Developmental Psychology
2010, Vol. 46, No. 5, 1227–1244

0012-1649/10/$12.00 DOI: 10.1037/a0020211

Understanding the Positive Role of Neighborhood Socioeconomic Advantage in Achievement: The Contribution of the Home, Child Care, and School Environments

Veronique Dupere and Tama Leventhal
Tufts University

Robert Crosnoe
University of Texas at Austin

Eric Dion
Université du Québec à Montréal

The goal of this study was to examine the mechanisms underlying associations between neighborhood socioeconomic advantage and children's achievement trajectories between ages 54 months and 15 years. Results of hierarchical linear growth models based on a diverse sample of 1,364 children indicate that neighborhood socioeconomic advantage was nonlinearly associated with youths' initial vocabulary and reading scores, such that the presence of educated, affluent professionals in the neighborhood had a favorable association with children's achievement among those in less advantaged neighborhoods until it leveled off at moderate levels of advantage. A similar tendency was observed for math achievement. The quality of the home and child care environments as well as school advantage partially explained these associations. The findings suggest that multiple environments need to be considered simultaneously for understanding neighborhood–achievement links.

Keywords: neighborhood, achievement, home environment, child care, school

Living in an advantaged neighborhood where a sizeable proportion of residents are affluent, educated professionals is associated with children's and adolescents' achievement, over and above other markers of family advantage (for a review, see Leventhal, Dupéré, & Brooks-Gunn, 2009). This association has been substantiated in studies looking at a range of periods and outcomes. From early childhood to adolescence, it has been observed in studies looking at tests scores, and in later adolescence, it has been observed in studies looking at years of schooling, high school graduation, and college attendance (e.g., Ainsworth, 2002; Boyle, Georgiades, Racine, & Mustard, 2007; Leventhal, Xue, & Brooks-Gunn, 2006). Generally, these studies find that neighborhood advantage is associated with children and youths' schooling outcomes more strongly and consistently than neighborhood poverty or disadvantage.

Although neighborhood advantage–achievement links are well documented, much less is known about how neighborhood conditions may enhance children's achievement, in effect limiting the translation of this knowledge into practical recommendations. The goal of this study is to examine how these neighborhood effects are channeled through a series of related contexts that are embedded in, and often bounded by, the neighborhood environment. Specifically, we used longitudinal data on a diverse sample of youths followed from birth through adolescence to explore the mediating role of three key contexts in children's achievement growth: the home, child care, and school environments. Before reviewing the relevant theoretical frameworks, the next section discusses the nature and shape of the neighborhood–achievement link.

Neighborhood and Achievement: The Nature and Shape of the Link

Observational studies linking neighborhood advantage and children's achievement need to be viewed with caution. A number of family characteristics beyond family income, such as parental motivation and attitudes, may drive both neighborhood choice and children's achievement. In effect, neighborhood–achievement links may not exist aside from these underlying (or omitted) associations. More stringent designs have been used in neighborhood research in an attempt to address this selection bias. These

Veronique Dupere and Tama Leventhal, Department of Child Development, Tufts University; Robert Crosnoe, Department of Sociology, University of Texas at Austin; Eric Dion, Département d'éducation et formation spécialisées, Université du Québec à Montréal, Montréal, Québec, Canada.

We acknowledge the Canadian Institutes of Health Research for their support. Additional support was provided by the William T. Grant Foundation. The National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development through a cooperative agreement (U10) that calls for a scientific collaboration between NICHD staff and participating investigators (Tama Leventhal and Robert Crosnoe were both principal investigators for Phase IV). We gratefully acknowledge the data set provided by this study and express our appreciation to NICHD for its financial support, to the study coordinators at each site who supervised data collection, to the research assistants who collected the data, and especially to the children, parents, and teachers who participated in this study. In addition, we thank Sara Anderson for her helpful comments on a draft of this article.

Correspondence concerning this article should be addressed to Veronique Dupere, Department of Child Development, 105 College Avenue, Tufts University, Medford, MA 02155. E-mail: veronique.dupere@tufts.edu

designs include sibling fixed-effect models, which hold family characteristics constant (Aaronson, 1998; Plotnick & Hoffman, 1999; Vartanian & Buck, 2005); instrumental variable analysis, which minimizes unmeasured correlations between neighborhood characteristics and child outcomes (Foster & McLanahan, 1996); behavior genetic models, which differentiate between genetic and environmental influences (Caspi, Taylor, Moffitt, & Plomin, 2000; Cleveland, 2003); and propensity scoring methods, which match children who do and do not live in certain types of neighborhoods (Harding, 2003; Sampson, Sharkey, & Raudenbush, 2008). Generally, these studies using more rigorous analytic approaches find significant associations between neighborhood characteristics and children's and adolescents' outcomes.

Despite the strengths of these designs, experimental studies remain the method of choice for tackling selection issues. Neighborhood studies with experimental or quasi-experimental designs have yielded mixed findings. In most of these studies, low-income, predominately minority families living in public housing in high-poverty neighborhoods were offered vouchers to move to more advantaged neighborhoods. In one Chicago quasi-experimental study, the Gautreaux program, where neighborhood assignment was based on housing availability, youths who moved to middle-class, predominately European American suburbs were more likely to graduate from high school and attend college at a 10-year follow-up than their peers who remained in the city in mostly poor neighborhoods (Rubinowitz & Rosenbaum, 2000). However, conflicting results emerged from the five-site Moving to Opportunity program, a true experimental study with randomized neighborhood assignment. A 5-year evaluation of Moving to Opportunity found beneficial outcomes of moving to low-poverty neighborhoods (vs. staying in high poverty) only on adolescent girls' education as assessed by a combination of high school completion/enrollment and achievement test scores (Kling, Liebman, & Katz, 2007); however, several other Moving to Opportunity evaluations reported no such favorable effects on achievement-related outcomes (Leventhal, Fauth, & Brooks-Gunn, 2005; Orr et al., 2003; Sanbonmatsu, Kling, Duncan, & Brooks-Gunn, 2006). These mixed results could be related to the observation that early neighborhood characteristics may have enduring associations with children's achievement, despite later neighborhood change (Sampson et al., 2008).

In addition to asking whether there is a link between neighborhood advantage and educational outcomes, researchers have also speculated about the shape of this link. A small body of research suggests that the association may be curvilinear, with maximum beneficial effects seen as soon as a significant proportion of residents are affluent professionals and a diminishing rate of return beyond that point. Just as increases in family income are more beneficial for poor children than for children who are not poor (Dearing, McCartney, & Taylor, 2001), increases in neighborhood advantage may support achievement only up to a certain level. Thus, the benefits of leaving a disadvantaged neighborhood for a middle-class one, as documented in the experimental literature, might not generalize to those leaving middle-class neighborhoods for more affluent ones. Along these lines, one study found that differences in youths' educational outcomes were particularly marked at the lower end of the neighborhood affluence continuum, between those living in neighborhoods with very few residents holding professional or managerial jobs and youths living in middle-class neighborhoods (Crane, 1991, see also Carpiano, Lloyd, & Hertzman, 2009). Middle-class neighborhoods may be especially supportive because they offer advantages both from the presence of more affluent residents and from programs serving lower income residents (see Carpiano et al., 2009). At the far end of the continuum, the culture of very affluent communities might pose challenges for youths (Luthar, 2003).

Although the question of selection remains unresolved, this past research suggests that neighborhood characteristics may influence achievement in a nonlinear fashion, with the strongest associations at the lower end of the socioeconomic spectrum. In this study, we investigated such neighborhood effects and took this work a step further by exploring underlying mechanisms of the effects we observed.

Neighborhood and Achievement: Potential Pathways

In his ecological model of human development, Bronfenbrenner (1979) proposed that development is shaped by a complex web of embedded social contexts. He argued that larger social structures influence development through more proximal contexts directly involving children. For instance, larger socioeconomic structures and cultures may influence parenting norms and parental access to educational resources and may, in turn, influence children's outcomes. Following a similar logic, theories of neighborhood effects on development propose that neighborhood influences likely operate indirectly through various proximal social contexts, such as families, peers, child care, and schools (e.g., Leventhal & Brooks-Gunn, 2000; Sampson, Morenoff, & Gannon-Rowley, 2002). Specifically, it is thought that neighborhood advantage enhances achievement by increasing the quality of learning experiences within the family and within neighborhood institutions serving children, most notably child care and school settings. In the next sections, we expand on these conceptual models by elaborating on the ways in which neighborhood affluence might affect familial and institutional practices relevant to achievement.

Neighborhood Advantage, Home Stimulation, and Children's Achievement

A first theoretical model linking neighborhood advantage and achievement focuses on parenting and the quality of the home environment (Leventhal & Brooks-Gunn, 2000). According to this perspective, collective norms and socialization, as well as the relative level of stress and support in the neighborhood, are primary ways in which neighborhood characteristics may influence parenting and, in turn, achievement. Parenting practices vary from community to community (Furstenberg, Cook, Eccles, Elder, & Sameroff, 1999; Lareau, 2002, 2003). For instance, in high-resources communities, parents tend to actively cultivate learning by creating a myriad of learning opportunities for their children, both inside and outside of the home. Lower middle or working class parents living in less advantaged communities, on the other hand, tend to adopt a less managerial style toward child rearing, capitalizing instead on natural processes of growth (for a description of contrasting norms in affluent and disadvantaged communities, see Luthar, 2003; Wilson, 1987). A concentration of families utilizing certain types of practices may create strong collective norms and consolidate pre-existing socioeconomic differences in parenting. Evidence suggests that shared norms regarding accept-

able behaviors are especially cohesive in advantaged neighborhoods (Harding, 2007; Sampson, Raudenbush, & Earls, 1997). On the other hand, social norms are more heterogeneous, and cohesion is typically lower in less advantaged neighborhoods, potentially weakening social pressures encouraging more mainstream practices (Simons, Simons, Burt, Brody, & Cutrona, 2005). Weak norms and lack of cohesion could diminish social sanctions against the use of unresponsive or harsh parenting practices (e.g., see Molnar, Buka, Brennan, Holton, & Earls, 2003; Simons et al., 2005). Related to this, in neighborhoods marked by danger and low levels of cohesion, parents may resort to restrictive strategies as a response to perceived threats (Furstenberg et al., 1999).

The levels of environmental strains and supports also tend to vary by neighborhood socioeconomic status (SES). Less advantaged neighborhoods often expose residents to stressors in the form of noise, pollution, crime, and disorder that appear to damage adults' mental and physical health (e.g., Hill, Ross, & Angel, 2005). In contrast, living in a resource-rich, well-kept, stable, and safe neighborhood may enhance parental well-being and, in turn, parents' ability to provide and direct learning activities in the home (see Kohen, Leventhal, Dahinten, & McIntosh, 2008). Supporting this view, results from the Moving to Opportunity experiment showed that moving to a more advantaged neighborhood benefited parents' mental health (Orr et al., 2003). Also, resource-rich neighborhoods support parents in their effort to foster positive development by providing infrastructures and activities. For instance, parents in neighborhoods with higher SES have access to children's literature in greater quantity and quality in local stores and libraries, as compared with those in less advantaged neighborhoods (Neuman & Celano, 2001).

Studies directly investigating quality of the home environment as a transmission mechanism between neighborhood affluence and achievement are few and far between. A first empirical test conducted in two independent samples of 3- to 6-year-olds found that the positive association between neighborhood advantage and children's cognitive test scores was partly attributable to the quality of the home environment (Klebanov, Brooks-Gunn, Chase-Lansdale, & Gordon, 1997; Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998). Other studies looking at preschoolers and first graders obtained similar results (Greenberg et al., 1999; Kohen et al., 2008). Among adolescents, nonexperimental (Ainsworth, 2002) and experimental (Leventhal & Brooks-Gunn, 2004) evidence has revealed that time spent on homework, a routine activity conditioned by the structure of the home environment, partially explained the association between neighborhoods with higher SES and youths' tests scores. In contrast, other studies found no indication that home stimulation explains the neighborhood advantage–achievement link (Caughy & O'Campo, 2006; Eamon, 2005; McCulloch, 2006). These inconsistencies, along with findings showing only partial mediation, suggest that home stimulation is not the only mechanism at play.

