimulation?

Method

Data Source

Data collection for the SECCYD (http://secc.rti.org) began in 1991 in 10 locations: Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton, NC; Seattle, WA; Madison, WI. During selected sampling periods, study personnel visited new mothers in the hospital. To be eligible, the mother had to be 18 years of age or older, healthy, and conversant in English, and the infant had to be a singleton. A month later, 1,364 families were enrolled in the study. The collection of data from parents, children, and other adults in home, laboratory playroom, child care, and school visits proceeded in several stages from birth and is ongoing. Because of our focus on the transition into school, we drew on the SECCYD data through the children's fifth grade year. Some families dropped out or were lost by this time point (n = 287), and others missed some data collections. Because deleting cases with item- or wave-specific missingness can bias the sample, full information estimation methods were employed to allow for the retention of all observed data.

Measures

Child learning—Two Woodcock-Johnson Psycho-Educational Battery–Revised subtests (WJ-R; Woodcock & Johnson, 1989) were assessed in the laboratory at 54 months and Grades 1, 3, and 5. Letter-Word Identification gauged reading skills, and Applied Problems gauged math skills. Raw scores on the subtests were converted to W scores, transformations of the Rasch ability scale that centered the raw score at 500 in order to ease comparisons across the multiple WJ-R administrations. Table 1 includes mean scores on these subtests at each time point (as well as descriptive statistics for the other study variables). Scores increased across grades.

Family SES—Three SES measures tapped characteristics of the families themselves, reported by parents when children were 1 month old. Parent education was a binary marker (1 = *at least one parent had a college degree*, 0 = *other*). Income to needs was a continuous variable representing total income divided by the federal poverty threshold for a family of that size (U.S. Census Bureau, 2008). Marital status was a binary marker (1 = *parents married*, = *other*). A fourth SES measure tapped collective characteristics of families in children's neighborhoods. Neighborhood affluence was the mean of two standardized census block variables: (a) the percentage of professionally educated persons over the age of 25 in the block group and (b) the median household income in the block group (α = .89). The descriptive statistics in Table 1 reveal that the sample exceeds national averages on many socioeconomic indicators. Ancillary analyses revealed a great degree of stability in these measures over time.

Environmental stimulation—Our typology was based on three *observational* indicators of environmental cognitive stimulation. First, cognitive stimulation in the family at 54 months was measured with the Home Observation of Measurement of the Environment (HOME; Bradley & Caldwell, 1979). The HOME enrichment scale summed the learning materials (sum of 11 binary items), academic stimulation (5 items), and variety (9 items) subscales (α = .88). Second, cognitive stimulation in child care at 54 months was based on the Observational Rating of the Care Environment (ORCE; NICHD ECCRN, 2005b). The ORCE stimulation of cognitive development subscale was defined by ratings of high-quality stimulation provided in lessons, explanations, and activities (1 = *not at all characteristic*, 4 = *highly characteristic*). Third, cognitive stimulation in the first grade classroom was based on the Classroom Observation System (COS; Pianta, Belsky, Houts, Morrison, & NICHD ECCRN, 2007). The instructional quality composite (α = .70) summed four ratings (1 = *uncharacteristic*, 7 = *extremely characteristic*): literacy, evaluative feedback, instructional conversation, and child responsibility.

To capture accumulation and configuration of environmental stimulation, these three scales needed to be categorized into levels and then combined in theoretically meaningful ways. After extensive preliminary analyses, the most stimulating contexts were identified as those scoring above the median on the HOME, ORCE, and COS. The final typology then represented the different combinations of 0-3 high-stimulation environments. Cross-classifying these binary measures created dummy variables tapping six categories of environmental consistency: (a) triple stimulation (32%), which included children above the median on all three; (b) family-child care stimulation (15%), which included children above the median on the HOME and ORCE only; (c) family-school stimulation (11%), which included children above the median on the HOME and COS only; (d) child care-school stimulation (9%), which included children above the median on the ORCE and COS only; (e) single stimulation (26%), which included children above the median on either the HOME, ORCE, or COS but not the other two; and (f) low stimulation (7%), which included children below the median on all three.

Other child/family factors—Several control variables were created to account for major observable confounds, including binary markers of gender (1 = *male*) and race (1 = *non-White*), maternal employment dummy variables (employed for pay part- or full-time, unemployed, on leave from work), and a continuous measure of school readiness at 36 months. This last measure was based on the Bracken (1984) Basic Concept Scale, a composite of five cognitive assessments of children: identifying and recognizing colors, letters, numbers, comparisons, and shapes (range = 0-61, $\alpha = .93$).

