



Expanding notions of social reproduction: Grandparents' educational attainment and grandchildren's cognitive skills

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ABSTRACT

Inherited privilege and status remain powerful factors in the distribution of opportunity in American life. These transfers of socioeconomic resources across generations are facilitated by the links between adult educational attainment and children's cognitive skills. Our current study expands the notion of social reproduction beyond this narrow two-generation approach to investigate the links between grandparents' educational attainment and their grandchildren's academic abilities. Using a nationally representative sample of over 13,000 children who participated in the Early Childhood Longitudinal Study—Kindergarten Cohort (ECLS-K), we find that familial advantages in human capital persist over time and that these advantages are associated with improved cognitive outcomes among later generations. Even after controlling for a wide array of socioeconomic and demographic characteristics, young children with college-educated grandparents possess stronger literacy and mathematics skills at the start of formal schooling. Propensity score approaches, which address concerns regarding the endogeneity inherent in the topic, yield similar results, suggesting the robustness of our findings.

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Large-scale demographic shifts since the end of World War II have changed the landscape of grandparenthood in the United States. Post-war families generally have tighter, more sustained linkages between grandparents and grandchildren, and increased life expectancy has allowed more grandparents to become active participants in the lives of their grandchildren (Barranti, 1985). Moreover, decreasing fertility rates have enhanced the per-child investment grandparents can make, while increases in parental divorce have further heightened grandparents' roles (Uhlenberg & Kirby, 1998). In recent decades, grandparents have expanded their responsibilities further to encompass co-residency and primary caregiver status, with roughly 6.6 million children living with their grandparents. Nearly 23% of these children have no parents in residence—a 66% increase from 1970 (Simmons & Dye, 2003). Despite these transformations to family structures, the extant literature on the associations between socioeconomic status and child outcomes generally maintains a focus almost exclusively on two generations—parents and their children. This is certainly a conceptual limitation, as grandparents represent an increasingly important link in the chain of social reproduction.

Our current study recognizes the substantial time and resources grandparents often invest in their grandchildren's lives. Indeed, families rarely raise their children in complete isolation. These intergenerational familial networks often serve as important sources of logistic, financial, and psychological support. But as with parents, grandparents differ widely in the resources they bring to bear in childrearing. As such, grandparents' influence is likely conditioned by socio-demographic factors such as their health, economic security, marital status, proximity, and the focus of this study—educational attainment. Specifically, these analyses investigate the extent to which grandparents' education is associated with their young grandchildren's cognitive skills even after accounting for the socioeconomic benefits these grandparents passed on to their own children.

1. Background

We situate this study within both micro- and macro-level conceptualizations of child development. At the micro level, our analyses are informed by developmental ecological theory, which recognizes that cognitive development flows from multiple sources related to children's environments (see Bronfenbrenner, 1979; Bronfenbrenner & Morris, 1998). The social, economic, and physical contexts in which young children's lives are enmeshed form an ecology of interconnected factors that support their social and intellectual growth (Brooks-Gunn, 1995; Eccles, 2005). These multiple

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spheres of influence, reflected in the attributes and capacities of families, caregivers, peers, and neighborhoods, must be interpreted with an understanding of the tight links between socioeconomic circumstances and child development (see McLoyd, 1998). Indeed, a considerable body of research in the developmental ecological tradition focuses on the associations between children's material conditions and their overall well-being (see Brooks-Gunn & Duncan, 1997; Smith, Brooks-Gunn, & Klebanov, 1997).

Central to the research presented here, however, is the recognition that children's social ecologies are not born anew with each generation. Rather, they are partly transmitted within families from one generation to the next in the form of resources, attributes, and skills. This necessarily requires us to extend beyond traditional conceptualizations of developmental ecological theory. In response, at the macro level we turn to social reproduction theory, which examines how socioeconomic relations and structures are reproduced from one generation to the next (see Bourdieu, 1977, 1984, 1985; Bowles & Gintis, 1976, 2001; Weber, 1946; Willis, 1977). Throughout this study, we distinguish between social *inequality*—the extent to which status and resources are unequally distributed at a given point in time, and social *mobility*—the degree to which socioeconomic origins predict the educational, occupational, and economic outcomes of individuals and those of subsequent generations. This focus is important, as U.S. domestic social policy has historically concerned itself more with social mobility and opportunity than with equalizing the distribution of social and economic resources (Corcoran, 2001). As such, efforts aimed at reducing the negative effects of socioeconomic disadvantage on young children must consider how such disadvantage is reproduced over time.

2. Social reproduction

Inherited privilege and status remain powerful factors in the distribution of opportunity in American life. Indeed, one of the least disputed findings within the social science literature is that parents pass on a portion of their socioeconomic advantage (or disadvantage) to their children (see Brooks-Gunn & Duncan, 1997; Jencks et al., 1972; Mayer, 1997). The topic has occupied social scientists for nearly a century. Two of the earliest studies in this arena, Lynd and Lynd's (1929) *Middletown* and Hollingshead's (1949[1975]) *Elmtown's Youth*, both portrayed the intricate and enduring class structures in two relatively small and racially homogenous U.S. Midwestern towns, and detailed the importance of parental human, social, cultural, and economic capital to child outcomes and to the perpetuation of socioeconomic hierarchies across generations.

Since these early studies, an expansive body of research has examined the extent to which socioeconomic status is "shuffled" from one generation to the next (Becker, 1991; Becker & Tomes, 1986; Blau & Duncan, 1967; Ganzeboom, Treiman, & Ultee, 1991; Mazumder, 2005; Musick & Mare, 2006). Although the U.S. experiences considerable upward and downward social mobility, children's socioeconomic origins remain strongly associated with their adult outcomes. Authors have reported correlations between multi-year indicators of father and son's earnings of between 0.4 and 0.6 (Corcoran, 2001; Mazumder, 2005; Solon, 1999). Put another way, over 30% of children born into families with incomes in the bottom decile will find themselves similarly disadvantaged as adults (Hertz, 2005). However, the extent of income mobility across generations varies dramatically by racial background. Less than 17% of White children born into the bottom income decile will find themselves there as adults, compared to over 40% of Black children (Corcoran, 2001). Similar patterns emerge with educational attainment; correlations between father and son's completed schooling are reported to be in the range of .35 (Mulligan, 1999). These associations are reflected in the fact that students whose parents were

college graduates are almost twice as likely to attend college compared to those whose parents had obtained a high school diploma or less (U.S. Department of Education, 2001). Similarly, 66% of students with family income in the top quartile begin post-secondary schooling compared to only 28% of students in the bottom income quartile (Ellwood & Kane, 2000).