Neighborhood Advantage, Child Care and School Quality, and Children's Achievement

A second general theoretical model proposes that community socioeconomic characteristics shape the composition and quality of local institutions, such as child care and schools, whose mission revolves around children's cognitive growth and that this, in turn, influences achievement (Leventhal & Brooks-Gunn, 2000; Sampson et al., 2002). Elaborating on this perspective, we propose that neighborhood financial, human, and social capital all influence the strength and vitality of neighborhood learning institutions.

At the most basic level, institutional composition generally reflects the larger community makeup. As such, child care and school settings in more advantaged communities should comprise students from more affluent families than institutions in more disadvantaged neighborhoods. A sizeable body of research indicates that school compositional advantage is favorably associated with student achievement (see, e.g., recent work by Konstantopoulos, 2006; Levine & Painter, 2008). These benefits likely arise because greater concentrations of high-achieving students may facilitate instruction and learning and create a context with norms supportive of achievement (e.g., Aikens & Barbarin, 2008). Although less often investigated, similar compositional effects may also emerge in child care settings, a factor that may help explain why children with lower SES tend to receive lower quality care (e.g., NICHD Early Child Care Research Network, 1997).

In addition to shaping local institutions' composition, community characteristics likely influence their access to financial and human resources. Neighborhood public services are in large part funded by local tax revenues based on property values and business activities, both of which increase with neighborhood SES. Private services, notably child care, are also likely to reflect parents' collective willingness and capacity to pay for high-quality services. Financial capital generates better infrastructure, but perhaps more important, it often translates into human capital, probably because it allows for better salaries and working conditions. In fact, schools in wealthy suburbs are better at hiring and retaining highly qualified, effective teachers compared with urban schools with large enrollments of poor minority students (Guarino, Santibañez, & Daley, 2006). In the same manner, high-quality care is more accessible in advantaged than disadvantaged neighborhoods (Burchinal, Nelson, Carlson, & Brooks-Gunn, 2008; Fuller, Kagan, Caspary, & Gauthier, 2002). This situation may limit access to high-quality care among children in less affluent communities. Lack of high-quality care in the proximal environment may be especially problematic for children of low-income mothers, because practical constraints, primarily regarding location, are likely to take precedence over quality concerns when these mothers select child care arrangements (Peytona, Jacobsa, O'Brien, & Roy, 2001).

Social dynamics in higher SES neighborhoods, including parental advocacy and social capital, might also strengthen institutions serving children. Compared with lower income parents, advantaged parents tend to expect higher quality services for their children, notably when it comes to instruction (Lareau, 2000, 2002). They also tend to scrutinize service providers more closely and to exert pressures if dissatisfied. Child care and school administrators may respond to these demands more keenly in middle or upper income communities (vs. lower income neighborhoods), where parents typically have more leverage. For instance, in advantaged communities, parents can tap into wide social capital resources, because of high levels of participation in preschool- and school-related activities (Ream & Palardy, 2008; Waanders, Mendez, & Downer, 2007). Such networking also has the advantage of facilitating the flow of information regarding educational opportunities, for instance, about where to find stimulating child care

providers or outstanding teachers (see Sampson, Morenoff, & Earls, 1999). In addition to helping parents secure high-quality services for their children, such informal exchange of information and its impact on parental choice is likely to generate reinforcement contingencies favoring the growth and preservation of well-functioning services in affluent communities. These social resources likely benefit not only children of actively involved parents but the community as a whole.

A handful of studies focusing on achievement have examined neighborhood conditions in conjunction with child care or school characteristics; these studies provide suggestive evidence of mediated neighborhood effects. Studies conducted among both children and adolescents have found that child care or school experiences (e.g., teacher-reported classroom activities) are correlated with neighborhood characteristics and are independently associated with children's achievement (Aikens & Barbarin, 2008; Cook, Herman, Phillips, & Settersen, 2002; Eamon, 2005), two necessary but insufficient conditions for identifying mediated effects. One study formally testing mediation revealed that school climate, as reported by school administrators, did not mediate the association between neighborhood advantage and 10th graders' math and reading achievement (Ainsworth, 2002). Studies not directly looking at neighborhoods have nonetheless provided some support for the institutional perspective. One study evaluated the effectiveness of a high-quality school operating in a disadvantaged New York neighborhood and exploited the fact that available slots were allocated at random. This study found that when children received services on par with those usually available in more advantaged neighborhoods, important gains in achievement ensued (Dobbie & Fryer, 2009). A second study was based on a natural experiment in which a sudden influx of Ethiopian immigrants were assigned quasi-randomly to Israeli communities with schools of varying quality. This study found that school quality was associated with youths' lower dropout rates and higher passing rates on matriculation exams (Gould, Lavy, & Paserman, 2004). As a whole, these studies support the institutional resources model, but studies explicitly focusing on neighborhoods and directly testing mediation through direct observations of children's experiences in both child care and schools are needed.

The Current Study

Research directly investigating pathways of influence is needed to supplement the nascent literature focused on explaining the link between neighborhood advantage and achievement. Such research should attempt to reduce potential selection bias by at least including controls beyond family income and structure and should consider potential nonlinear effects. However, research looking simultaneously at both the home environment and institutional resources is especially needed. These two pathways can be construed as either competing or complementary, but the existing literature generally does not adjudicate between them. Considering the two pathways in conjunction is important for understanding how the neighborhood context may shape a series of related environments that plays a key role in children's achievement.

This study provides a comparatively comprehensive assessment of the mechanisms underlying neighborhood advantage effects on children's vocabulary, reading, and math achievement trajectories from early childhood (4.5 years old) to adolescence (15 years old). We expected that children living in neighborhoods with higher SES would have higher achievement than their peers in less advantaged neighborhoods but that this relationship might stabilize at high levels of neighborhood advantage. We expected that this link would be detectable even after controlling for a number of potential confounders, including basic demographic controls, such as child gender, child race/ethnicity, family structure, family income and maternal education, as well as controls tapping into nonmaterial resources, such as mothers' vocabulary, personality, and attitudes toward child rearing. Finally, we expected that the home (quality and maternal mental health), child care (quality), and school (composition and quality) environments would each play a role in explaining the association between neighborhood advantage and children's achievement trajectories.

Method

Sample

This study is based on data from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (see NICHD Early Child Care Research Network, 2005, and http://secc.rti.org for details). This longitudinal study followed children and families from 10 sites across the United States—Little Rock, Arkansas; Irvine, California; Lawrence, Kansas; Boston, Massachusetts; Philadelphia, Pennsylvania; Pittsburgh, Pennsylvania; Charlottesville, Virginia; Morganton, North Carolina; Seattle, Washington; and Madison, Wisconsin. Participants were recruited through hospital visits when the children were born in 1991. Families were not eligible if the mother was under 18, did not speak English, or had a substance abuse or serious health problem; if the family planned to move, lived too far from the study site, or in a location deemed too dangerous for home visiting; or if the child was hospitalized for more than 7 days postpartum, had obvious disabilities, or had a twin. About half of the eligible families were invited to participate (invited families were chosen through a conditional random sampling plan). Of those invited, 58% agreed to participate, leaving a final total sample of 1,364 families. The sample reflected the economic, educational, and racial–ethnic diversity of the catchment area at each site and included 24% racial/ethnic-minority children, 10% low-education mothers (less than high school), and 14% single parents. Following an initial assessment at 1 month, children and their families were studied in a range of settings when children were 6, 15, 24, 36, and 54 months of age, when they were in Grades 1, 3, and 5, and again when they were 15-years-old.

As in any longitudinal study, some participants dropped out, missed occasional data collection points, and/or had partial missing data on specific measures. For instance, although there were virtually no missing data on early family demographics, the response rate on the main outcome measures varied between 78% at 54 months and 65% at 15 years old (see Table 1 for details). To avoid potential bias resulting from deletion of incomplete cases, we used multiple imputation to handle missing data (Allison, 2001). Five multiply imputed data sets (created through the SAS MI procedure) were used for all descriptive and multivariate analyses.

Table 1
Descriptive Statistics (N = 1,364)

Variable	Child's age	Valid *N*	%	*M*	*SD*
Child characteristics					
Male	1 month	1,364	51.7		
Race/ethnicity[a]					
Black	1 month	1,364	12.9		
Other	1 month	1,364	6.7		
Maternal and family characteristics					
Education[b]	1 month	1,363		0.23	2.51
Child-rearing beliefs	1 month	1,358		75.61	16.85
Personality	6 months	1,272		58.66	14.28
Vocabulary[c]	36 months	1,167		−1.83	18.98
Income to needs[d]	1–54 months	1,355		0.39	2.70
Partnered	1–54 months	1,364	83.7		
Neighborhood advantage	1–54 months	1,289		−0.01	1.02
Mediators					
Maternal depressive symptoms	1–54 months	1,363		9.88	6.77
Quality of home learning environment	6–54 months	1,305		−0.02	1.03
Child care quality	6–54 months	1,134		2.91	0.50
Classroom instructional quality	Grade 1	965		15.63	5.16
School advantage[e]	Kindergarten	559		0.77	0.34
Children's achievement					
Vocabulary (WJ-R Vocabulary)					
1	54 months	1,060		458.75	15.84
2	Grade 1	1,020		483.17	13.35
3	Grade 3	1,014		496.29	12.03
4	Grade 5	992		505.36	13.71
5	15 years	889		517.76	16.06
Reading (WJ-R Letter–Word)					
1	54 months	1,056		368.37	23.22
2	Grade 1	1,025		451.82	28.21
3	Grade 3	1,014		493.12	20.45
4	Grade 5	993		509.48	20.72
Math (WJ-R Applied Problems)					
1	54 months	1,053		423.15	24.15
2	Grade 1	1,023		469.29	18.86
3	Grade 3	1,013		496.86	14.02
4	Grade 5	993		509.28	15.09
5	15 years	887		523.39	18.77

Note. Percentages, means, and standard deviations are based on multiply imputed data sets. WJ-R = Woodcock–Johnson Psycho-Educational Battery–Revised.
[a] Reference category: White. [b] In years, centered at 14 years. [c] Peabody Picture Vocabulary Test–Revised standardized scores, centered at 100. [d] Centered at 3. [e] The rate of missing data is higher on this variable because National Center for Educational Statistics data were not collected in all of the states every year; thus, participants in some sites did not have measures of school advantage before Grade 3 (the same was true for those attending private schools, with principal data being available only in Grade 3); to ensure an acceptable level of data quality despite this systematic pattern of missing data, we included highly correlated measures of school advantage with wider coverage (i.e., 995 participants had a valid value in Grade 3) in the imputation process, thus increasing the precision of imputed data for this variable.

Measures

Table 1 presents descriptive statistics for all study variables.

Outcome measures. Vocabulary and reading and math achievement were measured with three different subtests of the Woodcock–Johnson Psycho-Educational Battery–Revised (Woodcock & Johnson, 1989). The Vocabulary and Applied Problems (math) subtests were administered on five occasions (age 54 months, Grade 1, Grade 3, Grade 5, and age 15 years). For reading achievement, however, no subtests were administered at all times; we thus selected the single subtest with the maximum number of measurement occasions, the Letter–Word Identification subtest, which was administered four times (age 54 months, Grades 1, Grade 3, and Grade 5).[1] To monitor change over time more easily, raw scores for each subtest were converted to *W* scores, special transformations of the Rasch ability scale that centered the raw score on a value of 500. As expected, the average Vocabulary, Letter–Word Identification, and Applied Problems scores gradually increased with age (see Table 1).