Procedure

As a first step, growth curves for reading/math test scores were estimated with free-loading latent curve models (Meredith & Tisak, 1990), which did not impose any specific trend over time but instead allowed the data to dictate it. The four WJ-R scores (54 months; Grades 1, 3, 5) served as indicators of latent variables representing the intercept and slope of the trajectory of reading/math achievement. The model was identified with constraints on the Grade 1 and 5 loadings. Specifically, the Grade 1 loading was constrained to 0 to allow the intercept to be interpreted as the mean level of achievement in Grade 1. Note that the intercept was situated at Grade 1 rather than 54 months so that the parallel learning categories (some of which contained the classroom item measured in Grade 1) could be meaningful predictors of the intercept. Next, the Grade 5 loading was constrained to 1 to allow the slope to be interpreted as the change in achievement between Grades 1 and 5. All other loadings were freely estimated. These loadings can be interpreted as a proportion of change in reading/math test scores based on the total change between Grades 1 and 5. For example, a Grade 3 loading of .60 would indicate that 60% of the total change in reading/math test scores between Grades 1 and 5 was achieved by Grade 3.

Next, environmental stimulation categories, family SES, and the family/child controls were entered into the baseline model as predictors of the intercept and slope of the reading/math achievement. Comparing how results for socioeconomic circumstances and for environmental stimulation changed with the addition of the other two sets of factors to the model assessed the extent to which the mediational or spurious arrangements held in this sample. As a final step, interactions between the family SES and environmental stimulation variables were added to the growth curve model as predictors of the intercept and slope to explore moderation.

In all models, parameter estimates were obtained with full information maximum likelihood (FIML) in Mplus (Muthen & Muthen, 2004). Models were evaluated with several fit indices: χ^2, Root Mean Squared Error of Approximation (RMSEA), the Tucker-Lewis Index (TLI), and the Comparative Fit Index (CFI).

Results

As a starting point, Table 2 presents mean family socioeconomic characteristics for children in the six environmental stimulation categories. As expected, children in the triple stimulation category typically had the most advantaged family backgrounds, and those in the low stimulation category typically had the least advantaged family backgrounds. Of the four other environmental stimulation categories, family-child care and family-school stimulation had higher mean levels on the family socioeconomic factors than child care-school and single stimulation. Generally speaking, then, family socioeconomic circumstances and exposure to stimulating environments increased in tandem, but, perhaps not surprisingly, the link between family socioeconomic circumstances and stimulation at home appeared especially strong.

Of course, attempts to understand relations between SES factors and environmental stimulation categories are sensitive to the potential for sparse coverage in various SES × environmental category cells. Cross-classifying the environmental stimulation typology with a set of categories for each SES indicator (parent married to child's other parent vs. not; parent college educated vs. not; income to needs of 0-2, 1-3, 3+; low, medium, and high neighborhood affluence defined by standard deviation cuts) revealed that some cells contained small numbers of children (e.g., 10 or fewer). The smallest cells were for children in the low stimulation category who had college-educated parents, middle-income parents, neighborhoods of low affluence, and neighborhoods of high affluence. The case coverage in these particular cells warrants caution when interpreting null or significant results.

Differences in Reading and Math Trajectories

Before assessing differences in test scores by environmental stimulation categories and family socioeconomic circumstances, we first had to determine the functional form of the test score trajectories across elementary school. Table 3 presents the results from unconditional free-loading growth curve models for reading and math.

For these unconditional models, fit was somewhat marginal for reading and moderate for math, although fit statistics improved in later modeling iterations. As explained earlier, the mean intercept for both subjects represents the average test score in Grade 1 (even though the 54-month score was also included), and the mean slope represents the average total change in test scores between Grades 1 and 5. Thus, children scored about 450 points, on average, on the Grade 1 WJ-R test for reading and then added an additional 55 points by the end of Grade 5. The basic growth curve was similar for math, although children started off, on average, a little higher on this WJ-R test and gained slightly fewer points over time. For both reading and math, most of the upward change in the slope occurred between Grades 1 and 3. Worth noting is that the significant variance estimates indicate that children in the sample varied significantly around the mean intercept and slope for both reading and math. Such significant variation can then potentially be explained by independent variables, including the environmental stimulation dummy variables and family socioeconomic factors. Below, we present the results for reading test scores in detail and then later summarize the findings for math test scores.

Consistent Environmental Stimulation, Family SES, and Reading

The first set of models in Table 4 (see Model 1) included the environmental stimulation dummy variables as the only predictors of the intercepts and slopes of the growth curve. The stimulation coefficients are interpretable as test point differences relative to the reference, child care-school stimulation, which was chosen because it provided the contrast with the largest number of observable significant differences among categories. Of note is that post hoc between-group comparisons were performed (based on the corresponding model-implied parameter estimates and standard errors) to catalog *all* pairwise differences among categories—not just those in relation to the reference category. Thus, the reference is important for interpreting coefficients in the tables but not important for understanding the full set of patterns analyzed.