While the above studies focused on adult outcomes, extant research has found evidence of social reproduction during earlier stages of the life span. Because children have not yet attained their own social class, researchers have instead investigated the links between parental social class and children's academic outcomes, usually standardized test scores. Even prior to the start of formal schooling, higher-SES children possess considerably stronger cognitive skills than their lower-SES peers (Brooks-Gunn & Duncan, 1997; Entwisle, Alexander, & Olson, 1997; Lee & Burkam, 2002; Smith et al., 1997). Myriad explanations have been offered for this inequality, including disparities in family and neighborhood resources, the persistent links between socioeconomic status and race/ethnicity, and the negative social, environmental, and physical effects associated with poverty (for a review, see Rothstein, 2004). In addition, higher-SES parents are often able to devote more hours to parenting and are more likely to have cognitively stimulating verbal exchanges with their children in early childhood (Hart & Risley, 1992; Heath, 1983; Lareau, 2003).

As the discussion above suggests, the relationship between parental characteristics and child outcomes has been well established. However, much of this literature has focused exclusively on two generations—parents and children. This suggests an important limitation, as grandparents can also play a central role in the intergenerational transmission of societal advantage. Our aim here is to discern whether the links between grandparents' educational attainment and their grandchildren's cognitive performance operate solely through parents, as the above studies suggest, or whether the association remains after holding constant parental education and a host of other parental socioeconomic characteristics.

3. Three generations: considering the role of grandparents

Systematic research on grandparenthood began during the latter half of the twentieth century; previously, studies were based on anecdotal evidence that portrayed grandparents as a disturbance to the normal functioning of the nuclear family (Tomlin, 1998). As recently as the 1980s, studies essentially ignored the influence of grandparents on grandchildren, arguing that the real forces of socialization operated only through parents (Szinovacz, 1998). A developing literature, however, is examining the associations between grandparent social class and grandchild outcomes. As with the two-generation studies described above, research adopting a three-generation approach can be divided into one of two distinct groups. The first group examines how grandparent social class influences the social class ultimately attained by their adult grandchildren. The second area of inquiry focuses on the connections between grandparent characteristics and the academic skills possessed by their young grandchildren. In terms of adult grandchildren, studies have reported grandparents' education, occupation, and income to be non-significant factors in occupational status and educational attainment among adult grandchildren, holding parental characteristics constant (Warren & Hauser, 1997). Other studies using Finnish data, however, have reported positive links between grandfathers and adult grandchildren's social class (Erola & Moisio, 2007).

Unlike research estimating the effects of grandparents on older grandchildren, studies of grandparents and their younger grandchildren provide more consistent findings. Although not their explicit focus—grandparent attributes were employed largely

as covariates—authors have found positive associations between grandparents' education, income, and wealth and grandchildren's standardized test scores, even after controlling for similar parental characteristics (Grant, 2005; Hill & O'Neill, 1994; Yeung & Conley, 2008). These grandparent effects may operate through the symbolic, direct, and indirect support grandparents afford. Symbolic support can represent a psychological buffer that provides families peace of mind through the knowledge that grandparents are there if needed (Denham & Smith, 1989). Grandparent effects are also manifest through more direct support. Important to our focus here, educated grandparents are more likely to mentor and support grandchildren, discuss their plans with them, and impart specific skills (King & Elder, 1997, 1998). The intergenerational influence of grandparent education potentially even operates through parenting practices, with the children of more-educated parents generally applying parenting practices with their own children that are positively associated with children's cognitive development (Phillips, Brooks-Gunn, Duncan, Klebanov, & Crane, 1998). Finally, grandparents often directly support families as coresidents (Jendrek, 1993; Moyi, Pong, & Frick, 2004) or primary caregivers (Bowers & Myers, 1999; Bryson & Casper, 1999; Jendrek, 1993; Kropf & Burnette, 2003), especially when children are young or during times of familial economic or emotional crisis.

Perhaps the most tangible manifestation of grandparent involvement is financial assistance. Importantly, the ability to provide such support is associated with grandparents' educational attainment. Authors have noted that wealth is more readily passed on to subsequent generations than is income, as it is easier to transfer material assets than occupations and their attendant wages (Becker & Tomes, 1986; Wolff, 2002). One example is what Shapiro (2004) aptly calls "transformative assets," which often manifest as transfers of wealth from parents to their young adult children in the form of payments for college tuition or help with a down payment for a first home. Saddled with less debt and infused with start-up capital, these financial gifts from grandparents are crucial in helping young families secure middle-class lifestyles that might otherwise be beyond their reach. Key to the focus of our current study, these "transformative assets" often allow recipient families to live in more stable and resource-rich neighborhoods (see Durlauf, 1996). Therefore, grandparents' fiscal resources likely represent a unique source of variation in grandchildren's cognitive outcomes.

4. Challenges of estimating grandparent effects

In addition to OLS regression techniques, this study also employs propensity score matching, which addresses concerns regarding the endogeneity inherent in our research questions. Although randomization arguably produces the most robust treatment estimates, psychologists and social scientists often investigate topics that for temporal, logistical, and/or ethical reasons do not lend themselves well to random assignment. This is certainly the case in the context of our current study, as researchers are clearly unable to randomly assign children to grandparents with varying levels of education. In the absence of randomization, researchers have turned to multiple regression approaches with the aim of statistically controlling for characteristics that are related to both the outcome and the likelihood of receiving a particular treatment. However, concerns regarding unmeasured selection bias call into question the ability of traditional regression techniques to isolate unique treatment effects (Rubin, 1997). Alternately, researchers have employed matching techniques, but matching cases across many variables—particularly continuous variables—can be quite cumbersome (Rosenbaum & Rubin, 1983). More recently, researchers have used propensity score matching techniques as a tool to better approximate randomization. The

propensity score is simply the predicted probability of receiving the treatment based on a host of covariates (Shadish, Cook, & Campbell, 2002). These scores are then used to create matched pairs of treatment and control cases who are essentially identical across observed characteristics. In this study, each child with college-educated grandparents is paired with a child whose grandparents did not attend college, but who had the same probability (propensity) of having a grandparent with a college degree. One advantage of this approach is that cases can be matched on many variables simultaneously, which makes far fewer parametric assumptions than traditional regression approaches. We discuss our specific approach to propensity score matching in greater detail below.