Neighborhood socioeconomic advantage. Families' addresses were linked to 1990 (1–54 months) and 2000 (Grade 1 through age 15 years) U.S. Census data at the block group level to characterize the neighborhood environment. Census block groups are subdivisions of a census tract that comprise a combination of

[1] Other reading subtests were available at later assessments. However, because neighborhood effects emerged only for the intercept, the additional modeling complexity required for incorporating later subtests into reading growth curves was not justified.

street blocks and contain from 600 to 3,000 residents (U.S. Bureau of the Census, 1994). Census variables representing the percentage of adults with at least a bachelor of arts degree (e.g., at 1 month, $M_{1m} = 27.40$, $SD_{1m} = 18.39$), the percentage of households with incomes greater than $100,000 ($M_{1m} = 5.41$, $SD_{1m} = 8.89$), and the percentage of adults in managerial/professional jobs ($M_{1m} = 34.14$, $SD_{1m} = 14.78$) were standardized and averaged to create a measure of neighborhood advantage at each major assessment ($\alpha = .86$ to .93). These variables were selected on the basis of previous factor analysis of U.S. Census measures that identified the presence of high-income, educated, professional/managerial workers as representing a distinct neighborhood dimension (e.g., Duncan & Aber, 1997) and on the basis of previous studies based on the NICHD Study of Early Child Care and Youth Development sample that used a similar measure (Crosnoe, Leventhal, Wirth, Pierce, & NICHD Early Child Care Research Network, in press). In line with these results, a series of factor analyses with varimax rotation confirmed that these variables strongly loaded on a single factor distinct from neighborhood disadvantage (results available from the authors on request).

For analytic purposes, a standardized variable representing early neighborhood advantage was created by averaging the measures obtained at 1, 15, 36, and 54 months ($\alpha = .96$). To assess the presence of nonlinear associations with the outcome, this variable was then squared. In addition, to assess whether neighborhood change after 54 months was associated with the outcomes, we created a time-varying variable centered at the 1–54 months measure of neighborhood advantage. This within-child time-varying covariate represented deviations from each child's initial (1–54 months) value of neighborhood advantage and permitted examination of whether subsequent increases or decreases in one's relative position on neighborhood advantage are systematically associated with variations in achievement (Singer & Willett, 2003, pp. 173–191).

An important advantage associated with the use of such a within-child centered variable is that it essentially controls for potential unobserved time-invariant family and child confounds; however, this strategy still offers no guarantee against simultaneity bias and bias from time-varying confounds (see Dearing, McCartney, & Taylor, 2006; Duncan, Magnuson, & Ludwig, 2004; Singer & Willett, 2003, pp. 173–191). Although there were some changes in neighborhood advantage over time, it is important to note that neighborhood characteristics tended to be stable, with correlations between the early (1–54 months) and later (Grade 1 to 15 years old) neighborhood advantage measure ranging from .69 to .78.[2] Children's residential moves to more advantaged neighborhoods over time were uncommon, a tendency observed in other nationally representative samples (Hango, 2003; Leventhal & Brooks-Gunn, 2001; South, Crowder, & Trent, 1998). For instance, between 54 months and Grade 1, among those with valid data ($n = 1,035$), only 85 children moved to a neighborhood at least one half of a standard deviation above their initial neighborhood advantage level, and less than half of them ($n = 36$) remained in that neighborhood until at least Grade 5. Neighborhood stability also was reflected in the mean neighborhood change (in absolute value) from one assessment to the next, which averaged below one quarter of a standard deviation between ages 54 months and 15 years (average $M = 0.22$, $SD = 0.36$).

Maternal depression. The Center for Epidemiological Studies Depression Scale (Radloff, 1977) was used to measure maternal depression. Measures obtained when children were ages 1, 6, 15, 24, 36, and 54 months were averaged into a single composite ($\alpha = .84$), and later measures (Grade 1 through age 15 years) were used to construct a within-child time-varying covariate centered around the initial 1–54 months value, following an approach similar to that described earlier for neighborhood advantage.

Quality of home learning environment. Subscales from the Home Observation for Measurement of the Environment (HOME) inventory (Bradley & Caldwell, 1979) were used to measure quality of home learning environment. The HOME inventory combines information from observations and maternal interview to evaluate the quality and structure of the home environment. Developmentally appropriate adaptations of the HOME were administered at different assessments. To facilitate longitudinal analysis of the HOME scales, composite scores representing comparable constructs were computed from the items available at each assessment. For the present analysis, we added the scores of three composites representing parental responsiveness, the presence of learning materials, and the level of stimulation in the home. Because the exact content and number of items in each composite varied at each assessment, the total scores were standardized to ensure comparability. A standardized variable representing early quality of the home learning environment was created by averaging the standardized measures from ages 6, 15, 36, and 54 months ($\alpha = .82$). The same within-child centering approach described for neighborhood advantage was used; later assessments of quality of the home learning environment were coded as time-varying covariates representing deviations from the early home quality measure.[3] Although quality of the home learning environment tended to be fairly stable over time, variation was seen, with correlations between the early home quality measure (6–54 months) and the later measures (Grade 3 to age 15 years) ranging from .61 to .64.

Child care quality. The Observational Rating of the Care Environment (ORCE), a standardized procedure created specifically for the NICHD Study of Early Child Care and Youth Development, was used to measure child care quality. Details about the procedure, training, coding, and reliability of the ORCE are available elsewhere (NICHD Early Child Care Research Network, 2002a), and only a general overview is provided here. Observations of child behaviors, caregiver–child interaction, and the child care environment were conducted with the ORCE at 6, 15, 24, 36, and 54 months in nonmaternal care arrangements that were used for at least 10 hr per week. A series of 44-min observation cycles was made during half-day visits, and at the end of each of these cycles, observers made judgments about the quality of the care-

[2] Because the source of information about neighborhoods changed between 54 months (1990 census) and Grade 1 (2000 census), variations can have two distinct causes: changes in internal neighborhood conditions between the 1990 and 2000 censuses or changes in neighborhood conditions following a move. To take into account these two processes, we included in preliminary analyses interaction terms between the time-varying measure of changes in neighborhood advantage and dummy time-varying variables representing residential moves. Because no significant results emerged, we excluded them from the final models.

[3] Because the HOME was not administered in Grade 1, an average of the 54-month and Grade 3 assessments was used.

giving along several dimensions on a series of 4-point scales that ranged from *not at all characteristic* to *highly characteristic*. At 6, 15, and 24 months, these dimensions included the caregiver's sensitivity to child's nondistress signals, stimulation of child's development, positive regard toward child, detachment (reflected), and flatness of affect (reflected). At 36 months, two additional dimensions (fosters child's exploration and intrusiveness [reflected]) were included in the positive caregiving composite. At 4 1/2 years, the composite included four dimensions: sensitivity and responsivity, stimulation of cognitive development, intrusiveness (reflected), and detachment (reflected). Cronbach's alphas for the composite ranged from .72 to .89. A total quality score was computed by averaging mean scores obtained within each assessment from 6 to 54 months. A large majority of children (83%) had the quality of their child care environment rated at least once over the course of the study.

Classroom instructional quality. We assessed classroom instructional quality in Grade 1 with another instrument designed for this study, the Classroom Observation System (see NICHD Early Child Care Research Network, 2002b, for details about procedure, training, codification, and reliability). As with the ORCE, the Classroom Observation System was based on 44-min observation cycles made during half-day visits and focused on the child's activities, behavior, and interaction with the teacher as well as general features and activities of the whole classroom. At the end of each cycle, observers rated the quality of literacy instruction (e.g., rich literacy instruction and activities), evaluative feedback (e.g., teacher provides corrective feedback and encourages effort, persistence, and creativity), instructional conversation (e.g., teacher provides explanations, synthesis, and encourages reasoning), and child responsibility (e.g., opportunities for leadership roles) on a 7-point scale ranging from *uncharacteristic* to *extremely characteristic*. These three ratings were summed to assess the quality of classroom instruction in Grade 1.

School advantage. School advantage was captured with a variable representing the proportion of students not eligible to receive free lunch. National Center for Educational Statistics data describing basic school demographics were linked with children's school history for each grade, starting in kindergarten. The kindergarten measure was used as the initial school advantage score, and later scores were converted to time-varying within-child deviations, as described earlier for neighborhood advantage. It is important to note that the level of missing data was high for the kindergarten measure, because National Center for Educational Statistics data were not available for children attending private schools and were not systematically available at all sites before Grade 3. Fortunately, in Grade 3, it was possible to obtain the proportion of students not eligible for free and reduced-price lunch for all participating children, including those in private schools, from a study questionnaire sent to school principals.[4] To ensure an acceptable level of data quality in kindergarten despite the systematic pattern of missing data, we included highly correlated measures of school advantage in Grades 1 through 9 in the imputation process. This procedure is likely to provide an adequate estimate of school advantage in kindergarten, because school characteristics tended to be fairly stable over time. To illustrate, among those with valid data, the correlations among the kindergarten, Grade 1, Grade 2, and Grade 3 measures were high (r = .75 to .91), probably because a majority of children remained in the same or similar schools (as was the case for neighborhoods).

Child and family background characteristics. To address concerns about selection bias, a number of factors likely to influence both neighborhood characteristics and children's achievement were included as covariates. Child gender and race/ethnicity (White, Black, or other) and maternal education (in years, centered at 14 years) were controlled for in all analyses, as was study site (with a set of dummy variables).[5] Controls for maternal vocabulary (assessed when children were 36 months old with standard scores, centered at 100, from the Peabody Picture Vocabulary Test–Revised; Dunn & Dunn, 1981), maternal personality (assessed at when children were 6 months old with a composite of the Neuroticism, Extroversion, and Agreeableness scales from the NEO Five-Factor Inventory, a short form of the NEO Personality Inventory; Costa & McCrae, 1985), and parental beliefs about childrearing were also included. This last control was measured when children were 1 month old with a 30-item questionnaire discriminating between modern and traditional beliefs, with higher scores indicating more nonauthoritarian childrearing beliefs (Schaefer & Edgerton, 1985). Also included as covariates were the proportion of data collection points when a husband/partner was present in the home from ages 1 to 54 months and the average income-to-needs ratio (total family income divided by the poverty level for the respective household size, centered at 3). A within-child time-varying variable centered at the initial value was also created for income to needs.

Results

Before moving to multivariate growth curves models (or hierarchical linear models), intercorrelations among the variables of primary interest were reviewed (see Table 2). Given that significant neighborhood effects emerged for the intercept only (see next section) and the relatively high correlations among achievement measures over time, we focused on achievement in Grade 1. Neighborhood advantage was correlated in the expected direction with children's vocabulary, reading, and math achievement as well as with the home, child care, and school mediators, with comparatively stronger associations with home quality and school advantage. The five mediators were also positively associated with the three outcomes, and the strength of the association was especially strong for the home environment and, to a lesser degree, for school advantage. Children who lived in supportive homes were also more likely to be exposed to higher quality child care and school

[4] School principals reported the number of students in their school eligible for free/reduced-price lunch, as well as total school enrollment, from which the proportion of students receiving free/reduced-price lunch was calculated when not available in the National Center for Educational Statistics data files. Principals appeared to be reliable sources: Among those who had data from both sources in Grade 3 (n = 562), the correlation between the two measures was r = .92, and the distributions of the variables were virtually identical (for the National Center for Educational Statistics, M = .292, SD = .229; for principals, M = .287, SD = .218).

