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## Do Effects of Early Child Care Extend to Age 15 Years? Results From the NICHD Study of Early Child Care and Youth Development

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### Abstract

Relations between nonrelative child care (birth to 4 ½ years) and functioning at age 15 were examined ( $N = 1364$ ). Both quality and quantity of child care were linked to adolescent functioning. Effects were similar in size as those observed at younger ages. Higher quality care predicted higher cognitive-academic achievement at age 15, with escalating positive effects at higher levels of quality. The association between quality and achievement was mediated, in part, by earlier child care effects on achievement. Higher quality early child care also predicted youth reports of less externalizing behavior. More hours of nonrelative care predicted greater risk taking and impulsivity at age 15, relations that were partially mediated by earlier child care effects on externalizing behaviors.

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The transition from childhood to adolescence involves substantial changes in multiple features of children's lives, which raises fundamental questions about the importance of early experience as an influence on adolescent development. Adolescence is defined by physical and cognitive changes (Kuhn, 2009; Susman & Dorn, 2009) as well as transformations in parent-child and peer relationships (Collins & Steinberg, 2006) and schooling (Eccles & Roeser, 2009). With these myriad changes, there is reason to wonder whether effects of early child care experiences persist into adolescence. This is the central issue addressed in this report. Specifically, we ask if nonrelative child care during the first 4½ years of life predicts academic achievement and behavioral adjustment at age 15. Then, we consider developmental processes that may mediate these associations. Finally, we ask if links between early child care and adolescent outcomes are moderated by child gender or familial risk.

The work to be reported is based on a large, nonexperimental field study—the National Institute of Child Health and Human Development Study of Early Child Care and Youth

Development (NICHD SECCYD)—which affords estimation of statistical rather than causal effects. When causal language (e.g., effect, influence) is employed in this report, it is for heuristic purposes.

## Child Care and Child Development

Two different perspectives have guided much of the research examining the effects of early child care. For at least 50 years, nursery schools and preschools have been viewed by parents and educators as a means to promote social and academic skills prior to entry to formal schooling (Lamb & Ahnert, 2006). In contrast, others, influenced in part by attachment theory, have expressed concerns that extensive nonmaternal care, especially beginning very early in life, could disrupt attachment bonds and result in problem behaviors (Belsky, 1986, 1988; Egeland & Hiester, 1995).

Research findings provide support for both views. Experimental studies of high-quality early intervention programs have demonstrated that these programs can enhance social, cognitive, and academic development of economically disadvantaged children (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001; Love et al., 2005; Reynolds, 2000; Schweinhart, Weikart, & Lerner, 1986). Correlational studies of economically and ethnically diverse samples also have fairly consistently found higher quality child care to be associated with better cognitive and academic outcomes (Broberg, Wessels, Lamb, & Hwang, 1997; Burchinal et al., 2000; Cote et al., 2007; Gormley, Gayer, Phillips, & Dawson, 2005; Mashburn et al., 2008; Peisner-Feinberg & Burchinal, 1997). Evidence of social benefits of child care has been more mixed. Although some have found benefits of high-quality care for social development (Cote et al., 2007; Howes, Phillips, & Whitebook, 1992; Vandell, Henderson, & Wilson, 1988), other researchers have identified potentially adverse consequences of long hours of care, especially though not exclusively if initiated early in life (Bates et al., 1994; Belsky, 2001; Cote, Borge, Geoffroy, Rutter, & Tremblay, 2008; Haskins, 1985; Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; Nomaguchi, 2006; Vandell & Corasaniti, 1990). Time in center-type settings has been related to negative social behavioral outcomes but also positive academic outcomes (Huston et al., 2001; Loeb et al., 2007; Magnuson, Ruhm, & Waldfogel, 2007). Efforts to understand and integrate these disparate findings has led to a conceptualization of child care that differentiates quality of care, quantity of care, and types of care as potentially distinct influences on children's development.

The NICHD SECCYD was launched in the early 1990s to examine the effects of these three distinctive aspects of early child care. In previous reports of child functioning prior to school entry (NICHD Early Child Care Research Network [ECCRN], 2002), in the primary grades (NICHD ECCRN, 2005c), and later in elementary school (Belsky et al., 2007), child care quality, quantity, and type were differentially linked to children's development. In general, higher quality of child care was related to higher cognitive/academic performance, whereas more hours of child care (especially by nonrelatives) was related to more problem behavior. More experience in center-type care was related to better cognitive skills, but also more problem behavior. Although this general pattern of findings was detected at three time periods (preschool, early elementary, later elementary), effects were small by traditional standards, and over time some previously detected child care effects disappeared when evaluated at later ages, raising the core issue of the current inquiry, namely, whether effects of early child care are evident in adolescence.