5. Research focus

The importance of parental social class to child outcomes is well documented. More recently, however, researchers have begun to expand their scope beyond two generations to investigate the direct and indirect role grandparents play in their grandchildren's social and academic development. Clearly, grandparent influences are important to consider for both their micro-level effects on children's cognitive growth and their macro-level implications for socioeconomic reproduction. As more children move toward stronger, longer-lasting ties with their grandparents, it will be crucial to understand these relationships, their net benefits, and how families and social policy impact these increasingly influential bonds. This study aims to expand traditional conceptualizations of social class beyond the parent-child dyad to examine how naturally occurring variability in grandparent educational attainment influences grandchildren's cognitive ability. We use a large and nationally representative sample of over 13,000 children from the Early Childhood Longitudinal Study, Kindergarten Cohort (National Center for Educational Statistics, 2004a) to address the following questions:

- *Research Question 1:* How can we characterize the associations between grandparents' education and their grandchildren's socio-demographic characteristics? To what extent are disparities in educational attainment manifest as socioeconomic inequalities two generations later?
- *Research Question 2:* After accounting for children's socio-demographic backgrounds—including their parents' socioeconomic status—is there a residual relationship between grandparents' education and their grandchildren's cognitive ability? In other words, is there an intergenerational link between grandparents' education and their grandchildren's academic skills?
- *Research Question 3:* Given that this study employs a non-experimental design, how robust are our findings? Do propensity score techniques and traditional regression approaches produce similar estimates of the associations between grandparents' education and their grandchildren's cognitive abilities?

6. Method

6.1. Data

This study employed data from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K), sponsored by the National Center of Education Statistics (National Center for Educational Statistics, 2004b). The ECLS-K collection of base-year (1998) data followed a stratified random design structure. The primary sampling units were geographic areas consisting of counties or groups of counties from which about 1000 public and private schools offering kindergarten programs were selected. A target sample of

roughly twenty-four children was then drawn from each school. From the full ECLS-K sample, we constructed our analytic sample in three stages. First, we selected children whose biological mother or father was identified as the respondent for the parent survey. We then selected children for whom both mathematics and reading scores were reported for the initial data collection wave (the fall of kindergarten). Finally, we selected children who had a non-missing base-year design weight.

Our final analytic sample includes a socio-demographically diverse group of 13,003 children, which is smaller than the overall ECLS-K sample due largely to the fact that children deemed non-English proficient were not administered the literacy assessments. Children identified as English Language Learners (ELLs) were administered the Oral Language Development Scale (OLDS). Approximately half of these children were identified as having sufficient English skills to complete the standard literacy assessment. As such, readers should bear in mind that our indicator of non-English home language does not necessarily indicate children who possess no English language skills. Moreover, due to these selection criteria, our sample is somewhat more socioeconomically advantaged than the full ECLS-K sample, and contains fewer Hispanic and Asian children. One implication is that our estimates of the links between grandparent education and their grandchildren's academic skills are likely to be somewhat conservative (i.e., the intergenerational inequality we report below may actually be somewhat greater in the actual population).

6.2. Measures

6.2.1. Dependent variables

As primary outcomes, these analyses used measures of children's mathematics and literacy skills at kindergarten entry. The ECLS-K cognitive assessments were conducted one-on-one between a designated assessor and each child. Though un-timed, each assessment lasted between 50 and 70 min. The literacy assessment tested children's abilities in three key areas: basic skills (print familiarity, letter recognition, beginning and ending sounds, rhyming sounds, word recognition), vocabulary (receptive vocabulary), and comprehension (listening comprehension, words in context). The reliability of the reading assessment was quite strong (0.93; *National Center for Educational Statistics, 2004b*). The mathematics assessment items, which measured conceptual and procedural knowledge and problem solving, can be organized into five proficiency areas: (1) identifying and counting numbers and geometric shapes; (2) reading one-digit numbers and counting beyond 10, recognizing sequential patterns, and comparing object size using nonstandard objects; (3) reading two-digit numbers, identifying number sequences and ordinal positions, solving simple word problems; (4) simple addition and subtraction, and; (5) simple multiplication and division, and recognizing more complex patterns (*National Center for Educational Statistics, 2004b*). The reliability of the mathematics assessment was also strong (0.92 for fall; *National Center for Educational Statistics, 2004b*). We used these test scores as z-scores ($M=0$, $SD=1$) in our analyses, which permits the discussion of results in effect size (SD) units. This is important given our large sample size and the statistical power it affords (see Cohen, 1988).

6.2.2. Socioeconomic status measures

The focus of this paper is the link between grandparents' education and their grandchildren's cognitive skills. During the ECLS-K parent interviews, the respondent biological parent was asked for his or her mother and father's level of education. Possible responses included all primary and secondary school grades, high school diploma, vocational school without high school diploma, vocational school with high school diploma, some college, associates

degree, college degree, some graduate/professional school, Master's degree, Doctorate, graduate/professional degree. Due to the non-interval nature of the measure, we collapsed these responses into three categories that define the highest level of education attained by either of the two grandparents: high school or below, some college, and college or more. We entered separate dummy variables for high school or below (yes = 1, else = 0) and college or more (yes = 1, else = 0) into the regression models, with some college or more serving as the uncoded comparison group.

We also controlled for three separate indicators of parental SES—parental education, income, and occupational prestige. Respondent parents reported on their own education, as well as that of the child's other parent (if applicable). Similar to grandparents' level of education, we organized the highest level of education between the two parents into three groups: high school or below, some college, and college or more; we included dummy variables for high school or below and college or more into the models, with some college serving as the comparison group. To correct for the measure's positive skew, we employed a log-transformed indicator of household income. Our models also included separate continuous measures of mothers and fathers' occupational prestige (z-scored; $M=0$, $SD=1$), derived from the 1998 General Social Survey occupational prestige scores.