[5] Maternal education, maternal vocabulary, and family income-to-needs ratios were centered because they had nonlinear associations with at least one outcome (see the Results section); centering was performed to reduce multicollinearity when integrating squared terms in the models (Aiken & West, 1991) and to avoid having squared variables with very large values.

Table 2
Intercorrelations Among Neighborhood Advantage, Home, Child Care, School, and Achievement Measures (N = 1,364)

Measure	1	2	3	4	5	6	7	8	9
1. Neighborhood advantage[a]	—								
2. Maternal depressive symptoms[a]	−.21***	—							
3. Quality home environment[a]	.36***	−.37***	—						
4. Child care quality[a]	.20***	−.10**	.31***	—					
5. Classroom instructional quality	.15***	−.07†	.14***	.04***	—				
6. School advantage	.39***	−.19***	.46***	.21***	.19***	—			
7. Vocabulary[b]	.31***	−.20***	.46***	.22***	.08†	.32***	—		
8. Reading[b]	.21***	−.21***	.33***	.18***	.11**	.25***	.41***	—	
9. Math[b]	.29***	−.23***	.41***	.19***	.08**	.32***	.51***	.60***	—

[a] Measures obtained between 1 and 54 months. [b] Based on Grade 1 measures.
† $p < .10$. ** $p < .01$. *** $p < .001$.

environments; no association emerged, however, between child care quality and classroom instructional quality.

Hierarchical Linear Models

We selected a growth curve modeling strategy to test our hypotheses. Analyses were conducted with the HLM 6.04 software (Raudenbush, Bryk, Cheong, & Congdon, 2004). In Level 1 equations capturing individual growth patterns, time was coded in terms of years (age in months divided by 12) and centered at Grade 1, whereas the slope described annual linear change in children's achievement between 4.5 and Grade 5 (for reading) or 15 years old (for vocabulary and math). We selected Grade 1 as the intercept to ensure an adequate temporal order, because one of the mediators, classroom instructional quality, was measured only in Grade 1. To account for this situation, this variable was coded into a time-varying variable with values set at 0 at 54 months. Thus, classroom quality was allowed to influence scores only starting in Grade 1.[6]

At Level 1, quadratic models were selected to represent individual growth over time, which was based on visual examination of individual growth patterns, on results from previous studies using the same sample (e.g., NICHD Early Child Care Research Network, 2007), and on unconditional growth models indicating a significant quadratic slope for each of the three outcomes. At Level 2, the intercept and slope were allowed to vary randomly, whereas the quadratic slope was fixed. Results of unconditional models with site as a covariate revealed significant variation in both the intercept and linear slope for each of the three outcomes; however, the intercept was estimated much more reliably (reliabilities between .88 and .91) than the slope (reliabilities between .35 and .45; complete results are available from the authors on request).

To estimate the role of neighborhood advantage, three models were tested in sequence for each outcome. First, neighborhood advantage was entered along with the full battery of controls to estimate linear associations between neighborhood advantage and the outcome. Then, a squared term was added in a second model to assess the presence of nonlinear effects. Finally, to investigate whether changes in neighborhood advantage were associated with changes in the outcome, a third model incorporated time-varying deviation scores. The equations for this last model are provided in the Appendix as an illustration. When significant neighborhood effects emerged in one of these models, a second series of mediation models was estimated. In this second step, hypothesized mediators—maternal depression, quality of the home environment, child care quality, classroom instructional quality, and school advantage—were added one by one before full models that included all significant mediators were run. The significance of mediation was formally assessed for models considering mediators separately and jointly, following a method tailored for hierarchical linear models (Krull & MacKinnon, 2001). In the next sections, results for children's vocabulary and reading and math achievement are presented in sequence.

Before moving to the presentation of the hierarchical linear model results, we should note that a series of preliminary analyses was conducted to determine which control variables had significant within-child effects and/or had nonlinear associations with the achievement outcomes. All preliminary analyses included the full set of controls. Then, for each outcome (and when applicable), the time-varying and squared variables corresponding to each covariate were included one at a time. For the sake of parsimony, time-varying or squared control variables that had no significant associations with any of the three outcomes were then excluded from both the imputation procedure and final analysis. On the basis of these analyses, we included squared terms for maternal education, maternal vocabulary, maternal personality, and family income to needs, whereas time-varying deviations were incorporated only for family income to needs.

Vocabulary. Table 3 presents the results of the three models estimating the association between neighborhood advantage and children's vocabulary. Model 1 shows that neighborhood advantage was marginally associated with the vocabulary intercept in a linear fashion but was not associated with the slope; however, Model 2 denotes the presence of a nonlinear association between neighborhood advantage and the vocabulary intercept. With a positive linear trend and a negative quadratic term, we should expect a predominantly positive association that gradually levels

[6] In the mediation models incorporating this time-varying covariate, a dichotomous time indicator coded 0 at 54 months and coded 1 after 54 months was incorporated to ensure that no built-in time effects could be confounded in the parameter estimating the impact of classroom quality.

Table 3
Hierarchical Linear Models Predicting Vocabulary Between Ages 54 Months and 15 Years (N = 1,364)

Variable	Model 1			Model 2			Model 3		
	Intercept	Linear slope	TV deviation[a]	Intercept	Linear slope	TV deviation[a]	Intercept	Linear slope	TV deviation[a]
Male									
B	1.81**	0.06		1.77**	0.06		1.77**	0.06	
SE	0.49	0.07		0.49	0.07		0.49	0.07	
Race									
Black									
B	−5.75***	−0.23		−5.57***	−0.24		−5.57***	−0.24	
SE	1.12	0.16		1.12	0.17		1.12	0.17	
Other									
B	1.00	0.30*		1.02	0.30*		1.01	0.30*	
SE	1.13	0.15		1.13	0.15		1.13	0.15	
Maternal education									
B	0.59**	0.02		0.56**	0.03		0.56**	0.03	
SE	0.16	0.02		0.16	0.02		0.16	0.02	
Maternal education squared									
B	−0.04	−0.01†		−0.04	−0.01†		−0.04	−0.01*	
SE	0.03	0.01		0.03	0.01		0.03	0.01	
Maternal vocabulary									
B	0.23***	0.00		0.23***	0.00		0.23***	0.00	
SE	0.02	0.00		0.02	0.00		0.02	0.00	
Maternal vocabulary squared									
B	0.00	0.00		0.00	0.00		0.00	0.00	
SE	0.00	0.00		0.00	0.00		0.00	0.00	
Maternal personality									
B	0.12	0.00		0.13	0.00		0.13	0.00	
SE	0.12	0.02		0.12	0.02		0.12	0.02	
Maternal personality squared									
B	0.00	0.00		0.00	0.00		0.00	0.00	
SE	0.00	0.00		0.00	0.00		0.00	0.00	
Childrearing beliefs									
B	−0.02	0.00		−0.02	0.00		−0.02	0.00	
SE	0.02	0.00		0.02	0.00		0.02	0.00	
Income to needs									
B	0.70**	−0.03	0.06	0.69**	−0.03	0.06	0.68**	−0.03	0.05
SE	0.20	0.03	0.06	0.20	0.03	0.06	0.20	0.02	0.06
Income to needs squared									
B	−0.04*	0.00		−0.04*	0.00		−0.04*	0.00	
SE	0.02	0.00		0.02	0.00		0.02	0.00	
Mother partnered									
B	−0.55	−0.09		−0.45	−0.09		−0.45	−0.09	
SE	1.01	0.14		1.00	0.14		1.00	0.14	
NA at 1–54 months									
B	0.58†	−0.08		1.15**	−0.11†		1.19**	−0.10	0.20
SE	0.33	0.05		0.41	0.06		0.43	0.06	0.33
NA at 1–54 months squared									
B				−0.43*	0.02		−0.42*	0.02	
SE				0.19	0.03		0.19	0.03	

Note. All models include site as a covariate on the intercept and linear slope. TV = time varying; NA = neighborhood advantage.
[a] Time-varying deviations are obtained by centering around each child's initial value of the variable (Time 1 centering, see Singer & Willett, 2003, p. 176).
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

off. The top of Figure 1 confirms this shape.[7] The figure illustrates that increases in neighborhood advantage were most strongly associated with children's higher vocabulary scores in Grade 1 for those living in relatively less advantaged neighborhoods. To further probe the quadratic association, simple slope analyses were conducted (Aiken & West, 1991). The results revealed that the association between neighborhood advantage and children's vocabulary scores in Grade 1 was significant until neighborhood advantage reached .58, at which point the simple slope was estimated at 0.65 ($SE = 0.33$ and $t = 1.96$). In other words, neighborhood advantage was significantly associated with children's

[7] Nonlinear results were replicated with two alternative specifications. The first one used a logarithmic transformation of the neighborhood measure and yielded a significant neighborhood effect for both vocabulary and reading and a nearly significant effect for math. The second specification used dummies representing quintiles of neighborhood advantage. With the fourth quintile as the reference category, results showed that participants in the lowest quintile (and second lowest for reading) of neighborhood advantage had lower achievement scores. This last specification imposed no particular shape on the neighborhood–achievement relationship, but the results were consistent with the quadratic trends used in the final models.

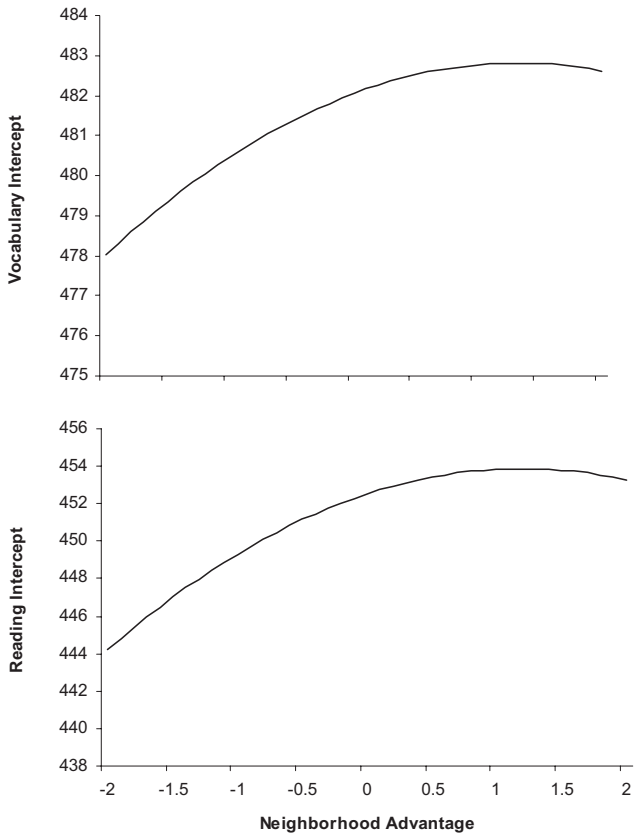

Figure 1. Nonlinear associations between neighborhood advantage and children's vocabulary (based on Model 2, Table 3) and reading achievement (based on Model 2, Table 4); control variables are fixed at their average value.

better vocabulary scores until over one half of a standard deviation above the mean of the neighborhood advantage measure, which corresponds to about the 77th percentile of its distribution.