Some have contended that child care effects would fade away over time (Blau, 1999; Colwell, Pettit, Meece, Bates, & Dodge, 2001; Deater-Deckard, Pinkerton, & Scarr, 1996), especially by the time young people are in high school because subsequent life experiences

likely override child care experiences that occurred a decade or more earlier. At the same time, however, in view of the fact that development in adolescence builds on prior periods and that some effects of early experience may not manifest themselves until adolescence (so-called “sleeper effects”), some effects of early child care might remain even among teenagers.

To date, only a few early intervention studies have tracked effects of high-quality early child care and education into the high school years and beyond. Low-income children exposed to high-quality program care show better academic outcomes through high school and higher rates of employment and less criminal activity as young adults (Campbell et al., 2001; Lazar & Darlington, 1982; Schweinhart et al., 1986). Several large longitudinal studies that included middle-income as well as low-income participants have documented quality effects in elementary school (Melhuish et al., 2008; Peisner-Feinberg et al., 2001), but none has considered child care effects in adolescence.

The current study extends previous research by examining the links between routine early child care experience (i.e., not high-quality early intervention programs) and adolescent functioning at age 15 in a large and economically diverse sample. Three related issues are considered. The first concerns the specificity of child care effects. Previous analyses of SECCYD data indicated that child care quality positively predicts cognitive and academic functioning, more hours of care predicts more problem behavior, and more experience in center care predicts both better academic outcomes and more problem behavior at various times during the preschool and middle childhood years (Belsky et al., 2007; NICHD ECCRN, 1998, 2003, 2005c). Here, we examine whether such domain specificity is maintained at age 15.

A second issue involves possible pathways through which child care could affect adolescent development. The most simple and straightforward proposition is that differences in child functioning at entry to school that are linked to early care are carried forward to middle adolescence. We address this possibility by evaluating the extent to which observed effects of child care on adolescent functioning at age 15 are mediated by prior cognitive and social functioning in early and middle childhood.

A third issue that merits attention is whether associations between child care and adolescent functioning are moderated by child gender or familial risk. Hypotheses regarding differential gender effects have been in the literature for years (Belsky, 1988; Love et al., 2003; Maccoby & Lewis, 2003), with some evidence of these effects reported for child care and developmental outcomes in the preschool and early elementary years (Caughy, DiPietro, & Strobino, 1994; Crockenberg, 2003; Peisner-Feinberg et al., 2001). Additionally, some early studies of maternal employment highlighted negative effects for boys and positive effects for girls (Gottfried & Gottfried, 1988; Hoffman & Youngblade, 1999). A recent re-analysis of the Abecedarian, Perry Preschool, and the Early Training Projects found long-term educational benefits for girls, but not boys (Anderson, in press), although a cost-benefit analysis of the Perry Preschool participants at an age 40 indicated greater benefits for men than women, primarily because of economic savings associated with reductions in the men’s incarcerations (Belfield, Nores, Barnett, & Schweinhart, 2006).

There also is some evidence that the effects of child care may vary as a function of familial risk. Quality of early child care has emerged as a protective factor of familial social risk (measured by maternal education, family income, household size, and maternal depression) in terms of academic achievement in elementary school (Burchinal, Vandergrift, & Pianta, 2009). A report based on a large national survey found that children of low-income families benefited more in terms of cognitive-academic performance when they experienced more

hours of child care (labeled a compensatory effect), whereas children of middle-income households functioned more poorly when they experienced more hours of child care (labeled a lost-resources effect) (Desai, Chase-Lansdale, & Michael, 1989). In other research, more time in center care predicted larger academic gains among low-income than middle-income children (Gormley et al., 2005; Magnuson et al., 2007). For the most part, however, previous analyses of the SECCYD have failed to detect familial risk- or gender-moderated child care effects (NICHD ECCRN, 2002, 2005c). We examine whether such effects emerge in adolescence.