6.2.3. Demographic characteristics

Evidence suggests that a number of other child characteristics are associated with the intergenerational transfer of both socioeconomic status and children's cognitive abilities. To capture race/ethnicity, we used a series of dummy-coded measures indicating whether the child was Asian, Hispanic, Black, Native American, or multiracial, with Whites serving as the uncoded comparison group. Family composition measures included a dummy-coded indicator of single parent status (yes = 1; no = 0) and a measure of the number of siblings. We also accounted for the primary language the child used at home (non-English = 1; English = 0); gender (female = 1, male = 0); whether the child repeated kindergarten (yes = 1; no = 0); child's age (in months, centered); and mother's age at first birth (in years, centered). We considered neighborhood urbanicity with dummy-coded indicators of large city, mid-size city, and small-town or rural, with suburban communities as the uncoded comparison group. We also controlled for pre-kindergarten daycare type with indicators for relative care, non-relative care, Headstart, center-based care, and varied care, with parental care serving as the comparison group in the multivariate models. *Table 1* provides descriptive information for all measures.

Models not presented here also controlled for the number of living grandparents, whether the grandparents reported were maternal or paternal, and whether they lived in proximity. These measures, however, were not included in the final models as none were significant (all $p > .05$). The extant literature further suggests that the effects of grandparents' schooling on grandchildren's cognitive and educational outcomes may differ by grandparent and child gender (Hill & O'Neill, 1994; Louri, 2006), co-resident versus caregiver status (Aquilino, 1996; DeLeire & Kalil, 2002; Edwards & Daire, 2006; Gordon, 1999; Moyi et al., 2004), and race/ethnicity (Dunifon & Kowaleski-Jones, 2007). We tested these potential associations using interaction terms, but found none that were significant ($p > .05$). Only one interaction term was significant at the $p < .10$ level—college-educated grandparents by Black child. The sign of this coefficient was negative, which indicates that Black children with grandparents with college degrees score somewhat lower than White children with grandparents with only some college. This result may reflect historic racial disparities in post-secondary educational quality between Black and White grandparents.

Table 1
Variable means and standard deviations ($n = 13,003$).

	Mean	SD
Math achievement	20.1	7.3
Reading achievement	22.5	8.4
<i>Grandparents' highest level of education (%)</i>		
High school or less	67.3	–
Some college	11.9	–
Bachelor's or more	20.8	–
<i>Parents' highest level of education (%)</i>		
High school or less	36.3	–
Some college	35.8	–
Bachelor's or more	27.9	–
Parental income (\$)	55,072.7	56,062.1
Mother's occupational prestige	43.7	11.2
Father's occupational prestige	43.4	11.0
<i>Race/ethnicity (%)</i>		
White	69.5	–
Black	11.6	–
Hispanic	12.4	–
Asian	2.1	–
Native American	1.9	–
Multiracial	2.4	–
Female (%)	48.9	–
Single parent family (%)	20.1	–
Non-English speaking household (%)	5.4	–
Kindergarten repeater (%)	3.8	–
Number of siblings	1.4	1.1
Child's age (in months)	65.7	4.3
Mother's age at first birth (in years)	23.9	5.4
<i>Location (%)</i>		
Large city	13.7	–
Mid-size city	19.4	–
Suburb	44.8	–
Small-town/rural	22.1	–
<i>Pre-K Care Type (%)</i>		
Pre-k care by parent(s)	16.5	–
Pre-k care by relative	12.9	–
Pre-k care by non-relative	11.6	–
Headstart	7.3	–
Pre-k center-based care	46.7	–
Multiple/various pre-k care	5.0	–

6.2.4. Design weights

Because ECLS-K used a multistage stratified sampling design, the data include a series of design weights. As with other longitudinal NCES data sets, analyses using ECLS-K require the use of weights to compensate for unequal probabilities of selection within and between schools (e.g., the intentional oversampling of Asian and Pacific Islander children) and non-response effects. Our descriptive and analytic analyses used the base-year child-level weight (C1CWO), normalized to a mean of 1 to reflect the actual (smaller) sample size for statistical testing.

6.3. Analytic approach

We begin by describing the associations between grandparent educational attainment and their grandchildren's cognitive and socio-demographic backgrounds, which highlights the strong degree of intergenerational transfer of advantage that characterizes U.S. society. To test for statistically significant group mean differences, we used one-way analysis of variance (ANOVA) for continuous measures (with Sheffé post hoc tests) and chi-squares for categorical variables. We then employed a series of multiple regressions to investigate the associations between young children's cognitive skills and their grandparents' educational attainment. We ran separate analyses for both the mathematics and literacy outcomes. These models were constructed in a hierarchical fashion

in four steps (see Cohen, Cohen, West, & Aiken, 2003). Model 1 established the unadjusted association between grandparents' education and their grandchildren's measured cognitive abilities. Model 2 introduced parental education to gauge the extent to which the link between grandparent education and grandchildren's cognitive skills operated through parental education. Model 3 added additional parental socioeconomic status measures, including household income and occupational prestige. In the fourth and final model, we controlled for a wide variety of covariates that correlated with both children's academic skills and grandparents' education. Our focus throughout was the adjusted, residual associations between grandparents' schooling and children's test scores.

Our third analytic approach entailed propensity score matching to check the robustness of the regression findings. As noted above, propensity score matching creates matched pairs of treatment and control cases who are essentially identical on all observed characteristics, but one—in this instance grandparents' educational attainment (see Gelman & Hill, 2007; Rubin, 1997; Rubin & Thomas, 1996). Thus, children are considered “identical” based on the predicted probability (propensity) of receiving the treatment—having a college-educated grandparent—given observed covariates. Since the multivariate findings for high school versus some college were non-significant across all models, we collapsed these two categories and created a dichotomous treatment variable (grandparents with college or more = 1, grandparents with less than college = 0). As is customary, we used probit models to estimate the propensity scores. To match the treated and control groups, we used nearest-neighbor matching with replacement and common support, which restricted the sample to cases that did not have propensity scores below or above the range of propensity scores for the control cases (Brand & Halaby, 2005).

One unique aspect of the “treatment” here was its duration. In the context of our current study, the influence of grandparent educational attainment theoretically stretched from the child's birth to kindergarten entry. A key identification requirement for propensity score matching is that all covariates used in the probit model to estimate the propensity scores must be pre-treatment, with the exception of time-invariant covariates, such as race/ethnicity (Morgan & Harding, 2006). This required us to employ characteristics associated with the child or the responding parent before or at the time of the child's birth. Accordingly, to estimate the propensity scores, we used mother's age at first birth, low birthweight (less than 5.5 pounds), premature birth (more than two weeks early), mother on welfare at time of birth, mother married at time of child's birth, respondent's participation in an academic program in high school (versus commercial or vocational), whether the respondent took trigonometry, calculus, and/or physics in high school, whether English was a second language for the child, and race/ethnicity of the child (time-invariant).