To evaluate the practical significance of these findings, effect sizes (*d*) associated with increases of one standard deviation in neighborhood advantage were computed in different regions of the curve. First, we calculated the difference between the expected score at minus two and minus one standard deviations from the mean and divided this difference by the standard deviation of the outcome measure, here the standard deviation for vocabulary in Grade 1, because the models were centered there. This calculation indicated a moderate effect size in that region of the curve: $d = (480.48 - 478.03)/13.35 = 0.18$. As expected, the effect size diminished when the calculation involved the difference in expected scores between one standard deviation below the mean and the mean value: $d = (482.05 - 480.48)/13.35 = 0.12$. Effect size was reduced even further when the difference between the expected score at the mean and one standard deviation above the mean was considered: $d = (482.77 - 482.05)/13.35 = 0.05$. In an effort to assess the relative magnitude of these effects, we calculated the average effect sizes associated with one standard deviation increases for other family background variables generally considered important for children's achievement, including maternal education ($d = 0.56 \times 2.51/13.35 = 0.11$), maternal vocabulary ($d = 0.23 \times 18.98/13.35 = 0.33$), and family income ($d = 0.69 \times 2.70/13.35 = 0.14$). Here, the average *d*s were obtained by calculating the product of the estimated linear coefficient associated with the variable of interest and its standard deviation, again divided by the standard deviation of the outcome measure. These results suggest that among children living in relatively less advantaged neighborhoods, the magnitude of the effect associated with increasing neighborhood advantage is comparable with that of maternal education and family income and is about half that of maternal vocabulary.

In Model 3, variations in neighborhood advantage occurring after 54 months were not systematically associated with changes in children's vocabulary scores.

Reading achievement. Table 4 presents similar models for reading achievement. In general, the pattern of results was similar to the pattern for vocabulary, with Model 1 showing only a nearly significant linear association between neighborhood advantage and the reading intercept and with Model 3 indicating no significant effect of neighborhood change. Here again, Model 2 indicates the presence of a nonlinear, concave downward relationship between neighborhood advantage and the reading intercept. The bottom of Figure 1 confirms that the shape of the relationship is similar, with increases in neighborhood advantage more strongly associated with children's higher initial reading scores for those living in relatively less advantaged neighborhoods. Simple slope analyses revealed that the association with the outcome was significant until neighborhood advantage reached .60, at which point the simple slope was estimated at 1.14 ($SE = 0.58$ and $t = 1.96$). Thus, neighborhood advantage was positively associated with children's reading scores until past one standard deviation above its mean, which corresponds to about the 78th percentile of the neighborhood advantage distribution.

Effect sizes associated with increases of one standard deviation in terms of neighborhood advantage were computed in the same regions of the curve as for vocabulary. The calculation of the effect sizes associated with the difference between the expected score at minus two and minus one standard deviation from the mean indicated a moderate effect size in that region of the curve: $d = (449.32 - 444.22)/28.21 = 0.18$. Again, the effect sizes diminished as neighborhood advantage increased: For between minus one standard deviation and the mean, $d = (452.53 - 449.32)/28.21 = 0.11$, and for between the mean and one standard deviation above the mean, $d = (453.84 - 452.53)/28.21 = 0.05$. As benchmarks, average effect sizes were also calculated for maternal education ($d = 1.28 \times 2.51/28.21 = 0.11$), maternal vocabulary ($d = 0.21 \times 18.98/28.21 = 0.14$), and family income ($d = 1.51 \times 2.70/28.21 = 0.14$). Again, these results suggest that at least in the lower half of the neighborhood advantage distribution, the effect sizes associated with neighborhood advantage are roughly comparable with those of maternal education, maternal vocabulary, and family income.

Math achievement. The same models were also conducted for math achievement. Results from the first model again revealed a marginally significant linear association between neighborhood advantage and children's math intercept ($B = 0.73$, $SE = 0.43$, $p = .09$). In the second model incorporating the quadratic term, the linear association became significant ($B = 1.19$, $SE = 0.56$, $p = .04$), but the associated quadratic term did not reach statistical significance ($B = -0.35$, $SE = 0.30$, $p = .25$). These results indicate that the association between neighborhood advantage and math achievement

Table 4
Hierarchical Linear Models Predicting Reading Between Ages 54 Months and 15 Years (N = 1,364)

Variable	Model 1			Model 2			Model 3		
	Intercept	Linear slope	TV deviation[a]	Intercept	Linear slope	TV deviation[a]	Intercept	Linear slope	TV deviation[a]
Male									
B	−3.23**	0.68**		−3.32**	0.69**		−3.32**	0.69**	
SE	1.02	0.19		1.03	0.19		1.03	0.19	
Race									
Black									
B	−5.57**	−0.31		−5.19**	−0.36		−5.18**	−0.36	
SE	1.72	0.42		1.70	0.42		1.70	0.41	
Other									
B	1.73	−0.41		1.77	−0.41		1.77	−0.42	
SE	1.94	0.39		1.93	0.39		1.93	0.39	
Maternal education									
B	1.36***	−0.10		1.28***	−0.09		1.28*	−0.09	
SE	0.32	0.06		0.32	0.06		0.32	0.06	
Maternal education squared									
B	−0.14*	0.01		−0.14*	0.01		−0.14*	0.01	
SE	0.06	0.01		0.06	0.01		0.06	0.01	
Maternal vocabulary									
B	0.21***	0.01		0.21*	0.01		0.21***	0.01	
SE	0.04	0.01		0.04	0.01		0.04	0.01	
Maternal vocabulary squared									
B	0.00†	0.00		0.00	0.00		0.00	0.00	
SE	0.00	0.00		0.00	0.00		0.00	0.00	
Maternal personality									
B	0.09	0.02		0.10	0.02		0.10	0.02	
SE	0.24	0.06		0.23	0.06		0.23	0.06	
Maternal personality squared									
B	0.00	0.00		0.00	0.00		0.00	0.00	
SE	0.00	0.00		0.00	0.00		0.00	0.00	
Childrearing beliefs									
B	−0.02	0.01		−0.02	0.01		−0.02	0.01	
SE	0.04	0.01		0.04	0.01		0.04	0.01	
Income to needs									
B	1.54**	−0.13	0.09	1.51**	−0.13	0.09	1.51**	−0.13	0.09
SE	0.43	0.08	0.22	0.44	0.08	0.22	0.44	0.08	0.22
Income to needs squared									
B	−0.11**	0.01		−0.10*	0.00		−0.10*	0.00	
SE	0.04	0.01		0.04	0.01		0.04	0.01	
Mother partnered									
B	−0.20	0.22		0.02	0.19		0.02	0.19	
SE	1.98	0.36		1.98	0.36		1.97	0.36	
NA at 1–54 months									
B	1.03†	−0.15		2.26**	−0.32†		2.25**	−0.32	−0.05
SE	0.58	0.14		0.72	0.17		0.74	0.19	0.71
NA at 1–54 months squared									
B				−0.95**	0.13†		−0.95**	0.13†	
SE				0.33	0.07		0.33	0.07	

Note. All models include site as a covariate on the intercept and linear slope. TV = time varying; NA = neighborhood advantage.
[a] Time-varying deviations are obtained by centering around each child's initial value of the variable (Time 1 centering; see Singer & Willett, 2003, p. 176).
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

followed a shape similar to those found for reading and vocabulary, although the quadratic coefficients did not reach significance (but see results of alternative specifications in footnote 7). Because the quadratic term was not significant and the linear effect alone was only nearly significant, mediation was not investigated for math achievement. Finally, in the third model, the time-varying variable representing changes in neighborhood advantage had no significant association with children's math scores ($B = -0.20$, $SE = 0.46$, $p = .67$), consistent with the other outcomes.

Tests of Mediation

Formally testing for mediational effects in hierarchical linear models involves the consideration of two aspects: (a) the association between the initial variable (here neighborhood advantage) and mediators, net of the effect of covariates, and (b) the association between mediators and outcomes, independent of the effect of the initial variable and covariates (Krull & MacKinnon, 2001). Once the two coefficients representing the independent association between the

initial variable and a mediator and between the mediator and the outcome are known, the mediated effect can be estimated by computing the product of these coefficients, and statistical tests such as the Sobel test (Sobel, 1982) can be used to estimate its significance.

For the first aspect, associations between neighborhood advantage and the mediators, all Level 2 variables, were evaluated in ordinary least squares regression models adjusting for the full battery of Level 2 controls following Krull and MacKinnon's (2001) recommendations. Results of these models confirmed significant positive associations between neighborhood advantage and quality of the home environment ($B = 0.08$, $SE = 0.03$, $p = .017$), between neighborhood advantage and child care quality ($B = 0.07$, $SE = 0.02$, $p < .001$), between neighborhood advantage and classroom quality ($B = 0.59$, $SE = 0.19$, $p = .004$), as well as between neighborhood advantage and school advantage ($B = 0.06$, $SE = 0.01$, $p < .001$), net of covariates. However, maternal depression was not significantly associated with neighborhood advantage ($B = 0.00$, $SE = 0.25$, $p = .99$). The associations were especially strong for the child care and school environments. In preparation for the full models including more than one mediator at a time, additional regression analyses were conducted to estimate the association between neighborhood advantage and each of the mediators while inserting other relevant mediators in the equation as covariates.[8] When competing mediators were added as covariates in the equation, the association between neighborhood advantage and quality of the home environment became nonsignificant.

For the second aspect, a series of models introducing the mediators one by one were tested for vocabulary and reading achievement, the two outcomes with significant associations with neighborhood advantage.[9] Then, for each outcome, we estimated a final model including all of the mediators that were individually significant. For all of these models, Sobel tests of mediation were performed to investigate statistical significance of the mediated effect (calculated as the product of the coefficients). Because the power to detect significant mediation effects with the Sobel test is comparatively low (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), Sobel tests were one tailed. The results of all of these models and of associated mediated effects are presented in Table 5.

Vocabulary. The left panel of Table 5 presents the results for vocabulary. Models 1 through 5 indicate that only quality of the home environment and quality of the child care environment were significant mediators, whereas school advantage was nearly significant. Model 6, incorporating both the home and child care environment as mediators, suggests that the magnitude of mediation was similar for both the home and child care environments but that the level of significance was slightly higher for the child care environment ($p = .01$) as compared with the home environment ($p = .04$). In other words, although the home environment had a stronger direct association with children's vocabulary, the quality of the child care environment appeared more important for explaining the association between neighborhood advantage and children's vocabulary scores (recall here that the association between neighborhood advantage and the quality of the home environment became nonsignificant when the quality of the child care environment was included as a covariate in the regression equation). It is important to note that only part of this association was accounted for by the two mediators. Indeed, the positive linear association between neighborhood advantage and children's vocabulary scores remained significant in Model 6, and the mediators explained only about one third of this effect: $(1.15 - 0.80)/1.15 = 0.30$.

Reading. The right panel of Table 5 presents the results for reading. Results of Models 1 through 5 revealed significant mediated effects for three variables, including the home environment, the child care environment, and school advantage. Model 6 incorporated the three significant mediators. In this model, only the school environment showed a significant mediated effect, whereas the home and child care environments were nearly significant, even though the home environment had the strongest direct association with the outcome. Again, the strength of the mediated effects was somewhat stronger for child care ($p = .066$) than for the home ($p = .096$) environment. Thus, for reading, school advantage played a unique role in explaining the association between neighborhood advantage and children's reading achievement, along with the quality of the child care and home environments, although to a lesser degree. Together, the mediators incorporated in Model 6 also explained about one third of the positive linear association between neighborhood advantage and reading scores: $(2.26 - 1.42)/2.26 = 0.37$.

Discussion

This study examined the mechanisms underlying the association between neighborhood socioeconomic advantage and children's achievement trajectories through adolescence. It also examined the shape of this association. Building on Bronfenbrenner's (1979) ecological system theory and on related theories of neighborhood effects (see Leventhal & Brooks-Gunn, 2000; Sampson, Morenoff, & Gannon-Rowley, 2002), we proposed that neighborhood socioeconomic circumstances would influence the family, child care, and school environments, such that children living in advantaged neighborhoods would be exposed to enriched experiences across these contexts, as compared with their peers living in less advantaged neighborhoods. In turn, exposure to advantaged settings was expected to increase children's achievement. In addition, just as income gains are especially important for children growing up in poor families (Dearing et al., 2001), we hypothesized that exposure to affluent, educated neighbors would be especially important at the lower end of the neighborhood advantage continuum. Results from growth curve models generally supported these hypotheses for children's vocabulary and reading achievement, whereas a consistent but weaker pattern was observed for their math achievement. We discuss these results in two steps. First, we consider the shape and strength of the neighborhood–achievement link. Second, we look at the mechanisms underlying this link.