In all nonexperimental studies of child care, selection bias is a concern because family and child characteristics are related to quality, type, and hours of care as well as to children's functioning (Committee on Family and Work Policies, 2003). To reduce the likelihood of selection bias, extensive covariates measured in early childhood are used as control variables in all analyses, following the practice adopted in our previous reports. Primary analyses also include extensive covariates measured in middle childhood and adolescence, in line with our prior work and consistent with the standard adopted by developmental psychologists who have argued that controlling for subsequent family and school experiences provides a more conservative test of effects associated with early experience (Bradley, Caldwell, & Rock, 1988; Kovan, Chung, & Sroufe, in press; Lamb, Thompson, & Gardner, 1984). Failing to include such controls risks attributing effects to early experience that could just as well (and perhaps more parsimoniously) be a function of later experience. Nevertheless, we also test relations without the middle childhood and adolescent covariates because family factors in middle childhood and adolescence may have been influenced by child care. If early child care affected these covariates, then their inclusion might result in over- or underestimates of child care effects.

In sum, this report provides new insights into potential long-term child care effects by tracking a large sample of American children to age 15 years to determine whether variations in early child care quality, quantity, and type are related to cognitive development, academic achievement, and socio-emotional functioning in adolescence.

## METHOD

### Participants

Hospital visits were conducted with mothers shortly after the birth of a child in 1991 in 10 locations in the U.S. During selected 24-hr intervals, all women giving birth ( $N = 8,986$ ) were screened for eligibility. Of those families, 3,142 were excluded due to a priori criteria such as failure to speak English and plans to move within the next 3 years. At a follow-up phone interview at 2 weeks, 1,353 could not be contacted or refused to participate. Families were randomly selected among the remaining pool of eligible participants. A total of 1,364 families were recruited and completed a home interview at 1 month and became the study participants. Overall, this constituted a 52% response rate from the original approach to families in the hospital to successful recruitment in the study.

In terms of demographic characteristics, 26% of the mothers in the recruited sample had no more than a high school education at recruitment; 21% had incomes no greater than 200% of the poverty level; and 22% were minority (i.e., not non-Hispanic European American). Details of the sampling plan can be found in NICHD ECCRN (2005b). It should be noted that the primary analyses to be presented estimate effects based on all 1,364 children originally recruited into the sample.

At age 15, measures of adolescent outcomes were obtained for 958 youth (70% of the original recruitment sample). Comparisons of the age 15 sample and the other 406 youth in

the birth cohort sample revealed four significant differences on the 30 early and middle childhood variables listed in Table 1 and Table 2. Nonparticipants were more likely to be male (56% vs. 50%) and to have lower scores at 4½ years on a test of math skills (97.8 vs. 102.5); and their mothers were less educated (13.4 years vs. 14.3 years) and provided lower quality parenting (−.25 standardized parenting score vs. −.02 standardized parenting score).

## Measures

Children were followed from birth to age 15. Assessments occurred when the children were 1, 6, 15, 24, 36 and 54 months old; when they were in kindergarten and Grades 1, 2, 3, 4, 5, and 6; and at age 15. The following sections describe the specific measures used in the present analyses and the time points of administration. Additional details about all data collection procedures, psychometric properties of the instruments, and descriptions of how composites were derived and constructed can be found in the study's Manuals of Operation and Instrument Documentation (<http://secc.rti.org>).

Measurements are described in terms of their roles in the analyses. Measures reflecting the child's experiences in early child care are presented first, followed by the adolescent cognitive and social outcome measures. Variables used to control for family factors and schooling are then described. Finally, we describe measures of child functioning in early and middle childhood that are used in the meditational pathway analyses.

## Child Care Characteristics

Three aspects of child care were measured from birth through 4½ years: type of care, quantity of care, and quality of care (see Table 1).

**Child care type**—During phone and personal interviews conducted at 3-month intervals (or epochs) through 36 months and 4-month intervals (or epochs) to age 4½ years, mothers reported types and hours of regularly used nonmaternal care. During each interview, mothers reported all of the care arrangements used since the previous interview. Arrangements were classified as center, child care home (any home-based care outside the child's own home), in-home care (any caregiver in the child's own home), father care, and grandparent care. The proportion of epochs in which the child received care in a center for at least 10 hours per week was computed and used as variable to represent *type of care*.

**Child care hours**—The hours per week in all types of nonmaternal care excluding fathers and grandparents were tallied for each epoch, and then the mean of nonrelative care hours across epochs was computed.

**Child care quality**—Observational assessments were conducted in the primary child care arrangement at ages 6, 15, 24, 36, and 54 months. Quality was assessed during two half-day visits scheduled within a 2-week interval at 6–36 months and one half-day visit at 54 months. Observers completed four 44-min cycles of the Observational Record of the Caregiving Environment (ORCE) per child age through 36 months and two 44-min ORCE cycles at 54 months. Detailed descriptions of the ORCE assessments can be found in NICHD ECCRN (2002), including coding definitions, training procedures, and interobserver agreement. Reliability exceeded .90 at 6 months, .86 at 15 months, .81 at 24 months, .80 at 36 months, and .90 at 54 months.