7. Results

7.1.1. Descriptive results

Table 2 presents information on children's cognitive and socio-demographic backgrounds organized by their grandparents' educational attainment. These descriptive results address the first of our three research questions. A strong linear relationship is evident between children's cognitive skills and their grandparents' level of education. A roughly one-third standard deviation gap in initial mathematics and literacy skills separates children with college-educated grandparents from those whose grandparents had attended college, but did not graduate. Similarly, children with grandparents who attained at most a high school degree performed roughly one-fifth standard deviation below those whose grandparents had some college education. Moreover, the gaps

Table 2
Child socio-demographic and academic characteristics by grandparent educational attainment ($n = 13,003$).

	Grandparents' highest level of education		
	High school or below ($n = 6955$)	Some college ($n = 1775$)	College or more ($n = 2634$)
Mathematics achievement, M^a	-0.15 [*]	0.03	0.37 [*]
SD	(0.93)	(0.97)	(1.06)
Reading achievement, M^a	-0.15 [*]	0.02	0.34 [*]
SD	(0.90)	(0.99)	(1.11)
<i>Race (%)</i>			
White	64.1 [*]	70.7	77.0 [*]
Black	15.1 [*]	12.5	8.9 [*]
Hispanic	14.8 [*]	9.4	7.3 [*]
Asian	2.2	2.3	3.5 [*]
Native American	1.6	1.7	1.0 [*]
Multiracial	2.2 [*]	3.3	2.4 [*]
<i>Parents' highest level of education (%)</i>			
High school or below	40.8 [*]	18.7	9.4 [*]
Some college	36.5 [*]	42.6	26.3 [*]
College or more	2.7 [*]	38.8	64.2
Parental income (\$), M	48,037 [*]	57,482	80,138 [*]
SD	(44,847)	(50,832)	(78,329)
Mother's occupational prestige, M^a	-0.12 [*]	0.16	0.44 [*]
SD	(0.92)	(1.03)	(1.13)
Father's occupational prestige, M^a	-0.14 [*]	0.11	0.40 [*]
SD	(0.91)	(1.03)	(1.16)
Single parent family (%)	23.1	22.1	14.7 [*]
Non-English speaking household (%)	6.3 [*]	2.5	4.4 [*]
Kindergarten repeater (%)	4.5 [*]	3.0	3.0
Number of siblings, M	1.46 [*]	1.34	1.39
SD	(1.10)	(1.02)	(1.00)
Child's age (in months), M	65.68	65.74	65.69
SD	(4.26)	(4.18)	(4.25)
Mother's age at first birth (in years), M	23.26 [*]	24.25	26.31 [*]
SD	(5.27)	(5.34)	(5.21)
<i>Location (%)</i>			
Large-city	13.0	13.1	13.9
Mid-city	18.5 [*]	20.6	20.8
Large/mid suburb	39.4	42.0	47.6
Small-town or rural	29.1 [*]	24.3	17.8 [*]
<i>Pre-K Care Type (%)</i>			
Pre-k care by parent(s)	18.8 [*]	14.4	12.1 [*]
Pre-k care by relative	14.8 [*]	12.8	8.7 [*]
Pre-k care by non-relative	10.8 [*]	12.5	13.0
Headstart	10.3 [*]	7.0	3.1 [*]
Pre-k center-based care	40.1 [*]	48.4	58.2 [*]
Multiple/various pre-k care	5.2	4.9	4.9

^{*} $p < .05$. "Some college" is the comparison group for significance testing.

^a Measure is z-scored ($M = 0$; $SD = 1$).

between children with only high-school-educated grandparents and those with college-educated grandparents were considerably larger (roughly one-half standard deviation).

The remainder of Table 2 provides clear indication that multi-generational human capital tends to be concentrated across generations within particular socio-demographic subgroups. Fewer than 9% of children with at least one college-educated grandparent were Black, and fewer than 8% were Hispanic. At the same time, over 15% of children with grandparents who did not go beyond high school were Black and nearly 15% were Hispanic. Conversely, while White children constituted 69.5% of the sample, they represented 77.0% of children with college-educated grandparents. In

short, almost one-third of children with the least-educated grandparents were Black or Hispanic, whereas less than 17% of children with the most-educated grandparents shared these racial/ethnic backgrounds. Similar patterns emerged with parental education, highlighting the reality that disparities in human capital are first passed from grandparents to parents. Fewer than 10% of children with college-educated grandparents had parents who failed to go beyond high school, while over 40% of children with grandparents who did not make it beyond high school had similarly educated parents. More striking still, less than one-quarter of children whose grandparents never went to college had parents with a college degree. This preliminary evidence of the nature and scope of the intergenerational transmission of educational attainment suggests the central role—either directly or indirectly—grandparents play in their grandchildren's cognitive skills.

Reflecting additional inequalities associated with grandparents' education and the intergenerational transfer of economic resources, we found stark differences in parental income by grandparents' education. The average annual income of a family with grandparents whose education did not extend beyond high school was less than \$50,000, compared to over \$80,000 for a family with college-educated grandparents. Similar differences were evident in terms of parental occupational prestige, with over half a standard deviation gap in parental occupational prestige separating the lowest and highest levels of grandparent education.

Other socio-demographic characteristics, such as single-parent households, English language use, and number of siblings were also strongly associated with grandparents' education. Fewer than 15% of children with college-educated grandparents were raised in single-parent households, whereas over 23% of children whose grandparents were not educated beyond high school were raised in similar families. The average number of siblings decreased slightly as grandparents' educational attainment increased, while mothers whose parents had attained a high school degree or less were on average three years younger at the birth of their first child compared to those with college-educated parents. A noticeable difference also existed between children of the least- and most-educated grandparents in kindergarten repetition rates. Roughly 4.5% of children with the least-educated grandparents repeated kindergarten, compared to only 3% of those with college-educated grandparents.