[8] The mediators included as covariates were selected in accordance with the full models presented in Table 5.

[9] In preliminary analyses, squared terms were incorporated for each of the mediators, but because no significant effects were found, they were not included in the final analyses. We also excluded variables representing within-child time-varying deviations for maternal depression, quality of the home environment, and school advantage, because we found no within-child neighborhood effects. This decision was also based on the observation in preliminary analysis that none of these variables had significant effects for vocabulary and reading (with one exception for home stimulation and reading).

Table 5
Hierarchical Linear Models Predicting Vocabulary and Reading Achievement Intercepts: Testing Mediation of Neighborhood Effects (N = 1,364)

	Vocabulary						Reading					
Variable	1	2	3	4	5	6	1	2	3	4	5	6
Regression models												
NA												
B	1.15**	0.92**	0.95*	1.16**	1.02*	0.80*	2.26**	1.92*	2.01**	2.24**	1.79*	1.42†
SE	0.41	0.40	0.41	0.42	0.42	0.40	0.73	0.74	0.73	0.73	0.79	0.79
NA squared												
B	−0.43*	−0.37*	−0.38*	−0.43*	−0.41*	−0.34†	−0.94**	−0.85*	−0.88**	−0.94**	−0.86*	−0.75*
SE	0.19	0.18	0.18	0.19	0.19	0.18	0.33	0.33	0.32	0.33	0.33	0.33
Maternal depression												
B	−0.04						−0.23*					
SE	0.05						0.10					
Quality home environment												
B		2.99***				2.80***		4.38***				4.08***
SE		0.44				0.43		0.70				0.69
Child care quality												
B			2.64***			1.84**			3.42**			2.06†
SE			0.64			0.61			1.11			1.15
Classroom quality												
B				−0.03						0.05		
SE				0.06						0.12		
School advantage												
B					2.15						7.82†	6.19†
SE					1.63						3.81	3.50
Mediated effects												
Maternal depression												
B	0.00						0.00					
SE	0.01						0.06					
Quality home environment												
B		0.23*				0.16*		0.34*				0.17†
SE		0.10				0.09		0.15				0.13
Child care quality												
B			0.19**			0.12*			0.25**			0.11†
SE			0.07			0.05			0.10			0.07
Classroom quality												
B				−0.02						0.03		
SE				0.03						0.07		
School advantage												
B					0.13†						0.48*	0.36*
SE					0.10						0.24	0.21

Note. All models include the full set of controls on both the intercept and slope. The significance of the mediated effects is based on one-tailed Sobel tests. NA = neighborhood advantage.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Neighborhood Advantage and Achievement: Shape and Strength of the Link

Results showed that neighborhood advantage was associated with children's vocabulary and reading scores in a nonlinear fashion, after taking into account a number of potential confounds, including child gender, child race/ethnicity, family structure, family income, and a range of maternal characteristics (education, vocabulary, personality, child-rearing beliefs, depression). For both outcomes, neighborhood advantage seemed to matter most for children's achievement in relatively less advantaged neighborhoods. That is, the presence of educated, affluent professionals in the neighborhood had a favorable association with children's achievement until it leveled off at moderate levels of advantage. Correspondingly, the magnitude of the neighborhood–achievement link was not constant across the whole range of neighborhoods. In the lower range of the continuum—that is, in relatively less advantaged neighborhoods—neighborhood effects were found to be larger than at the higher end of the distribution, with effect sizes comparable with those of other factors generally recognized as important for achievement, such as maternal education or family income. For the sample as a whole, however, neighborhood effects were small, consistent with findings from much of the literature (Leventhal & Brooks-Gunn, 2000). Thus, the results indicate that the magnitude of the association between neighborhood advantage and children's achievement varies by the extent of neighborhood advantage.

This nonlinear association is consistent with social isolation, institutional resources, and collective socialization perspectives.

On the one hand, the social isolation perspective suggests that negative impacts on youths emerge when middle-class residents with mainstream values and lifestyles are largely absent from a community (Wilson, 1987). Previous findings suggest that it is indeed under such conditions that youths' educational and economic outcomes are especially poor (Carpiano et al., 2009; Crane, 1991; Vartanian & Buck, 2005). On the other hand, both the institutional resources and collective socialization perspectives imply that youths' achievement should increase gradually as the proportion of affluent and educated professionals increases, with their presence consolidating the quality of local services and strengthening community social organization, including the presence of adult role models and supervision (see Leventhal & Brooks-Gunn, 2000). Results from other studies looking at nonlinear associations between neighborhood advantage and youth outcomes are consistent with this incremental view (Duncan, Connell, & Klebanov, 1997; Kauppinen, 2007; Vartanian & Buck, 2005). These apparently conflicting points of view are not necessarily incompatible: Even if the worst outcomes are observed in neighborhoods with very few middle-class residents, additional improvements may occur as the proportion of such residents increase, although perhaps along a less abrupt gradient. Results of the present study suggest that both models may apply, with more pronounced differences in children's achievement found between less advantaged neighborhoods and moderately advantaged ones, along with moderate benefits still observable for most of the neighborhood advantage distribution.

At about the 75th percentile, however, the positive association between neighborhood advantage and children's achievement reached a plateau beyond which increases in the proportion of advantaged residents were no longer associated with higher achievement. This pattern may arise because mainstream norms and associated collective socialization mechanisms become firmly established as soon as a significant proportion of residents are educated, affluent professionals (i.e., a tipping point). It could also be related to the observation that in very affluent communities, the demanding careers of many parents leave less time for them to invest in neighborhood institutions and to generate the benefits associated with participation and social capital, which may offset additional gains in achievement (Luthar, 2003). In addition, children in mixed-income communities may fare best, with benefits both from the advantages associated with the presence of affluent, educated residents and from the presence of services for lower income families (Carpiano et al., 2009). Because much extant neighborhood research focuses on concentrated disadvantage rather than on concentrated advantage, these hypotheses require further investigation.

Although neighborhood advantage was associated with children's vocabulary and reading scores in Grade 1, it was not associated with learning rates in these domains. In the same manner, changes in neighborhood advantage following residential moves or neighborhood improvement or decay were not linked with changes in children's achievement scores over time. Because intercept effects are more prone to selection bias compared with slope and within-child effects, this pattern of results raises the possibility that the neighborhood–achievement link may be due to unobserved variables (see Limitation section). Alternatively, the results may indicate that neighborhood advantage sets children on a higher achievement course early and that this early advantage is unchanged as children progress in the school system. This *carry-forward* pattern is consistent with other findings indicating that early neighborhood conditions may have a long-term impact on achievement (Leventhal et al., 2006; Lloyd, Li, & Hertzman, 2010; Sampson et al., 2008). Finally, measurement issues represent a third explanation for the lack of slope and change effects. First, learning rates were estimated much less reliably than initial statuses. To track neighborhood effects on learning rates more effectively, studies with more frequent assessments of achievement based on measures highly sensitive to change are needed (e.g., Fuchs, Fuchs, & Compton, 2004). Second, those who moved usually relocated to fairly similar neighborhoods, restricting the magnitude of changes in neighborhood characteristics. The lack of variation in neighborhood change observed in this study (comparable with other samples, including nationally representative ones; Hango, 2003; Leventhal & Brooks-Gunn, 2001; South et al., 1998), combined with the relatively small sample size, certainly limited our ability to detect neighborhood change effects.

Explaining Links Between Neighborhood Advantage and Achievement

Beyond simply observing an association between neighborhood advantage and children's achievement, this study's major contribution is the examination and comparison of the potential mediating role of three major proximal contexts of development—the family, child care, and school environments. Substantial theoretically oriented work has put forward these contexts as central for understanding neighborhood effects on achievement (see Leventhal & Brooks-Gunn, 2000; Sampson et al., 2002). Detailed and integrated theoretical formulations of the impact of neighborhood advantage on the level of stimulation provided in the family and neighborhood institutions and, in turn, on children's achievement, however, are lacking, as is empirical work comprehensively testing these propositions. Indeed, the few available empirical evaluations suffer from important limitations. Previous studies have focused on only one mechanism at a time, limiting their ability to provide a more complete understanding of the processes at play. In addition, neighborhood studies looking at institutional resources have relied on "empirical measures . . . limited to the mere presence of neighborhood institutions based on survey reports . . . and archival records" (Sampson et al., 2002, p. 458).

In contrast, the present study used strong, on-site observational measurement to examine the respective roles of two institutions central to children's achievement—child care and classroom environments. An indicator of school advantage was used as well, to assess the role of school compositional effects, which in part reflect neighborhood sociodemographic makeup. The home environment also was assessed with a semi-structured measure that included an observational component, which is less subject to problems of shared method variance inherent in much of the neighborhood literature. Maternal depression was considered as well but had no mediating role. Our study demonstrated that the home, child care, and school environments together accounted for about one third of the positive association between neighborhood socioeconomic advantage and children's vocabulary and reading scores. When both sources of advantage, in the home and in institutions, were considered simultaneously, institutional factors—that is, the child care and school contexts—appeared to take

precedence over the home environment in explaining neighborhood effects (although the quality of the home environment had stronger direct effects). The school environment played a mediating role only for reading, perhaps because reading instruction is a primary mission in the early school years.

The quality of the home environment appears to play a lesser role in terms of mediation mainly because its association with neighborhood advantage was weak (and nonexistent for maternal depression) once various important family background characteristics were taken into account. In other words, neighborhood advantage was found to have a relatively small association with quality of the home environment after controlling for selection of advantaged families into advantaged neighborhoods. In contrast, strong associations with neighborhood advantage were observed for quality of the child care environment and for school advantage, even after controlling for the same family background characteristics. Thus, children raised in advantaged neighborhoods appear to receive higher quality child care and to attend more advantaged schools, even when family characteristics, such as the quality of the home environment, are held constant. In turn, access to advantaged institutions may explain why children in comparatively advantaged neighborhoods tended to have higher vocabulary and reading scores than their peers in less advantaged neighborhoods. In addition, community characteristics may be especially relevant for collective resources, such as child care centers and schools, more so than for individual home routines and practices. Individual parents certainly have the primary influence over what goes on inside their homes. On the other hand, although parents can and do have an impact on institutions serving children, the power of any individual parent over these institutions nevertheless remains limited, leaving more room for collective factors to operate.

Although school advantage in elementary school was a significant mediator of the association between neighborhood advantage and children's initial reading achievement, first-grade instructional quality was not. This surprising finding may be due, in part, to measurement issues. First, classroom instructional quality was assessed only once and with a restricted set of items, which contrasts with the other observational measures administered repeatedly over early childhood and with fuller sets of items. Second, the items did not focus on the specific content of instructional activities, a characteristic of demonstrated importance (Gersten, Baker, Haager, & Graves, 2005). Third, research has shown that what happens in the classroom is only one aspect that differentiates the school experiences of children in contrasting neighborhoods. For children in less advantaged neighborhoods to attain achievement scores comparable with those of their peers in more advantaged neighborhoods, many aspects of school life need to be addressed, including pedagogy, school hours, extracurricular activities, climate, and discipline (Dobbie & Fryer, 2009). The school advantage measure may have tapped more effectively into these multiple aspects than the measure of classroom quality.