For the reading intercept, the model coefficients and post hoc comparisons together indicated a basic rank ordering (from highest to lowest) in average Grade 1 reading scores: (a) triple stimulation, family-child care stimulation; (b) family-school stimulation; (c) child care-school stimulation, single stimulation; (d) single stimulation, low stimulation. In this rank ordering, an environmental stimulation category that is in two separate ranks is a “bridge” between ranks. For example, the coefficient for single stimulation was not significantly different from the child care-school stimulation coefficient or the low stimulation coefficient, but the child care-school stimulation and low stimulation coefficients did differ from each other. In other words, single stimulation bridged two different ranks.

For the slope, the positive low stimulation coefficient in the table indicated that children in this environmental stimulation category had more pronounced reading gains after Grade 1 than children in the child care-school stimulation category. Post hoc comparisons revealed that they also had larger reading gains than children in *all* other environmental stimulation categories. Basically, children in the low stimulation category (i.e., those with the least exposure to stimulation overall) appeared to benefit the most from the start of formal schooling. They had the greatest uptick in reading skills after school had begun. This pattern is interesting given that the classrooms they entered once school began were not high in cognitive stimulation.

Although our environmental categorization scheme was aligned with our conceptual emphasis on accumulation and configuration, we recognized that categorizing and combining continuous variables could raise concerns about loss of scale variation. Consequently, we estimated this model (and subsequent models) with different categorization schemes (e.g., with standard deviation cut points), finding no difference in results for the largest categories. Moreover, the model was estimated with two- and three-way interactions among the continuous versions of the HOME, ORCE, and COS scales. Doing so revealed weaker associations between links among the three setting factors and the outcomes, which was likely attributable to the nonlinear nature of the scales in combination with each other.

The second set of models in Table 4 (see Model 2) included the family socioeconomic factors as the only predictors of the intercepts and slopes of each growth curve (i.e., no environmental stimulation categories or family/child controls). All four significantly predicted the reading intercept. The difference between children with and without a college-educated parent equaled about 7.5 points on the reading test in Grade 1. The spread was half a point for each increase in the income-to-needs and 4 points between children with and without married parents. Standardizing all four coefficients revealed that the effect size for neighborhood affluence was between the effect sizes for parent education (the biggest) and family income to needs (the smallest). As for the reading slope, two family socioeconomic factors had significant, negative coefficients. Children with college-educated parents and children who lived in more affluent neighborhoods had slightly less pronounced upward rates of change in achievement after Grade 1. Again, the most disadvantaged appeared to benefit the most from formal schooling.

Assessing Mediation

Mediation entails differences in child learning by family SES channeled through corresponding SES differences in environmental stimulation. One way to assess mediation is to compare associations between socioeconomic circumstances and child test scores before and after taking environmental stimulation into account. If environmental stimulation mediates the associations between socioeconomic circumstances and child test scores, then these associations should be weaker after environmental stimulation is controlled. Assessing the degree to which they are weaker gauges the degree of mediation.

The baseline associations between the four family socioeconomic circumstances and the reading achievement intercept and slope appear in Model 2 of Table 4. Model 3 reveals what happened to these baseline associations once the full set of environmental stimulation dummy variables was added to the growth curve model without any other controls.

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Beginning with the previously observed association between parent education and the reading intercept, the parent education coefficient in Model 2 was attenuated by 10% with the inclusion of the environmental stimulation dummy variables in Model 3. Because triple stimulation and family-child care stimulation were the only significant coefficients among the environmental stimulation dummy variables in Model 3, they appeared to be driving this attenuation. The corresponding levels of attenuation between intercept Models 2 and 3 were 18% for family income, 33% for parent marital status, and 16% for neighborhood affluence. Thus, some of the advantage that children from more privileged backgrounds had over their peers in reading at the start of school appeared to be related to their greater likelihood of having stimulation at home matched with stimulation in child care and/or Grade 1classrooms.

Turning to the slope, the previously observed negative associations of parent education and neighborhood affluence with the reading slope (Model 2) were slightly attenuated by the inclusion of the environmental stimulation dummy variables. Because low stimulation was the only stimulation coefficient to achieve statistical significance in Model 3, it appeared to be driving this attenuation. Thus, the shallower reading gains that children from more privileged backgrounds exhibited across the elementary school years were, in part, related to their tendency to have stimulation in any or all settings of early childhood; in other words, to *not* be in the low stimulation category. They started off ahead and then had less to gain over time.

Model 4 added the full set of child/family controls, of which early school readiness was the only one to significantly predict both intercept and slope. More school-ready children had higher initial reading test scores but slightly less pronounced test score gains as elementary school progressed. The inclusion of the Bracken measure attenuated the associations between the family socioeconomic circumstances and the reading intercept by between an additional one-half and three-fourths (comparing the intercept coefficients for the socioeconomic factors in Model 3 to the corresponding coefficients in Model 4). Along with race, the inclusion of the school readiness scale also washed out the observed associations between parent education and neighborhood affluence on one hand and the reading slope on the other (comparing the slope coefficients for the socioeconomic factors in Model 3 and Model 4).