Several important overarching patterns emerge from these descriptive results. Children with college-educated grandparents began formal schooling with considerably stronger cognitive skills. Importantly, Black and Hispanic children are far less likely than Whites to have had college-educated grandparents. Many of these systematic racial/ethnic differences in grandparents' educational profiles point to historical disparities in access to higher education. Other differences in grandparents' education reflect the concentration of human capital within families over many generations: over 60% of children with college-educated grandparents also had college-educated parents. Conversely, less than a quarter of children with the least-educated grandparents had parents who successfully made it through college. Better-educated grandparents also had grandchildren whose families were better off financially. The mean household income of children with college-educated grandparents was more than one and a half times the income of children with the least-educated grandparents. These systematic differences suggest that a three-generation approach provides a more nuanced understanding of inequality in early childhood.

8. Analytic results

The previous section presented descriptive analyses exploring the associations between grandparents' education and their grand-

Table 3
Grandparent educational attainment and grandchildren's math skills ($n = 13,003$).

	Model 1	Model 2	Model 3	Model 4
<i>Grandparents' education^a</i>				
High school or below	0.00	0.05	0.04	0.01
College or more	0.51[*]	0.24[*]	0.20[*]	0.15[*]
<i>Parents' education</i>				
High school or below		-0.33 [*]	-0.21 [*]	-0.14 [*]
College or more		0.50 [*]	0.28 [*]	0.18 [*]
<i>Additional parental SES measures</i>				
Log income			0.18 [*]	0.09 [*]
Mother's occupational prestige			0.07 [*]	0.06 [*]
Father's occupational prestige			0.06 [*]	0.06 [*]
<i>Demographic controls</i>				
Black ^b			-0.22 [*]	
Hispanic			-0.19 [*]	
Asian			0.14 [*]	
Native American			-0.29 [*]	
Multiracial			-0.13	
Female			0.01	
Single parent			-0.08 [*]	
Non-English speaking household			-0.13 [*]	
Kindergarten repeater			0.57 [*]	
Number of Siblings			-0.03 [*]	
Child's age ^c			0.06 [*]	
Mother's age at first birth ^c			0.02 [*]	
Mother's age at first birth, squared ^c			0.00	
Large city ^d			0.02	
Mid-size city			-0.03	
Small-town or rural			-0.13 [*]	
Pre-k care by relative ^e			-0.01	
Pre-k care by non-relative			0.06	
Headstart			-0.03	
Pre-k center-based care			0.17 [*]	
Multiple/various pre-k care			0.08	
Intercept	-0.15 [*]	-0.17 [*]	-1.99 [*]	-0.94 [*]
R^2	0.05	0.15 [*]	0.18 [*]	0.28 [*]
ΔR^2		0.10 [*]	0.03 [*]	0.10 [*]

* $p < .05$.^a Grandparent and parent education compared to some college.^b All racial/ethnic groups compared to Whites.^c Measure is centered about its mean.^d Large-city, mid-city, and small-town/rural are compared to large and mid-size suburbs.^e Pre-k care measures compared to parental care.

children's cognitive profiles and socio-demographic backgrounds. The aim here is to investigate these complex and interrelated associations within a multivariate framework that identifies the unique links between grandparent educational attainment and their grandchildren's cognitive outcomes. Tables 3 and 4 present multivariate regression models predicting young children's mathematics and reading skills. We employed a hierarchical regression approach to highlight the changes in the grandparents' education estimates as subsequent models introduced additional demographic controls.

8.1. Mathematic skills

Model 1 in Table 3 establishes the unadjusted relationship between grandparents' education and children's mathematics skills. As our descriptive results suggested, the children of college-educated grandparents typically began kindergarten with stronger mathematics skills than children whose grandparents had obtained only some higher education ($ES[\text{effect size}] = 0.51$). In contrast, children with only high-school educated grandparents scored no different from those whose grandparents had only some higher education ($p > .05$).

Table 4
Grandparent educational attainment and grandchildren's literacy skills ($n = 13,003$).

	Model 1	Model 2	Model 3	Model 4
<i>Grandparents' education^a</i>				
High school or below	-0.01	0.03	0.02	0.01
College or more	0.47[*]	0.22[*]	0.18[*]	0.14[*]
<i>Parents' education</i>				
High school or below		-0.29 [*]	-0.18 [*]	-0.11 [*]
College or more		0.48 [*]	0.27 [*]	0.17 [*]
<i>Additional parental SES measures</i>				
Log income			0.14 [*]	0.07 [*]
Mother's occupational prestige			0.07 [*]	0.06 [*]
Father's occupational prestige			0.07 [*]	0.07 [*]
<i>Demographic controls</i>				
Black ^b				0.00
Hispanic				-0.10 [*]
Asian				0.28 [*]
Native American				-0.21 [*]
Multiracial				-0.03
Female				0.16 [*]
Single parent				-0.10 [*]
Non-English speaking household				-0.16 [*]
Kindergarten repeater				0.56 [*]
Number of siblings				-0.08 [*]
Child's age ^c				0.04 [*]
Mother's age at first birth ^c				0.02 [*]
Mother's age at first birth, squared ^c				0.00
Large city ^d				0.01
Mid-size city				-0.05
Small-town or rural				-0.15 [*]
Pre-k care by relative ^e				-0.02
Pre-k care by non-relative				0.00
Headstart				-0.06
Pre-k center-based care				0.17 [*]
Multiple/various pre-k care				0.04
Intercept	-0.13 [*]	0.17 [*]	-1.65 [*]	-0.78 [*]
R^2	0.04 [*]	0.13 [*]	0.16 [*]	0.24 [*]
ΔR^2		0.09 [*]	0.03 [*]	0.08 [*]

* $p < .05$.^a Grandparent and parent education compared to some college.^b All racial/ethnic groups compared to Whites.^c Measure is centered about its mean.^d Large-city, mid-city, and small-town/rural are compared to large and mid-size suburbs.^e Pre-k care measures compared to parental care.

In Model 2, we accounted for parental education and found that the estimate associated with college-educated grandparents was reduced by roughly 50% (i.e., from 0.51 to 0.24 SD). As one might expect, parental education accounted for a great deal of the association between grandparents' education and grandchildren's cognitive skills. On average, children with college-educated parents outperformed those whose parents attained only some college by one-half standard deviation, an estimate virtually identical to the college-educated grandparent coefficient in Model 1. Also important is the over three-quarter SD gap between the children of parents with a high school degree or less and those with college-educated parents ($ES = -0.33$ vs. 0.50). Despite these controls for parental education, grandparent possession of a BA or more remained positively associated with children's mathematics skills ($ES = 0.24$).