A mean quality of nonrelative care score was computed for each child.

## Adolescent Functioning at Age 15

Table 2 provides the descriptive statistics for the measures of adolescent functioning at age 15.

**Cognitive-academic achievement**—The Woodcock-Johnson Psycho-Educational Battery – Revised (WJ-R; Woodcock & Johnson, 1989) is a wide-range, comprehensive set of individually administered tests that consists of two major parts: the Tests of Cognitive Ability and the Tests of Achievement. At age 15, cognitive ability was assessed with two subscales, Picture Vocabulary and Verbal Analogies. Achievement was assessed using the Passage Comprehension and Applied Problems subscales. In this report, standard scores, which are based on a mean of 100 and a standard deviation of 15 and the equivalent percentile rank, were used.

**Risk taking**—Adolescents reported *risk taking* behaviors using an audio computer-assisted self-interview. Thirty-six risk-taking items were drawn from instruments used in prior studies of adolescents (Halpern-Felsher, Biehl, Kropp, & Rubinstein, 2004). Adolescents reported the extent to which, over the past year, they used alcohol, tobacco or other drugs, behaved in ways that threatened their own safety (e.g., rode in a vehicle without the use of seatbelts), used or threatened to use a weapon, stole something, or harmed property. Responses were made on a 3-point scale (0 = *never*, 1 = *once or twice*, 2 = *more than twice*). Ratings were summed across component items and then subjected to square root transformation to reduce skew and kurtosis (Cronbach alpha = .89).

**Impulsivity**—Adolescents completed an 8-item questionnaire to assess reactions to external constraints, taken from the Weinberger Adjustment Inventory (Weinberger & Schwartz, 1990). The measure asks participants to rate (1 = *false* to 5 = *true*) how closely their behavior matched a series of statements. Sample items include: “I’m the kind of person who will try anything once, even if it’s not that safe.” “I should try harder to control myself when I’m having fun.” “I do things without giving them enough thought.” Seven items were used to create an impulsivity composite score (Cronbach alpha = .82).

**Externalizing problems**—Adolescents self-reported externalizing behaviors using the Youth Self-Report (YSR; Achenbach & Rescorla, 2001). The scale consists of 119 items that reflect a broad range of behavioral/emotional problems as well as 16 socially desirable items. For each item, the adolescent is asked to rate how well that item describes him or her currently or within the last six months: on a 3-point scale (0 = *not true*, 1 = *somewhat or sometimes true*, 2 = *very true or often true*). The format of the YSR is similar to that of the Child Behavior Checklist completed by parents (CBCL; Achenbach, 1991a) and the Teacher Report Form completed by teachers (TRF; Achenbach, 1991b). The YSR, CBCL, and TRF have 89 problem items in common, but the YSR includes additional items that are specifically designed for adolescents. *Externalizing behaviors* are assessed by 30 items (Cronbach alpha = .86).

## Maternal, Child, Family, and School Controls

Measures of maternal, child, and family characteristics during early childhood, middle childhood, and adolescence, and school quality were used as controls for possible selection bias. See Table 1 for the descriptive statistics.

The early childhood covariates are *maternal education* (in years); *child gender*; *child race and ethnicity*; the proportion of epochs through 4½ years in which the mother reported a *husband/partner* was present; family income through 4½ years calculated as the mean *income-to-needs ratio*; *maternal PPVT* (Peabody Picture Vocabulary Test-Revised; Dunn &

Dunn, 1981) obtained when the study child was age 3 years; *maternal psychological adjustment* measured when the study child was age 6 months using three subscales (neuroticism, extraversion, agreeableness) of the NEO Personality Inventory (Costa & McCrae, 1985, 1989), the mean of *maternal depressive symptoms* assessed by the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) reported by the mother at 6, 15, 24, 36, and 54 months, and an *early parenting quality* composite score created by averaging standardized ratings of observed maternal sensitivity and observed home environmental quality measured at 6, 15, 24, 36, and 54 months. These control variables are described in detail in NICHD ECCRN (2002) and the instrument documentation available at the project website (<http://secc.rti.org>).