Assessing Spuriousness

Spuriousness occurs when test score differences across environmental stimulation categories are accounted for by the family socioeconomic circumstances that contribute to both environmental stimulation and test scores. One way to assess spuriousness is to compare associations between environmental stimulation categories and test scores before and after taking family socioeconomic circumstances into account. If these associations are spurious (confounded with family socioeconomic circumstances), then they should be weaker after family socioeconomic circumstances are controlled.

Again, comparing coefficients between models allows an assessment of spuriousness (see Table 4). The baseline associations between the environmental stimulation dummy variables and the reading intercepts and slopes have already been presented in Model 1. The coefficients in Model 3, which simultaneously regressed the intercept and slope of reading on the family socioeconomic circumstances and the environmental stimulation dummy variables, provide the appropriate comparison. For the reading intercept, the environmental stimulation coefficients were smaller when they were estimated simultaneously with the family SES factors (Model 3 Intercept) than when estimated in isolation (Model 1 Intercept). The coefficients for triple stimulation and family-child care stimulation (relative to child care-school as well as single and low stimulation) remained significant but were attenuated.

The coefficients for family-school stimulation and low stimulation were reduced by almost half and became nonsignificant.

When the other family/child controls were added in Model 4, the intercept coefficients for triple and family-child care stimulation appeared somewhat robust. Of the environmental stimulation dummy variables, they were the only two to be associated with the reading intercept after both the family socioeconomic circumstances and the child/family controls were taken into account. The slope coefficient for low stimulation was also robust to controls for family socioeconomic circumstances and other child/family characteristics.

Assessing Moderation

A final aim of this study was to investigate whether family socioeconomic circumstances and environmental stimulation were related to each other in more complex, multiplicative ways. Specifically, we were interested in whether the links between environmental stimulation categories and test scores varied as a function of family socioeconomic circumstances.

To assess moderation, the family socioeconomic factors, the environmental stimulation dummy variables, and their interactions were entered into the unconditional growth curve model as predictors of the reading intercept and slope. Interactions of the environmental stimulation dummy variables with each family socioeconomic factor were examined separately. Significant interactions were graphed to determine the degree to which the associations between environmental stimulation and reading test scores varied by family SES. These models were estimated with and without the set of child/family control variables. The results of revealed that, of the four socioeconomic factors, only family income to needs significantly interacted with the environmental stimulation categories in any consistent way. Table 5 presents the focal results of the reading models with the family income interactions. Model 1 was the baseline (i.e., main effects and interactions only), and Model 2 added the other family/child controls.

According to the results for Model 1, all environmental stimulation categories except low stimulation (recall the small cell size for income × low stimulation) significantly interacted with family income to needs to predict the reading intercept when child care-school stimulation was the reference. All of these interactions were negative in sign. To interpret these interactions, we calculated predicted intercept values for children in each environmental stimulation category (including the omitted category of child care-school stimulation) who came from low-income families (income to needs = 1) or high-income families (income to needs = 5), with all other variables held to their sample means. See Figure 1.

For high-income children, only triple stimulation was associated with a significantly higher reading intercept than the child care-school category reference. The difference between the two was 3 points, equaling 19% of a standard deviation in Grade 1 test scores (the time point that served as the intercept in the growth curve). The difference between triple stimulation and the other two environmental stimulation categories (family-school, family-child care) was 5 points (32% standard deviation), although these two other categories did not significantly differ from the child care-school category. More differences across environmental categories were detected, however, for low-income children. For example, the predicted reading intercept for children with child care-school stimulation (444), the category without high family stimulation, was significantly lower than for children with family-school stimulation (3 points, 19% standard deviation) and family-child care stimulation (4, 26%). In turn, the predicted intercept for children in these latter two categories, which tapped double stimulation when at least one stimulating environment was the home, was significantly lower than for children in the triple stimulation category (4 and 5 points, respectively, at 26% and 32% standard deviations). Indeed, the biggest within-income difference in Figure 1 was between low-income children with child care-school stimulation and children with triple stimulation (8 points, 51% standard deviation). Thus, among low-income children, each environmental stimulation category involving stimulation at home was associated with higher reading intercepts than child care-school stimulation.

When the full set of child/family controls was included (see Model 2 in Table 5), this basic pattern of moderation held only for the family-school environmental stimulation category. In other words, the observed "benefits" of having triple stimulation or family-child care stimulation were equal for low-income and high-income children of similar levels of early school readiness, but low-income children appeared to benefit more from linking stimulation at home and school than high-income but similarly school-ready peers.

Summary of Math Findings

In general, the results from the math models were similar to those for reading (Table 6). In terms of the associations between environmental stimulation and test scores, one major distinction (see Table 4) emerged. It involved the math intercept. Children in the triple and family-child care stimulation categories had significantly higher scores in Grade 1 than children in all other categories. Moreover, in addition to the same low stimulation association seen in the reading models, triple stimulation also predicted the math slope. Children in this category had less pronounced gains in math after Grade 1 relative to those in the child care-school stimulation category and indeed relative to all other categories (according to post hoc comparisons).