As indicated in Model 3, parental income was also positively related to children's measured academic abilities, as were mother and father's occupational prestige ($ES = 0.07$ and 0.06, respectively). These associations accounted for some of the link between parents' education and their children's cognitive skills. The effects of parental college attendance were reduced by roughly 40%, and the negative effects associated with attaining only high school or

below were reduced by 36%. Central to the focus of this study, the effect of college attainment for grandparents dropped by only 22%, and remained a significant predictor of children’s academic skills ($ES = 0.20$).

Model 4 controlled for additional socio-demographic characteristics, including race/ethnicity, gender, family composition, child’s age, mother’s age at first birth, urbanicity, and pre-kindergarten care. The coefficient associated with college-educated parents was reduced further when we included these additional covariates in the model. However, even after accounting for these covariates, we found that children with college-educated grandparents began kindergarten with somewhat stronger mathematics skills than children whose grandparents had only some college ($ES = 0.15$). Because these data are limited to grandparents’ education, the apparent relationship with grandchildren’s early cognitive ability may be conflated with other grandparent socioeconomic characteristics, particularly, income, wealth, and occupational prestige. But regardless of which aspects of SES the grandparent education coefficient is reflecting, the fact that the education of children’s grandparents remained associated with their cognitive skills suggests the influence multigenerational socioeconomic status has on even the youngest children.

8.2. Reading skills

As with children’s mathematics skills, grandparents’ educational attainment was associated with young children’s literacy skills. Model 1 in Table 4 indicates that the children of college-educated grandparents scored considerably above their peers who had grandparents with only some college education ($ES = 0.47$). There does not appear, however, to have been a significant benefit of having a grandparent with some college education versus one who did not progress beyond high school ($p > .05$). After incorporating parents’ educational attainment in Model 2, the effect of having college-educated grandparents was reduced by over half (from 0.46 to 0.22 SD). Similar to our findings with mathematics, the average child with at least one college-educated parent possessed literacy skills nearly one-half SD greater than one whose parents attended but did not graduate from college ($ES = 0.48$). Despite the inclusion of parents’ education, having a college-educated grandparent remained significantly related to children’s literacy skills ($ES = 0.22$).

Model 3 added controls for parental income and occupational prestige, and reduced the college-educated parent effect by over 40% (from 0.48 to 0.27 SD). Children with only high-school educated parents scored almost one-fifth standard deviation below those with parents with some higher education. Not surprisingly, household income was positively associated with literacy skills, as were both mother and father’s occupational prestige ($ES = 0.07$ and 0.06, respectively). Moreover, even after adjusting for these relevant socio-demographic characteristics, having college-educated grandparents remained positively associated with children’s cognitive skills ($ES = 0.18$). The final model accounted for a broad range of additional demographic characteristics. Central to our focus here is that the effect associated with college-educated grandparents remained significant (although small).

9. Regression-adjusted propensity matched estimates

We began this stage of the analyses by constructing a sample containing comparable treatment and control groups. Table 5, which displays the results for the probit estimation, indicates that parents’ high school educational background and welfare receipt were strong predictors of grandparent educational attainment. The next step in the propensity analysis required matching the treated

Table 5
Probit model estimations of having one or more college-educated grandparents.

	Coefficients
Mother’s age at first birth	0.00
Parent enrolled in academic program in high school ^a	0.41*
Parent took trigonometry in high school	0.14*
Parent took calculus in high school	0.10
Parent took physics in high school	-0.10*
Child is non-native English speaker	-0.06
Child is Black ^b	-0.02
Child is Hispanic	-0.15
Child is Asian	0.00
Child is Native American	0.02
Child is multiracial	0.01
Child had low birthweight	-0.03
Child was premature	-0.01
Mother on welfare at birth	-0.35*
Mother married at birth	-0.05
Constant	-1.15*

* $p < .05$.

^a Academic program is compared to commercial or vocational program.

^b All racial/ethnic groups are compared to Whites.

and control groups. Each individual child in the treatment group was paired with a child in the control group who had the same probability of having a grandparent with a college degree or more. Recall that the goal was to have treatment and control groups that did not differ systematically on observed covariates or controls. Analyses not presented here indicated good covariate balance, as the mean differences between the treatment and control groups were neither large nor statistically significant.

We then estimated the associations between grandparents’ education and their grandchildren’s entering kindergarten mathematics and reading scores using the regression-adjusted propensity matched estimates. These analyses included all covariates that were used in the probit model to estimate the propensity scores. This variant of propensity score matching (regression-adjusted) allowed us to use the propensity score weights and restrict the sample to those cases with similar propensity scores (i.e., to those cases with overlap). These estimates are considered to be unbiased provided that, based on the restriction of the sample using common support and matching, no significant correlations exist between the independent variables and the error term. Upon satisfying this condition, the grandparents’ education coefficient can be seen as the average treatment effect.

Table 6
Grandparent educational attainment and grandchildren’s literacy skills: propensity matched estimates.

	Mathematics	Reading
Grandparent(s)–Bachelor’s or more	0.17*	0.19*
Mother’s age at first birth	0.03*	0.02*
Parent enrolled in academic program in high school ^a	0.03	-0.02
Parent took trigonometry in high school	-0.08	0.04
Parent took calculus in high school	0.01	-0.07
Parent took physics in high school	0.12	0.18*
Child is non-native English speaker	-0.38*	-0.35*
Child is Black ^b	-0.07	0.13
Child is Hispanic	-0.12	0.01
Child is Asian	0.16	0.42*
Child is Native American	-0.22	-0.10
Child is multiracial	-0.22	-0.19
Child had low birthweight	0.24*	0.12
Child was premature	0.06	0.10
Mother on welfare at birth	-0.21*	-0.28*
Mother married at birth	0.07	0.10
Constant	-0.95*	-0.76*

* $p < .05$.

^a Academic program is compared to commercial or vocational program.

^b All racial/ethnic groups are compared to Whites.