The middle childhood covariates were measured when the study children were in Grades 1, 3, and 5. These family covariates paralleled those obtained in early childhood: the proportion of the middle childhood in which a *husband or partner* was present in the household, mean *income-to-needs ratio*, mean *maternal depressive symptoms*, and mean *observed parenting quality* (the average of standardized ratings of maternal sensitivity in a semi-structured task and a home observation). In addition, the quality of school experiences in middle childhood was rated during two 44-minute observations in Grade 1 and eight 44-minute observations in Grades 3 and 5, and a *mean classroom quality score* was computed. For more details about the classroom observations and the classroom quality composites, see NICHD ECCRN (2004, 2005a).

The adolescent family covariates collected at the age 15 data collection corresponded to those used in early and middle childhood: *presence of a husband or partner* in the household, *income-to-needs ratio*, *maternal depressive symptoms*, and the *observed parenting quality composite*.

The age 15 parenting quality composite was based on ratings of maternal sensitivity made from a video-recorded 8-min discussion of areas of disagreement between the adolescent and mother (e.g., chores, homework, money), selected by the adolescent (Allen et al., 2000), and a home observation combined with a semi-structured interview (HOME; Bradley et al., 2000). The discussion task was coded using 7-point rating scales, with higher scores indicating higher levels of sensitivity based on adaptations of the more micro-analytic coding systems of Allen and colleagues (Allen et al., 2000, 2001) and coding systems used at earlier ages in the SECCYD (NICHD ECCRN, 2008). Maternal sensitivity was the sum of the 7-point ratings of supportive presence, respect for autonomy, and hostility (reversed). Cronbach alphas for the sensitivity composite scores ranged from .80 to .85 and inter-rater reliabilities determined from intraclass correlations based on a second coding of 19.5% (196/1004) to 27% (271/987) of the videotapes at the different ages ranged from .84 to .91.

The adolescent version of the HOME scale consists of 44 items that assess five domains (Physical Elements, Learning Materials, Variety of Experiences, Acceptance and Responsiveness, and Regulatory Activities), which are combined to create a Total Score. The maternal sensitivity and HOME scores were standardized and averaged to create the parenting quality composite.

### Child Functioning in Early and Middle Childhood

Measures of children's functioning in early and middle childhood included cognitive-academic achievement and behavior problems. Descriptive statistics for these measures can be found in Table 2.

For *cognitive-academic achievement*, children were administered subtests from the Woodcock-Johnson Psycho-Educational Battery—Revised: *Letter-Word Identification* (4½

years and first grade) and *Broad Reading* (third and fifth grades), which adds assessment of passage comprehension to the assessment of identification of words; *Applied Problems*, which measures skill in analyzing and solving practical problems in mathematics; and *Picture Vocabulary*, which measures children's ability to name objects depicted in a series of pictures.

The Teacher Report Form (Achenbach, 1991b) was used to evaluate *Externalizing Problems* (e.g., "hits others", "disobedient at school", "argues a lot") at 4½ years and in first, third, and fifth grades.

## RESULTS

Data analyses focus on whether early child care quality, quantity, and type are associated with adolescent outcomes at age 15 years, and if so, whether child functioning at entry to school mediates these subsequent associations. We also examine whether gender or family risk moderate associations between early child care and age 15 outcomes. Descriptive analyses are conducted and structural equation models (SEM) test direct pathways, mediated pathways, and moderated relations between early child care experiences and 15 year outcomes. The SEMs account for missing data through full-information maximum likelihood (FIML) based on the data for all 1,364 children originally recruited for the study. Alphas was set at .05, and thus all results reported are significant at  $p < .05$  or better.

### Preliminary Analyses

Descriptive statistics are presented in Tables 1, 2, and 3. Table 1 describes the sample, presenting percentages, means, and standard deviations for the child care variables and the selected covariates in the early childhood, middle childhood, and adolescent periods. Figure 1 shows the sample distributions for child care quality, quantity, and type. Seventeen percent of the children experienced high-quality child care (ORCE scores of 3.30 or higher, on average); and 24% experienced moderately high-quality nonrelative care (ORCE scores, 3.0–3.29 on average). Less than one-quarter of the children (21%) were in nonrelative care for more than 30 hours a week. Sixty-four percent of the children participated in center type care for at least one epoch, with 24% experiencing more than one year of center care by age 4½ years.

Table 2 provides descriptive statistics for the adolescent outcomes and for children's prior academic and behavioral functioning. The first column lists the means and standard deviations for cognitive-academic and behavioral outcomes at age 15. The next four columns show earlier assessments of cognitive-academic functioning and teacher-reported externalizing problems that are examined as potential pathways by which child care experiences might be linked to age 15 outcomes. Table 3 presents correlations between child care variables and all child outcomes. Because the analysis created a latent cognitive-academic achievement variable, for these correlations a manifest composite was created.