Overall, the results of models examining the associations between family socioeconomic advantages and children's math trajectories were quite similar to the reading results in Table 4, with the one exception being that the association between parent education and the math slope was nonsignificant. Looking at mediation, the baseline associations between the family socioeconomic circumstances and the math intercept and slope were partially accounted for by the inclusion of the environmental stimulation dummy variables (family-child care and low stimulation for the intercept, low stimulation for the slope) and substantially mediated by the inclusion of the school readiness scale, as was the case for reading.

The only difference in the results of the spuriousness analyses for reading and math was that family-child care stimulation was the one environmental stimulation dummy variable to be associated with the math intercept before *and* after controlling for family socioeconomic circumstances and other family/child characteristics. Recall that, for reading, both the triple stimulation and family-child care stimulation demonstrated this pattern (see Table 4).

Finally, the results of math models testing for moderation (not presented but available upon request) were similar to the reading results presented in Table 5, except that family income also interacted significantly with single stimulation to predict the slope of the growth curve. Basically, the apparent "benefit" of stimulation in two or three early settings relative to only one was more pronounced for low-income children than high-income children, both when school readiness was and was not taken into account.

Discussion

At first glance, the findings of this study seem unsurprising. High-SES children had more exposure to stimulating environments that promote learning. On closer inspection, however, the findings highlight important qualifiers to established patterns in the literature. First, they address tradeoffs between additive/cumulative and configuration/typology approaches to environmental effects on children's learning. Second, they qualify for whom different types of resources matter. Both the number and configuration of early sources of cognitive stimulation were critical for children's early reading and math trajectories. Children who experienced cognitive stimulation in multiple settings of early childhood had higher rates of learning than their peers early in school, but only when one of these settings was the home. As elementary school unfolded, all children typically had similar rates of progress from their unequal starting points. Although children with the least cognitive stimulation across settings had slightly higher increases in learning from Grades 1 to 5 compared to their peers with more consistent stimulation, this advantage was small relative to the large gap that existed between them when school began. Thus, early learning disparities across environmental stimulation categories generally persisted over time.

Overall, linking stimulation in the family to stimulation in any other early childhood contexts—in child care and/or school for reading, in child care for math—seemed beneficial for children's learning. This means that the family is the first, but not the only, ingredient in early learning. Parents, after all, spend the most (and most consistent) time with their children across early childhood and play a leading role in preparing children for school (Hart & Risley, 1995; Lareau, 2004). Of course, this pattern reflects the consideration of *single* dimensions of family, child care, and school settings. At the same time, we acknowledge that the home environment and the selection of more formal settings for children may be capturing genetic relatedness between parents and their children. Still, these findings are noteworthy for several reasons.

In general, the results of this study suggest that targeting single settings as a means of improving children's learning might not be sufficiently powerful for establishing or deflecting trajectories of early achievement. Specifically, policies that focus solely on one setting, such as parenting programs, preschool interventions, or school standards movements, are unlikely to be as efficacious as those targeting consistency across multiple settings. This conclusion supports the tenets of contextual systems theory contending that multisetting approaches will add value to policy efforts, especially those aimed at at-risk populations. It also suggests that efforts to facilitate children's transitions between home and school should be deliberately expanded to include early child care and preschool. Doing so seems especially crucial for math achievement, for which cognitively stimulating child care more than stimulating entry-level school classrooms was what was needed to match with stimulating home environments to promote early learning.

A major component of this study concerned the multifaceted linkages among socioeconomic stratification and consistency of environmental stimulation. Findings revealed that children from more advantaged families started school with more developed skills than their more disadvantaged peers and that these disparities persisted through elementary school. Beyond replicating this well-documented phenomenon (Magnuson, Meyers, Ruhm, & Waldfogel, 2004), we also sought to elucidate whether consistent environmental stimulation explained the link between family SES and child learning (mediation), family SES accounted for the association between consistent stimulation and child learning (spuriousness), or some combination of both processes was occurring. The motivation for comparing these theoretical pathways was that policy efforts that seek to reduce academic disparities typically attempt to remedy the mechanisms through which socioeconomic advantages are thought to operate in the educational system rather than directly addressing family SES itself. Along these lines, having stimulation at home along with stimulation in one or two other early settings partially explained why higher SES children had higher overall skill levels. These findings generally concur with past research exploring the contextual resources through which family SES is associated with child learning (Brooks-Gunn & Duncan, 1997;

Entwisle et al., 1997). Yet, this study extends that research by incorporating the broader constellation of settings through which SES has its reach rather than focusing on single settings or on multiple settings in an isolated way.