Table 6 presents the results of the propensity score approach. These estimates suggest that having at least one college-educated grandparent was associated with an advantage in mathematics skills of 0.17 *SD* and a similar positive link between grandparent educational attainment and their grandchildren's literacy abilities. On average, children with college-educated grandparents scored 0.19 *SD* above those with non-college-educated grandparents. These grandparent education estimates for mathematics and reading in Table 6 are quite similar to the regression findings presented in Tables 3 and 4. This answers our third research question. The coefficient for college-educated grandparents in Table 6 is actually somewhat larger than that indicated by the regression in Table 3 (0.17 vs. 0.15 *SD*). Similarly for literacy, the matched case estimates from Table 6 are slightly stronger than the estimates from Table 4 (0.19 vs. 0.14 *SD*). These findings suggest that the regression results presented in Tables 3 and 4 of the association between grandparents' education and grandchildren's cognitive skills are quite robust and may even represent somewhat conservative estimates.

10. Discussion

The intergenerational crystallization of socioeconomic advantage has generated vigorous debate among social scientists, policymakers, and the public. Our current study confirms that historical disadvantages in educational attainment represent an additional source of variability in child outcomes. Across multiple cognitive and socio-demographic dimensions, children with more-educated grandparents differ systematically from those with less-educated grandparents. Indeed, our study suggests persistent, multigenerational influences of socioeconomic advantage. Even after accounting for a wide array of socioeconomic and demographic characteristics, children with college-educated grandparents tend to begin formal schooling with stronger literacy and mathematics skills. Although the effects we reported here are not particularly large, even modest academic disparities at such an early age can have substantial implications for children's academic placements and experiences in school. For example, decisions regarding grade retention, ability grouping, curricula, and assignment to special education and ESL programs can often come down to relatively small academic differences between children (Burkam, LoGerfo, Ready, & Lee, 2007; Entwisle et al., 1997; Smith & Shepard, 1988).

Our first research question inquired into the links between grandparents' education and their grandchildren's socio-demographic characteristics. The results suggest that college-educated grandparents tend to have grandchildren who are similarly advantaged, both socially and academically. The grandchildren of college-educated grandparents begin kindergarten with more mathematics and reading skills, tend to have mothers who were considerably older at the birth of their first child, and are more likely to come from two-parent, higher-SES households. Our second research question concerned the residual associations between grandparents' education and their grandchildren's literacy and mathematics skills. Even after controlling for grandchildren's socioeconomic status, the associations between grandparents' education and grandchildren's cognitive skills remain. The third research focus tested the robustness of these results using regression-adjusted propensity matched estimates. Importantly, the OLS findings were robust to alternate model specifications and approaches. The propensity score analyses supported our findings regarding the links between grandparents' education and their grandchildren's academic abilities. As previous authors have noted, the identification of social reproduction across three generations suggests quite different policy responses, as even dramatic reductions in educational inequality would take

more than one generation to reduce historic cognitive inequalities (see Phillips et al., 1998).

Across several dimensions, this study adds to the growing body of research on the intergenerational transfer of social, economic, and cognitive advantage. Unlike much of the existing literature, we explored intergenerational effects at the very start of children's formal schooling. Although some studies have addressed similar questions with school-entry-age children (e.g., Hill & O'Neill, 1994), others have employed samples of children several years into elementary school (e.g., Grant, 2005) or children from multiple age spans simultaneously (e.g., Yeung & Conley, 2008, whose sample includes children ranging from age 3 to 12). Limiting our analyses to children at the start of kindergarten permitted the estimation of grandparent educational attainment effects absent the effects of formal schooling. This is important, as school quality is associated with children's social class and initial academic skills, potentially producing estimates that conflate school, parental, and grandparent influences (Lee & Burkam, 2002). Moreover, in contrast to our current study, prior research rarely employed advanced causal inference techniques that address issues of endogeneity. Previous work, including the studies noted immediately above, also typically used relatively small samples (generally fewer than 1800 children). In contrast, we used a large and nationally representative sample of over 13,000 children.

Although this study holds several advantages over the extant research, it also has several limitations. Due to constraints inherent in our data, we could not examine the extent to which maternal versus paternal grandparents were associated with early cognitive outcomes within the same family. Moreover, we were unable to identify the precise mechanisms that facilitate the intergenerational transfer of cognitive ability. Future research might explore whether the cognitive benefits of having more educated grandparents reflect genetic transfer versus the historic accumulation of social, cultural, and economic capital. Additionally, the associations we reported here may be contingent upon the nature of the relationships between grandparents and grandchildren. For example, it is possible that college-educated grandparents more frequently interact with their grandchildren in ways that positively affect their grandchildren's literacy and math development. Other potential causal mechanisms may simply involve greater fiscal resources among more-educated grandparents, and an increased ability to assist their children and grandchildren. Because measures of social class are limited to grandparents' education within the ECLS-K data, the apparent relationship with grandchildren's early cognitive ability may be conflated with other grandparent socioeconomic characteristics, particularly, income, wealth, and occupational prestige. In short, the actual method of transfer is likely best characterized as a complicated nexus involving multiple influences that extend across generations.

Our results also suggest the need for future research that attends to the relationship between grandparents' education and grandchildren's literacy and math skills as grandchildren age. Given that children with college-educated grandparents enter kindergarten with more advanced literacy and math skills than their peers, we wonder whether grandparents' education influences grandchildren's academic growth once formal schooling has begun. Do grandchildren with college-educated grandparents learn more quickly than their peers whose grandparents did not earn post-secondary degrees? If so, intergenerational transfers will produce greater social inequality as grandchildren age. In contrast, the cognitive disparities independently attributed to grandparents' educational attainment may disappear as grandchildren grow older. Quite possibly, no relationship may exist between grandparents' education and grandchildren's learning rates. Moreover, the association between grandparents' education and grandchildren's cognitive ability may depend upon the nature of the pre-school

relationship between grandparents and grandchildren and therefore weaken—or disappear—as grandchildren age and become more independent.

The variability in grandparents' education among different racial/ethnic and socioeconomic groups may have its beginnings in inequities that occurred long ago. More significantly, current inequities among children could be related to past inequities experienced by their grandparents. If we are to fully understand the factors that are associated with and predictive of children's life outcomes, researchers must work to capture multigenerational measures of capital—human, financial, social, and cultural. To date, most studies that focus on children's achievement only account for parental socioeconomic status. Our current study makes clear that two generations—parents and children—are not sufficient. When available, future research should strive to include three generations in the construction of measures of SES. The findings reported here, combined with the historical evidence regarding grandparents' unequal access to higher education, suggest the crucial intergenerational role of human capital in exacerbating social inequalities.

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