### Substantive Analyses

Structural equation models with full information maximum likelihood (FIML) are used to test three sets of issues. The first examines direct associations between early child care experiences and adolescent outcomes at age 15. The second adds potential mediators and the third tests potential moderators. The use of FIML allows the inclusion of the entire sample ( $n = 1364$ ) in these analyses. FIML has been shown to be as effective as multiple imputation in addressing problems associated with missing data (Schafer & Graham, 2002). When statistically significant associations are found, effect sizes are computed as the anticipated



change in the outcome in standard deviation units when the predictor changes by a standard deviation or  $d = B \times SD_{\text{predictor}}/SD_{\text{outcome}}$  (see NICHD ECCRN & Duncan, 2003).

### Direct Associations between Early Child Care and Age 15 Outcomes

The first set of analyses fit a structural equation model in which age 15 outcomes were predicted from early child care hours, type, and quality adjusting for family experiences in early and middle childhood and adolescence and school experiences in middle childhood (see Figure 2). The particular child care variables of interest were child care hours, proportion of time in center care, and child care quality, computed from all care settings except those that involved fathers or grandparents. Preliminary analyses tested whether associations between the child care variables and age 15 outcomes were linear or quadratic, indicating that only quality showed the quadratic association and that having the other quadratic terms did not increase fit, Likelihood-Ratio test  $\chi^2(6) = 3.62, p = 0.27$ . Accordingly, the quality squared term was added to the model.

Academic achievement at age 15 was treated as a latent construct, with indicators of Woodcock-Johnson-Revised Applied Problems, Picture Vocabulary, Passage Comprehension, and Verbal Analogies scores. Preliminary attempts to form a latent construct for problem behaviors suggested a poor fit, so adolescent self-reports of externalizing, risk taking, and impulsivity were analyzed as separate manifest variables. The model also included the following covariates: research site, child gender, child ethnicity, maternal education, maternal PPVT, maternal psychological adjustment, elementary school classroom quality and repeated assessments from early childhood, middle childhood, and adolescence of family income, proportion time mother had a husband/partner, maternal depressive symptoms, and parenting quality. Including family covariates from the three developmental periods (early childhood, middle childhood, and adolescence) reduced the likelihood that observed associations between child outcomes and early child care experience were due to family selection factors.

The SEM model fit the data well ( $\chi^2 = 237.52(113)$ ;  $\chi^2/df = 2.10$ ; CFI = 0.97; RMSEA = 0.03). Generally, an RMSEA < 0.10 and a CFI  $\geq 0.90$  indicate good fit (Bollen, 1989). Table 4 shows the estimated coefficients and effect sizes for the paths from child care quality variables to age 15 outcomes and Figure 2 displays the statistically significant standardized coefficients. Results indicated that child care quality showed significant linear ( $B = 2.62, d = .09$ ) and quadratic ( $B = 3.35, d = .07$ ) associations with children's cognitive-academic achievement at age 15. The linear association suggested that children who experienced higher quality care had significantly higher levels of cognitive-academic achievement at age 15 while the quadratic association included this child care quality was more strongly related to achievement at moderately high levels of quality than at low or very low levels.

Figure 3 shows the estimated nonlinear association between child care quality and achievement. Plotted are predicted values from  $-2.0$  to  $+2.0$  SD around the quality mean of 2.90. As shown, higher quality is associated with higher academic outcomes when ORCE scores are 2.75 or higher. In contrast, quality is nonsignificantly negatively related to academic outcomes when mean quality is in the very low range, averaging less than 2.5 on the ORCE over the first 4½ years. The turning point or minimum point of the quadratic function describing the association between quality and academic outcomes is computed by taking the derivative of the quadratic function. This value is  $-.39$  on the mean-centered scale, and 2.51 in the original ORCE scale. Thus, the turning point in this function is almost one standard deviation (.45) below the sample mean (2.90). The effect sizes for quality vary around this turning point. To illustrate, effect sizes were computed in terms of standard deviation (SD) units of child care quality:  $d = .193$  at  $+2$  SD (ORCE = 3.8);  $d = .168$  at  $+1.5$  SD (ORCE = 3.58);  $d = .142$  at  $+1$  SD (ORCE = 3.35);  $d = .116$  at  $+.5$  SD (ORCE = 3.13),  $d$

= .090 at the mean (ORCE = 2.90),  $d = .064$  at  $-.5$  SD (ORCE = 2.67),  $d = .038$  at  $-1$  SD (ORCE = 2.45), and  $d = -.039$  at  $-2$  SD (ORCE = 2.00).