Importantly, evidence of spurious associations between configurations of stimulating settings and children's trajectories also emerged. That is, the consistency of environmental stimulation that children experienced around the transition into school was a proxy for socioeconomic circumstances more powerfully related to their learning. Yet, several exceptions existed. Triple stimulation (for reading) and family-child care stimulation (for reading and math) had potentially additive effects. Perhaps more importantly, moderation analyses revealed that the tendency for consistent environmental stimulation to simply be a proxy for family SES appeared to be less strong for children from low-income families. They appeared to gain more than high-income peers through school when early stimulation in extrafamilial settings was consistent with early stimulation at home. These findings are comparable to intervention efforts documenting higher achievement gains when at-risk children experienced more concentrated stimulation across contexts rather than in a single setting (Burchinal et al., 1997; Wasik et al., 1990). That low-income children benefited the most from stimulation at home in combination with other early childhood settings (especially entry-level school classrooms) is also in line with the intervention literature pointing to differential efficacy as a function of risk status (Burchinal et al. 1997; Winsler et al., 2008). Moreover, it is promising news for large-scale policy efforts targeting this population, including Head Start, public Pre-K, and No Child Left Behind.

In addition to those we have already discussed, several limitations of this study need to be addressed. Methodologically, although we examined family SES as a potential source of omitted variable bias in the association between consistency of environmental stimulation and children's learning, other unobserved factors, including parental efficacy and genetic traits, may account for these links. More sophisticated strategies to address unobservable confound should be utilized in the future if this line of research is to effectively inform policy intervention (Winship & Morgan, 1999). On a more conceptual level, our interest in connections among different early childhood settings focused on indirect, temporally spaced transactions rather than direct engagement between actors across settings. A comprehensive examination should include both direct and indirect forms and compare these two approaches to conceptualizing transactions among different settings of the early ecology. Finally, although the sample used in this study had many advantages for our study aims, it was not nationally representative. The generalizability of these findings, therefore, needs to be assessed in the future.

In sum, our results suggest that family socioeconomic advantages were a driving force behind children's exposure to cognitive stimulation in various settings and in their learning. Although this conclusion echoes criticisms of more direct parental involvement strategies in schools, it does not imply that policies should not have environmental foci, particularly in the case of low-income children. Indeed, in the SECCYD, these children uniquely benefited from the accumulation of stimulating settings. Clearly, altering environmental stimulation through preschools (e.g., Head Start, public pre-K) and schools (e.g., No Child Left Behind), while challenging, is likely more feasible than policies to reduce family socioeconomic disparities, at least in the short term. Efforts to address academic differentials need to include families (not just educational contexts), should be coordinated, and should start before children enter school.

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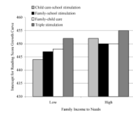

Figure 1.
Reading scores at intercept, by family income and environmental stimulation category

Table 1
Descriptive Statistics for Study Variables (n = 1,364)

Child, Family, and Setting Characteristics	*M*	*SD*
Child test scores		
Reading score (54 months)	424.72	19.72
Reading score (Grade 1)	470.05	15.54
Reading score (Grade 3)	493.50	12.76
Reading score (Grade 5)	510.54	13.04
Math score (54 months)	369.36	21.41
Math score (Grade 1)	452.59	23.99
Math score (Grade 3)	494.60	15.75
Math score (Grade 5)	507.63	14.12
Family socioeconomic circumstances		
Parent education (college graduate)	0.44	0.50
Family income to needs	3.63	3.17
Parent marital status (married)	0.77	0.42
Neighborhood affluence	-0.04	0.89
Environmental stimulation		
HOME stimulation (54 months)	17.84	2.47
Child care stimulation (54 months)	2.21	0.80
School classroom stimulation (Grade 1)	15.67	4.16
Other child/family factors		
Gender (male)	0.52	0.50
Race (non-White)	0.20	0.40
School readiness (36 months)	9.02	2.89
Maternal employment	0.67	0.47
Maternal employment (unemployed)	0.31	0.46
Maternal employment (on leave)	0.02	0.15

Note. For binary measures (parent education, marital status, gender, race, maternal employment), means represent the percentage of respondents in the 1 category.

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Table 2

Family Socioeconomic Circumstances, by Environmental Stimulation Categories

	M (SD)					
Family Characteristics	**Triple stimulation (n = 436)**	**Family-child care stimulation (n = 205)**	**Family-school stimulation (n = 150)**	**Child care-school stimulation (n = 123)**	**Single stimulation (n = 355)**	**Low stimulation (n = 95)**
Parent education (college graduate)	0.67 (0.47)	0.58 (0.50)	0.59 (0.50)	0.36 (0.48)	0.39 (0.49)	0.31 (0.47)
Family income to needs	4.85 (4.66)	4.27 (2.72)	4.80 (5.97)	3.44 (2.95)	3.43 (2.60)	2.66 (2.56)
Parent marital status (married)	0.89 (0.31)	0.84 (0.37)	0.85 (3.63)	0.76 (0.43)	0.70 (0.46)	0.40 (0.50)
Neighborhood affluence	0.29 (0.94)	0.06 (0.89)	0.11 (0.89)	-0.03 (0.81)	-0.13 (0.83)	-0.33 (0.76)

Note: For binary measures (parent education, marital status), means represent the percentage of respondents in the 1 category.