By underscoring the role of the quality of the child care environment and of school advantage, the results give credence to theories suggesting that neighborhood socioeconomic advantage facilitates institutions' efforts to cultivate children's achievement. Yet, the specific mechanisms through which neighborhood socioeconomic advantage strengthens institutions need to be explored further in future research. For instance, the importance of child care providers' behaviors for explaining neighborhood advantage–achievement links could be due to caregivers' perceptions of their role and of children's needs, job satisfaction, collective resources, or community and parental support. More detailed exploration of the mechanisms at play could provide further insights into specific aspects of community life that could be targeted in interventions aimed at strengthening achievement among children in less advantaged communities. Considering other aspects of community life in future research also appears essential given that the factors explored here only partially explained the neighborhood advantage–achievement link. For instance, involvement in high-quality extracurricular and after-school activities is another potentially important institutional aspect not investigated here.

Limitations

The present study has several limitations, in addition to those already discussed. Selection issues represent the most important threat to the validity of nonexperimental neighborhood studies, given the possibility that background characteristics unaccounted for may be responsible for apparent neighborhood effects (see Duncan et al., 1997). Consequently, special efforts were made to control for many important family characteristics that could be associated both with the selection of an advantaged, resourceful neighborhood and with children's achievement. Even so, there is no guarantee that selection is not operating. This limitation is important to underscore given that the only true experiment of neighborhood effects, Moving to Opportunity, yielded mixed results with respect to children's achievement (Kling et al., 2007; Leventhal et al., 2005; Orr et al., 2003; Sanbonmatsu et al., 2006). In addition, the generalizability of the findings remains uncertain in a study based on a single cohort of children born in 1991 and for a sample that is diverse but not nationally representative. Finally, although the results were consistent for the three outcomes considered, the results for math achievement were weaker, suggesting that the strength of the neighborhood–achievement link may vary as a function of the specific aspect of achievement considered (for similar results, see Lloyd et al., 2010). This may be because the acquisition of verbal skills typically depends on the quality of experiences in a variety of collective contexts, allowing for cumulative neighborhood influences, whereas math skills typically depend more heavily on a single institution, that is, schools (see Lloyd et al., 2010).

Despite these limitations, this study offers a valuable theoretical, empirical, and practical contribution. Of importance, it proposes and tests a model integrating both the family and institutional contexts for understanding links between neighborhood socioeconomic advantage and children's achievement. Results based on observational assessments confirm that these two contexts, but perhaps especially the institutional one, must be considered to understand more fully why living in neighborhoods with high SES promotes children's achievement. On a practical level, the results suggest that interventions aimed at improving achievement among children from less advantaged neighborhoods need to take a holistic approach and provide community services supporting not only families but also institutions and service providers in their efforts to create stimulating environments for children.

References

Aaronson, D. (1998). Using sibling data to estimate the impact of neighborhoods on children's educational outcomes. *Journal of Human Resources, 33,* 915–946.

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions.* Newbury Park, CA: Sage.

Aikens, N. L., & Barbarin, O. (2008). Socioeconomic differences in reading trajectories: The contribution of family, neighborhood, and school contexts. *Journal of Educational Psychology, 100,* 235–251.

Ainsworth, J. W. (2002). Why does it take a village? The mediation of neighborhood effects on educational achievement. *Social Forces, 81,* 117–152.

Allison, P. D. (2001). *Missing data.* Thousand Oaks, CA: Sage.

Boyle, M. H., Georgiades, K., Racine, Y., & Mustard, C. (2007). Neighborhood and family influences on educational attainment: Results from the Ontario Child Health Study follow-up 2001. *Child Development, 78,* 168–189.

Bradley, R. H., & Caldwell, B. M. (1979). Home observation for measurement of the environment: A revision of the preschool scale. *American Journal of Mental Deficiency, 84,* 235–244.

Bronfenbrenner, U. (1979). *The ecology of human development.* Cambridge, MA: Harvard University Press.

Burchinal, M., Nelson, L., Carlson, M., & Brooks-Gunn, J. (2008). Neighborhood characteristics and child care type and quality. *Early Education and Development, 19,* 702–725.

Carpiano, R. M., Lloyd, J. E. V., & Hertzman, C. (2009). Concentrated affluence, concentrated disadvantage, and children's readiness for school: A population-based, multi-level investigation. *Social Science & Medicine, 69,* 420–432.

Caspi, A., Taylor, A., Moffitt, T. E., & Plomin, R. (2000). Neighborhood deprivation affects children's mental health: Environmental risks identified in a genetic design. *Psychological Science, 11,* 338–342.

Caughy, M. O., & O'Campo, P. J. (2006). Neighborhood poverty, social capital, and the cognitive development of African American preschoolers. *American Journal of Community Psychology, 37,* 141–154.

Cleveland, H. H. (2003). Disadvantaged neighborhoods and adolescent aggression: Behavioral genetic evidence of contextual effects. *Journal of Research on Adolescence, 13,* 211–238.

Cook, T. D., Herman, M. R., Phillips, M., & Settersen, R. A., Jr. (2002). Some ways in which neighborhoods, nuclear families, friendship groups, and schools jointly affect changes in early adolescent development. *Child Development, 73,* 1283–1309.

Costa, P. T., & McCrae, R. R. (1985). *The NEO Personality Inventory manual.* Odessa, FL: Psychological Assessment Resources.

Crane, J. (1991). The epidemic theory of ghettos and neighborhood effects on dropping out and teenage childbearing. *American Journal of Sociology, 96,* 1126–1159.

Crosnoe, R., Leventhal, T., Wirth, R. J., Pierce, K., & NICHD Early Child Care Research Network. (in press). Family socioeconomic status and consistent environmental stimulation in early childhood. *Child Development.*

Dearing, E., McCartney, K., & Taylor, B. A. (2001). Change in family income-to-needs matters more for children with less. *Child Development, 72,* 1779–1793.

Dearing, E., McCartney, K., & Taylor, B. A. (2006). Within-child associations between family income and externalizing and internalizing problems. *Developmental Psychology, 46,* 237–252.

Dobbie, W., & Fryer, R. G., Jr. (2009). *Are high-quality schools enough to close the achievement gap? Evidence from a bold social experiment in Harlem.* Cambridge, MA: Department of Economics, Harvard University.

Duncan, G. J., & Aber, J. L. (1997). Neighborhood models and measures. In J. Brooks-Gunn, G. J. Duncan, & J. L. Aber (Eds.), *Neighborhood poverty: Context and consequences for children* (Vol. 1, pp. 62–78). New York: Russell Sage Foundation Press.

Duncan, G. J., Connell, J. P., & Klebanov, P. K. (1997). Conceptual and methodological issues in estimating causal effects of neighborhood and family conditions on individual development. In J. Brooks-Gunn, G. J. Duncan, & J. L. Aber (Eds.), *Neighborhood poverty: Context and consequences for children* (Vol. 1, pp. 219–250). New York, NY: Russell Sage Foundation Press.

Duncan, G. J., Magnuson, K. A., & Ludwig, J. (2004). The endogeneity problem in developmental studies. *Research in Human Development, 1,* 59–80.

Dunn, L. M., & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test–Revised.* Circle Pines, MN: American Guidance Service.

Eamon, M. K. (2005). Social–demographic, school, neighborhood, and parenting influences on the academic achievement of Latino young adolescents. *Journal of Youth and Adolescence, 34,* 163–174.

Foster, E. M., & McLanahan, S. (1996). An illustration of the use of instrumental variables: Do neighborhood conditions affect a young person's chance of finishing high school? *Psychological Methods, 1,* 249–260.

Fuchs, L. S., Fuchs, D., & Compton, D. L. (2004). Monitoring early reading development in first grade: Word identification fluency versus nonsense word fluency. *Exceptional Children, 71,* 7–21.

Fuller, B., Kagan, S. L., Caspary, G. L., & Gauthier, C. A. (2002). Welfare reform and child care options for low-income families. *Future of Children: Children and Welfare Reform, 12,* 97–119.

Furstenberg, F. F., Jr., Cook, T. D., Eccles, J., Elder, G. H., & Sameroff, A. (Eds.). (1999). *Managing to make it: Urban families and adolescent success.* Chicago, IL: University of Chicago Press.

Gersten, R., Baker, S., Haager, D., & Graves, A. (2005). Exploring the role of teacher quality in predicting reading outcomes for first grade English learners: An observational study. *Remedial and Special Education, 26,* 197–206.

Gould, E. D., Lavy, V., & Paserman, M. D. (2004). Immigrating to opportunity: Estimating the effect of school quality using a natural experiment on Ethiopians in Israel. *Quarterly Journal of Economics, 119,* 489–526.

Greenberg, M. T., Lengua, L. J., Coie, J. D., Pinderhughes, E. E., Bierman, K., Dodge, K. A., . . . McMahon, R. J. (1999). Predicting developmental outcomes at school entry using a multiple-risk model: Four American communities. *Developmental Psychology, 35,* 403–417.

Guarino, C. M., Santibañez, L., & Daley, G. A. (2006). Teacher recruitment and retention: A review of the recent empirical literature. *Review of Educational Research, 76,* 173–208.

Hango, D. W. (2003). *The effect of neighborhood poverty and residential mobility on child well-being.* Unpublished doctoral dissertation, Ohio State University, Columbus.

Harding, D. J. (2003). Counterfactual models of neighborhood effects: The effect of neighborhood poverty on dropping out and teenage pregnancy. *American Journal of Sociology, 109,* 676–719.

Harding, D. J. (2007). Cultural context, sexual behavior, and romantic relationships in disadvantaged neighborhoods. *American Sociological Review, 72,* 341–364.

Hill, T. D., Ross, C. E., & Angel, R. J. (2005). Neighborhood disorder, psychophysiological distress, and health. *Journal of Health and Social Behavior, 46,* 170–186.

Kauppinen, T. M. (2007). Neighborhood effects in a European city: Secondary education of young people in Helsinki. *Social Science Research, 36,* 421–444.

Klebanov, P. K., Brooks-Gunn, J., Chase-Lansdale, P. L., & Gordon, R. A. (1997). Are neighborhood effects on young children mediated by features of the home environment? In J. Brooks-Gunn, C. Duncan, & J. L. Aber (Eds.), *Neighborhood poverty: Context and consequences for*

children (Vol. 1, pp. 119–145). New York, NY: Russell Sage Foundation Press.

Klebanov, P. K., Brooks-Gunn, J., McCarton, C., & McCormick, M. C. (1998). The contribution of neighborhood and family income to developmental test scores over the first three years of life. *Child Development, 69,* 1420–1436.

Kling, J. R., Liebman, J. B., & Katz, L. F. (2007). Experimental analysis of neighborhood effects. *Econometrica, 75,* 83–119.

Kohen, D. E., Leventhal, T., Dahinten, V. S., & McIntosh, C. N. (2008). Neighborhood disadvantage: Pathways of effects for young children. *Child Development, 79,* 156–169.

Konstantopoulos, S. (2006). Trends of school effects on student achievement: Evidence from NLS:72, HSB:82, and NELS:92. *Teachers College Record, 108,* 2550–2581.

Krull, J. L., & MacKinnon, D. P. (2001). Multilevel modeling of individual and group level mediated effects. *Multivariate Behavioral Research, 36,* 249–277.

Lareau, A. (2000). *Home advantage: Social class and parental intervention in elementary education* (2nd ed.). Lanham, MD: Rowman & Littlefield.

Lareau, A. (2002). Invisible inequality: Social class and childrearing in Black families and White families. *American Sociological Review, 67,* 747–776.

Lareau, A. (2003). *Unequal childhoods: Class, race, and family life.* Berkeley, CA: University of California Press.

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: The effects of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin, 126,* 309–337.