Table 4 and Figure 2 also show significant direct pathways between early child care experience and problem behaviors. Adolescents who experienced more hours of nonrelative child care across their first 4½ years reported significantly more risk taking ( $B = .008$ ,  $d = .09$ ) and greater impulsivity ( $B = .08$ ,  $d = .13$ ) at age 15. In addition, children who experienced higher quality care had significantly lower externalizing scores ( $B = -1.89$ ,  $d = .09$ ).

Exposure to center care was not related to academic achievement or problem behaviors at age 15.

Several analyses were conducted to examine the robustness of these findings. First, because child hours and proportion time in center care were correlated ( $r = .51$ ), the SEM analysis was recalculated twice, first including quality and type and all covariates (but omitting hours of care) and, second, including quality and hours and all covariates (but omitting type of care). None of the paths involving type was significant in the first follow-up model. The findings associated with hours in these follow-up analyses remained the same as those reported in Table 4. Thus, more hours in nonrelative care, not proportion of measurement occasions spent in centers, predicted poorer social adjustment in adolescence.

Second, the basic SEM analysis examining quality, quality<sup>2</sup>, type, and hours was recalculated including the early childhood covariates and excluding the middle childhood and adolescent covariates. If early child care affects the middle childhood and adolescent covariates, then their inclusion might result in under- or over- estimates of the child care effects. For the most part, the same pattern of significant results was obtained when the middle childhood and adolescent covariates were removed from the model. Quality and quality<sup>2</sup> predicted higher academic outcomes ( $B = 2.74$ ,  $SE = 1.0$ ,  $p < .05$ , and  $B = 3.63$ ,  $SE = 1.51$ ,  $p < .01$ , respectively) and quality predicted less externalizing ( $B = -1.96$ ,  $SE = .87$ ,  $p < .05$ ). Hours of care predicted more impulsivity ( $B = .07$ ,  $SE = .03$ ,  $p < .001$ ).

Removing the middle childhood and adolescent covariates resulted in slightly different findings pertaining to adolescent reports of risk taking. More hours predicted more risk taking when all of the covariates were in the model ( $p < .05$ ) but was only marginally significant when the middle childhood and adolescent covariates were excluded ( $B = .007$ ,  $SE = .003$ ,  $p < .06$ ). Higher quality child care predicted less risk taking when the middle childhood and adolescent covariates were excluded ( $B = -.33$ ,  $SE = .15$ ,  $p < .05$ ) but was only marginally significant when these covariates were included ( $B = -.25$ ,  $SE = .15$ ,  $p < .10$ ).

Third, the quadratic association between child care quality and cognitive/academic skills was examined in additional analyses to determine the robustness of these findings. A spline approach tested the extent that the association between child care quality and cognitive-academic skills differed at varying levels of quality. The coefficient for quality as a continuous variable was estimated in models that included 2, 3, and 4 quality groups. These models did not provide a good fit to the data (CFI < .90), but did suggest that care quality was a nonsignificantly stronger predictor when quality was in the high range. A dummy variable approach estimated adjusted means for the outcome for the 4 quality groups. All of these analyses suggested that children's cognitive-academic skills at 15 years were higher when they experienced higher quality care and that differences among the group means were larger at the higher end of quality than at the lower end. The two group spline model with a knot at the mean, ORCE caregiving sensitivity = 2.90, indicated that quality was significantly related to achievement in the higher quality range ( $B = 4.61$ ,  $SE = 1.84$ ,  $p = .01$ ,

$d = .12$ ), was not significantly related in the lower quality range ( $B = -.22$ ,  $SE = 1.60$ ,  $p = .89$ ,  $d = -.01$ ) and that the difference in the magnitude of the association was “marginally” different ( $B = 4.84$ ,  $SE = 2.91$ ,  $p = .097$ ,  $d = .14$ ).

Other analyses that looked at other ORCE values between 2.5 and 3.1 to define higher or lower quality groups did not yield substantially different findings, suggesting that our data may not be able to identify a single cut-point for defining thresholds. These follow-up analyses indicate that the quadratic approach provided the most parsimonious description of the nonlinear association between child care quality and cognitive/academic outcomes.