Table 3
Results from Unconditional Growth Curve Models of Reading and Math Scores (n = 1,364)

	Reading		Math	
Model parameters	**Intercept**	**Slope**	**Intercept**	**Slope**
Mean (*SE*)	450.34*** (1.16)	55.00*** (0.72)	468.42*** (0.96)	41.83*** (0.59)
Variance (*SE*)	215.52*** (10.29)	31.41*** (4.39)	157.41*** (8.01)	16.23*** (3.33)

*** $p < .001$.

Chi-square (19 *df*) = 206.84*** (reading), 66.75*** (math); TLI = .93 (reading), .98 (math); CFI = .96 (reading), .96 (math); RSMEA = .08 (reading), .05 (math); 90% CI = .081-.104 (reading), .035-.059 (math)

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Table 4

Results from Growth Curve Models of Reading Scores by Environmental Stimulation Categories and Family SES (n = 1,364)

	B (SE) Model 1		*B (SE)* Model 2		*B (SE)* Model 3		*B (SE)* Model 4	
Predictors	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**
Environmental stimulation								
Triple stimulation	8.93^{***} (1.56)	-1.08 (0.77)			5.78^{***} (1.45)	-0.70 (0.78)	4.37^{***} (1.22)	-0.33 (0.75)
Family-child care stimulation	6.14^{*} (1.79)	-0.52 (0.88)			3.87^{*} (1.63)	-0.31 (0.88)	2.51^{+} (1.37)	-0.29 (0.85)
Family-school stimulation	3.03^{+} (1.69)	-0.97 (0.83)			1.69 (1.54)	-0.82 (0.82)	0.87 (1.29)	-0.71 (.79)
Child care-school stimulation	---	---			---	---	---	---
Single stimulation	-0.84 (1.57)	0.30 (0.77)			-0.23 (1.42)	0.23 (0.76)	-0.40 (1.19)	0.21 (0.73)
Low stimulation	-5.10^{*} (2.20)	3.73^{***} (1.08)			-2.82 (2.04)	3.51^{***} (1.09)	-0.5 (1.72)	3.10^{***} (1.05)
Fam. socioeconomic circumstances								
Parent education (college graduate)			7.57^{***} (1.03)	-1.25^{*} (0.56)	6.82^{***} (1.02)	-1.10^{*} (0.56)	3.22^{***} (0.87)	-0.13 (0.55)
Family income to needs			0.45^{**} (0.16)	-0.09 (0.08)	0.37^{*} (0.15)	-0.07 (0.08)	0.10 (0.13)	-0.01 (0.08)
Parent marital status (married)			4.08^{***} (1.08)	0.50 (0.60)	2.75^{*} (1.10)	1.07 (0.61)	1.33 (0.96)	0.73 (0.60)
Neighborhood affluence			2.82^{***} (0.59)	-0.75^{*} (0.32)	2.38^{***} (0.58)	-0.61^{+} (0.32)	0.80 (0.49)	-0.33 (0.31)
Other child/family factors								
Gender (male)							0.39 (0.69)	0.45 (0.43)
Race (non-White)							0.00 (1.01)	-2.71^{***} (0.64)
School readiness (36 months)							2.91^{***} (0.14)	-0.80^{***} (0.09)
Maternal employ. (unemployed)							-4.32^{+} (2.22)	-0.73 (1.38)

	B (SE) Model 1		*B (SE)* Model 2		*B (SE)* Model 3		*B (SE)* Model 4	
Predictors	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**
Maternal employ. (on leave)							-0.48 (0.75)	0.35 (0.48)

+ $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Chi-square/*df* = 212.47/29*** (M1), 215.00/27*** (M2), 219.82/37*** (M3), 224.24/47*** (M4); TLI = .94 (M1), .98 (M2), .94 (M3), .95 (M4); CFI = .87 (M1), .96 (M2), .88 (M3), .90 (M4); RSMEA = .07 (M1), .04 (M2), .05 (M3), .05 (M4); 90%CI = .063-.081 (M1), .029-.049 (M2), .053-.068 (M3), .047-.060 (M4)

Table 5

Selected Results from Reading Growth Curve Models with Family × Environmental Stimulation Category Interaction Terms to Assess Moderation (n = 1,364)