Leventhal, T., & Brooks-Gunn, J. (2001). Changing neighborhoods and child well-being: Understanding how children may be affected in the coming century. *Advances in Life Course Research, 6,* 263–301.

Leventhal, T., & Brooks-Gunn, J. (2004). A randomized study of neighborhood effects on low income children's educational outcomes. *Developmental Psychology, 40,* 488–507.

Leventhal, T., Dupéré, V., & Brooks-Gunn, J. (2009). Neighborhood influences on adolescent development. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology* (3rd ed., Vol. 2, pp. 411–443). Hoboken, NJ: Wiley.

Leventhal, T., Fauth, R. C., & Brooks-Gunn, J. (2005). Neighborhood poverty and public policy: A five-year follow-up of children's educational outcomes in the New York City Moving to Opportunity demonstration. *Developmental Psychology, 41,* 933–952.

Leventhal, T., Xue, Y., & Brooks-Gunn, J. (2006). Immigrant differences in school-age children's verbal trajectories: A look at four racial/ethnic groups. *Child Development, 77,* 1359–1374.

Levine, D. I., & Painter, G. (2008). Are measured school effects just sorting? Causality and correlation in the National Education Longitudinal Survey. *Economics of Education Review, 27,* 460–470.

Lloyd, J. E. V., Li, L., & Hertzman, C. (2010). Early experiences matter: Lasting effect of concentrated disadvantage on children's language and cognitive outcomes. *Health & Place, 16,* 371–380.

Luthar, S. S. (2003). The culture of affluence: Psychological costs of material well-being. *Child Development, 74,* 1581–1593.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7,* 83–104.

McCulloch, A. (2006). Variation in children's cognitive and behavioural adjustment between different types of place in the British National Child Development Study. *Social Science and Medicine, 62,* 1865–1879.

Molnar, B. E., Buka, S. L., Brennan, R. T., Holton, J. K., & Earls, F. (2003). A multilevel study of neighborhoods and parent-to-child physical aggression: Results from the Project on Human Development in Chicago Neighborhoods. *Child Maltreatment, 8,* 84–97.

Neuman, S. B., & Celano, D. (2001). Access to print in low-income and middle-income communities: An ecological study of four neighborhoods. *Reading Research Quarterly, 36,* 8–26.

NICHD Early Child Care Research Network. (1997). Familial factors associated with the characteristics of nonmaternal care for infants. *Journal of Marriage and the Family, 59,* 389–408.

NICHD Early Child Care Research Network. (2002a). Early child care and children's development prior to school entry: Results from the NICHD Study of Early Child Care. *American Educational Research Journal, 39,* 133–164.

NICHD Early Child Care Research Network. (2002b). The relation of global first-grade classroom environment to structural classroom features and teacher and student behaviors. *Elementary School Journal, 102,* 367–387.

NICHD Early Child Care Research Network. (2005). *Child care and child development: Results from the NICHD Study of Early Child Care and Youth Development.* New York, NY: Guilford Press.

NICHD Early Child Care Research Network. (2007). Age of entry to kindergarten and children's academic achievement and socioemotional development. *Early Education & Development, 18,* 337–368.

Orr, L., Feins, J. D., Jacob, R., Beecroft, E., Sanbonmatsu, L., Katz, L. F., . . . Kling, J. (2003). *Moving to Opportunity for Fair Housing demonstration: Interim impact evaluation.* Washington, DC: U.S. Department of Housing and Urban Development.

Peytona, V., Jacobsa, A., O'Brien, M., & Roy, C. (2001). Reasons for choosing child care: Associations with family factors, quality, and satisfaction. *Early Childhood Research Quarterly, 16,* 191–208.

Plotnick, R. D., & Hoffman, S. D. (1999). The effect of neighborhood characteristics on young adult outcomes: Alternative estimates. *Social Science Quarterly, 80*(1), 1–18.

Radloff, L. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385–401.

Raudenbush, S. W., Bryk, A., Cheong, Y. F., & Congdon, R. (2004). *HLM 6: Hierarchical linear and nonlinear modeling.* Lincolnwood, IL: Scientific Software International.

Ream, R. K., & Palardy, G. J. (2008). Reexamining social class differences in the availability and the educational utility of parental social capital. *American Educational Research Journal, 45,* 238–273.

Rubinowitz, L. S., & Rosenbaum, J. E. (2000). *Crossing the class and color lines: From public housing to White suburbia.* Chicago, IL: University of Chicago Press.

Sampson, R. J., Morenoff, J. D., & Earls, F. (1999). Beyond social capital: Spatial dynamics of collective efficacy for children. *American Sociological Review, 64,* 633–660.

Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing "neighborhood effects": Social processes and new directions in research. *Annual Review of Sociology, 28,* 442–478.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997, August 15). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science, 277,* 918–924.

Sampson, R. J., Sharkey, P. T., & Raudenbush, S. W. (2008). Durable effects of concentrated disadvantage on verbal ability among African-American children. *Proceedings of the National Academy of Sciences, 105,* 845–852.

Sanbonmatsu, L., Kling, J. R., Duncan, G. J., & Brooks-Gunn, J. (2006). Neighborhoods and academic achievement: Results from the Moving to Opportunity experiment. *Journal of Human Resources, 41,* 649–691.

Schaefer, E. S., & Edgerton, M. (1985). Parent and child correlates of parental modernity. In I. E. Sigel (Ed.), *Parental belief systems: The psychological consequences for children* (pp. 287–318). Hillsdale, NJ: Erlbaum.

Simons, R. L., Simons, L. G., Burt, C. H., Brody, G. H., & Cutrona, C. (2005). Collective efficacy, authoritative parenting and delinquency: A

longitudinal test of a model integrating community- and family-level processes. *Criminology, 43,* 989–1029.

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* Oxford, England: Oxford University Press.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology, 13,* 290–312.

South, S. J., Crowder, K. D., & Trent, K. (1998). Children's residential mobility and neighborhood environment following parental divorce and remarriage. *Social Forces, 77,* 667–693.

U.S. Bureau of the Census. (1994). *Geographical areas reference manual.* Washington, DC: U.S. Department of Commerce.

Vartanian, T. P., & Buck, P. W. (2005). Childhood and adolescent neighborhood effects on adult income: Using siblings to examine differences in ordinary least squares and fixed-effect models. *Social Service Review, 79,* 60–94.

Waanders, C., Mendez, J. L., & Downer, J. T. (2007). Parent characteristics, economic stress and neighborhood context as predictors of parent involvement in preschool children's education. *Journal of School Psychology, 45,* 619–636.

Wilson, W. J. (1987). *The truly disadvantaged: The inner city, the underclass, and public policy.* Chicago, IL: University of Chicago Press.

Woodcock, R. W., & Johnson, M. B. (1989). *Woodcock–Johnson Psycho-Educational Battery–Revised.* Allen, TX: DLM Teaching Resources.

Appendix

Equations Incorporating Time-Varying Deviations Scores and Representing Model 3 in Tables 3 and 4

Level 1 Model

$$y_{ti} = \pi_{0i} + \pi_{1i} \times (\mathrm{AGE}_{ti}) + \pi_{2i} \times (\mathrm{AGE}_{ti}^2) + \pi_{3i} \times (\mathrm{INC\_NEED}_{ti} - \mathrm{INC\_NEED}_{1\text{–}54\mathrm{m}i}) + \pi_{4i} \times (\mathrm{NEIGH\_ADV}_{ti} - \mathrm{NEIGH\_ADV}_{1\text{–}54\mathrm{m}i}) + e_{ti},$$

for $i = 1, \ldots, n$ subjects, where AGE_{ti} is the age (centered at Grade 1) at time t for person i.

Level 2 Model

$$\begin{aligned}\pi_0 = {} & \beta_{00} + \beta_{01} \times (\mathrm{ARK})_i + \beta_{02} \times (\mathrm{CAL})_i + \beta_{03} \times (\mathrm{KAN})_i + \beta_{04} \times (\mathrm{NHAMP})_i + \beta_{05} \times (\mathrm{PENN})_i \\ & + \beta_{06} \times (\mathrm{TEMPLE})_i + \beta_{07} \times (\mathrm{VA})_i + \beta_{08} \times (\mathrm{WA})_i + \beta_{09} \times (\mathrm{WCAR})_i + \beta_{010} \times (\mathrm{MALE})_i \\ & + \beta_{011} \times (\mathrm{BLACK})_i + \beta_{012} \times (\mathrm{OTHER})_i + \beta_{013} \times (\mathrm{MAT\_EDU})_i + \beta_{014} \times (\mathrm{MAT\_EDU}^2)_i + \beta_{015} \\ & \times (\mathrm{MAT\_VOC})_i + \beta_{016} \times (\mathrm{MAT\_VOC}^2)_i + \beta_{017} \times (\mathrm{MAT\_PERS})_i + \beta_{018} \times (\mathrm{MAT\_PERS}^2)_i \\ & + \beta_{019} \times (\mathrm{MAT\_BELIEFS})_i + \beta_{020} \times (\mathrm{INC\_NEED}_{1\text{–}54\mathrm{m}})_i + \beta_{021} \\ & \times (\mathrm{INC\_NEED}_{1\text{–}54\mathrm{m}}^2)_i + \beta_{022} \times (\mathrm{PARTNER})_i \\ & + \beta_{023} \times (\mathrm{NEIGH\_ADV}_{1\text{–}54\mathrm{m}})_i + \beta_{024} \times (\mathrm{NEIGH\_ADV}_{1\text{–}54\mathrm{m}}^2)_i + r_{0i}.\end{aligned}$$

$$\begin{aligned}\pi_1 = {} & \beta_{10} + \beta_{11} \times (\mathrm{ARK})_i + \beta_{12} \times (\mathrm{CAL})_i + \beta_{13} \times (\mathrm{KAN})_i + \beta_{14} \times (\mathrm{NHAMP})_i + \beta_{15} \times (\mathrm{PENN})_i \\ & + \beta_{16} \times (\mathrm{TEMPLE})_i + \beta_{17} \times (\mathrm{VA})_i + \beta_{18} \times (\mathrm{WA})_i + \beta_{19} \times (\mathrm{WCAR})_i + \beta_{110} \times (\mathrm{MALE})_i \\ & + \beta_{111} \times (\mathrm{BLACK})_i + \beta_{112} \times (\mathrm{OTHER})_i + \beta_{113} \times (\mathrm{MAT\_EDU})_i + \beta_{114} \times (\mathrm{MAT\_EDU}^2)_i + \beta_{115} \\ & \times (\mathrm{MAT\_VOC})_i + \beta_{116} \times (\mathrm{MAT\_VOC}^2)_i + \beta_{117} \times (\mathrm{MAT\_PERS})_i + \beta_{118} \\ & \times (\mathrm{MAT\_PERS}^2)_i + \beta_{119} \times (\mathrm{MAT\_BELIEFS})_i \\ & + \beta_{120} \times (\mathrm{INC\_NEED}_{1\text{–}54\mathrm{m}})_i + \beta_{121} \\ & \times (\mathrm{INC\_NEED}_{1\text{–}54\mathrm{m}}^2)_i + \beta_{122} \times (\mathrm{PARTNER})_i \\ & + \beta_{123} \times (\mathrm{NEIGH\_ADV}_{1\text{–}54\mathrm{m}})_i + \beta_{124} \\ & \times (\mathrm{NEIGH\_ADV}_{1\text{–}54\mathrm{m}}^2)_i + r_{1i}.\end{aligned}$$

$$\pi_2 = \beta_{20}.$$

$$\pi_3 = \beta_{30}.$$

$$\pi_4 = \beta_{40}.$$

Received March 2, 2009
Revision received February 22, 2010
Accepted April 26, 2010 ■