	B **(*SE*) for Model 1**		***B*** **(*SE*) for Model 2**	
Predictors	**Intercept**	**Slope**	**Intercept**	**Slope**
Environmental stimulation				
Triple stimulation	8.85*** (2.11)	-0.63 (1.14)	6.57*** (1.78)	0.09 (1.10)
Family-child care stimulation	5.01* (2.28)	0.00 (1.24)	4.07* (1.92)	-0.20 (1.19)
Family-school stimulation	3.37 (2.32)	-0.30 (1.26)	3.41 (1.97)	-0.45 (1.21)
Child care-school stimulation	---	---	---	---
Single stimulation	0.10 (1.88)	1.11 (1.02)	-0.66 (1.58)	1.30 (0.97)
Low stimulation	-0.56 (2.70)	3.17* (1.46)	1.23 (2.29)	2.72 (1.41)
Family socioeconomic circumstances				
Family income to needs	1.84*** (0.46)	-0.15 (0.25)	0.80* (0.39)	0.09 (0.24)
Interaction terms				
Income × triple stimulation	-1.02* (0.50)	-0.12 (0.27)	-0.20 (0.43)	-0.31 (0.26)
Income × family-care stimulation	-1.40* (0.65)	0.10 (0.35)	-0.75 (0.55)	-0.02 (0.34)
Income × family-school stimulation	-0.91* (0.38)	0.18 (0.21)	-0.73* (0.32)	0.13 (0.20
Income × care-school stimulation	---	---	---	---
Income × single stimulation	-1.34* (0.57)	0.62* (0.31)	-0.76 (0.48)	0.48 (0.29)
Income × low stimulation	-0.14 (0.92)	-0.49 (0.49)	-0.08 (0.77)	-0.66 (0.47)

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Chi-square/*df* = 236.78/57*** (M1), 224.24/67*** (M2); TLI = .94 (M1), .95 (M2); CFI = .88 (M1), .90 (M2); RSMEA = .05 (M1), .05 (M2); 90% CI = .042-.055 (M1), .047-.060 (M2)

Note: Model 1 included the other SES indicators. Model 2 added the child/family factors.

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Table 6

Main Results from Growth Curve Models of Math Scores (n = 1,364)

	B (SE) Model 1		*B (SE)* Model 2		*B (SE)* Model 3		*B (SE)* Model 4	
Predictors	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**
Environmental stimulation								
Triple stimulation	5.40*** (1.41)	-1.92* (0.77)			2.42 (1.29)	-1.45 (0.77)	1.24 (1.13)	-.99 (0.75)
Family-child care stimulation	6.16*** (1.60	-0.71 (0.87)			3.93** (1.45)	-0.39 (0.87)	2.49* (1.26)	0.03 (0.84)
Family-school stimulation	3.20* (1.52)	-0.91 (0.82)			1.86 (1.37)	-0.71 (0.82)	1.14 (1.19)	-0.48 (0.78)
Child care-school stimulation	---	---			---	---	---	---
Single stimulation	-0.72 (1.41)	-0.13 (0.76)			-0.13 (1.26)	-0.21 (0.76)	-0.21 (1.09)	-0.29 (0.73)
Low stimulation	-6.30*** (1.99)	2.15* (1.08)			-3.76* (1.82)	1.76 (1.09)	-2.08 (1.58)	1.15 (1.05)
Fam. socioeconomic circumstances								
Parent education (college graduate)			5.91*** (0.89)	-0.40 (0.56)	5.50*** (0.89)	-0.24 (0.56)	2.71*** (0.79)	0.68 (0.55)
Family income to needs			0.50*** (0.14)	-0.16 (0.08)	0.45*** (0.14)	-0.13 (0.08)	0.20 (0.12)	0.06 (0.08)
Parent marital status (married)			4.86*** (0.94)	-0.40 (0.60)	3.81*** (0.97)	-0.01 (0.61)	2.19* (0.87)	0.67 (0.61)
Neighborhood affluence			2.51*** (0.50)	-0.87* (0.32	2.26*** (0.50)	-0.75* (0.32)	0.99* (0.44)	-0.29 (0.31)
Other child/family factors								
Gender (male)							1.15 (0.63)	0.84 (0.45)
Race (non-White)							-2.04* (0.91)	1.24 (0.65)
School readiness (36 months)							2.22*** (0.13)	-0.72*** (0.09)
Maternal employ. (unemployed)							-4.39* (2.02)	1-.66 (1.39)

	B (SE) Model 1		*B (SE)* Model 2		*B (SE)* Model 3		*B (SE)* Model 4	
Predictors	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**	**Intercept**	**Slope**
Maternal employ. (on leave)							-1.30 (0.68)	-0.21 (0.48)

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Chi-Square/df = 79.76/29** (M1), 86.96/27*** (M2), 96.99/37*** (M3), 158.36/47*** (M4); TLI = .98 (M1), .98 (M2), .98 (M3), .96 (M4); CFI = .96 (M1), .95 (M2), .95 (M3), .92 (M4); RSMEA = .04 (M1), .04 (M2), .03 (M3), .04 (M4); 90%CI = .029-.049 (M1), .031-.050 (M2), .026-.043 (M3), .035-.049 (M4)