Because we had not detected the quadratic association between quality and cognitive-academic achievement at younger ages in our analyses that utilized somewhat different sets of covariates and analytic strategies, we re-examined possible links at these younger ages (54 months, grades 1, 3, and 5) using the SEM approach and covariates that were used in the current analyses. No significant relations between quality<sup>2</sup> and cognitive-academic achievement were detected at the younger ages in these re-analyses.

Finally, the association between higher child care quality and lower externalizing problems had not been detected in previous analyses at 54 months or elementary school (Belsky et al., 2007; NICHD ECCRN, 2002, 2003, 2005c), but those analyses also used somewhat different covariates and analytic methods. Therefore, follow-up analyses looked at externalizing ratings by the teacher at 4½ years, and in grades 1, 3, and 5 using the SEM approach and covariates described above. The SEM re-analysis detected one significant relation: quality of nonrelative care was a quadratic predictor of teacher reports of child externalizing behavior at grade 1 ( $B = -.07$ ,  $p = .02$ ). No other significant linear or quadratic associations between child care quality and children’s externalizing were detected between 4½ years and grade 6.

### Prior Functioning as Mediators

Next we sought to identify the pathways that might account for the associations between early child care and adolescent outcomes reported above. These analyses tested our hypothesis that observed associations between child care experiences and adolescent outcomes are due to the maintenance over time of earlier child care effects on child developmental outcomes. Due to complexity of the models, separate SEMs examined the pathways model for cognitive-academic achievement and the pathways model for the behavior outcomes. For these analyses, the initial SEM described in Figure 2 was modified to include child functioning at 4½ years, Grade 1, Grade 3, and Grade 5. Paths from the child care variables to both the 4½ year and 15-year outcomes were included as well as paths between repeated measures of the child functioning from 4½ years to Grade 5, allowing us to estimate a direct path from child care experiences to age 15 outcomes and a mediated path through the repeated assessments of prior functioning in that outcome domain.

The first pathway model tested the extent to which child care quality was related to age 15 academic achievement through the earlier associations between child care quality and academic achievement beginning at 4½ years. Figure 4 displays the standardized paths involving child care experiences and cognitive-academic achievement estimated by this model. The model fit these data adequately ( $\chi^2 = 2447.1$  (645);  $\chi^2/df = 3.70$ ; CFI = 0.88; RMSEA = 0.045). The indirect path between child care quality and academic achievement at age 15 through academic achievement prior to and during elementary school was statistically significant for child care quality ( $B = 1.23$ ,  $SE = .57$ ,  $p < .05$ ,  $d = .04$ ). In contrast, the corresponding direct pathways were statistically nonsignificant. This suggests that the observed association between child care quality and age 15 cognitive-academic

achievement can be explained at least partially by the association between child care quality and academic skills at entry to school, which was then maintained into high school. This mediated pathway account for 47% of the total association between quality and age 15 cognitive-academic achievement and 29% of the total association between quality-squared and age 15 cognitive-academic achievement.

A second pathway model tested the extent to which child care hours was related to youth reports of behavior problems, risk taking and impulsivity at age 15 though the maintenance of earlier teacher reported externalizing behaviors. The model fit these data adequately well despite the absence of latent variables in the model (RMSEA = 0.09). Results are shown in Figure 5.

Significant direct paths remained in these analyses from child care hours to age 15 assessments of risk taking ( $B = .007$ ,  $SE = .003$ ,  $p < .05$ ,  $d = .08$ ) and impulsivity ( $B = .07$ ,  $SE = .03$ ,  $p < .001$ ,  $d = .12$ ) and from child care quality to externalizing ( $B = -1.82$ ,  $SE = .86$ ,  $p < .05$ ,  $d = -.08$ ), remained suggesting that the hypothesized mediators—earlier caregiver/teacher-reported externalizing problems—did not account for most of the observed effect of hours on these adolescent behavioral outcomes although the mediated paths from child care hours through teacher ratings of externalizing behavior between preschool and grade 5 were significant for both risk taking ( $B = .001$ ,  $SE = .001$ ,  $p < .01$ ,  $d = .003$ ) and impulsivity ( $B = .002$ ,  $SE = .001$ ,  $p < .01$ ,  $d = .003$ ). As a percentage of the total effect, these mediated effects were small: 4% of the total path to risk taking and 3% of total path to impulsivity.

### Early Risk and Gender as Moderators

The final set of analyses addressed questions of moderation. One multiple group analysis tested familial risk and a second multiple group analysis tested gender as moderators of early child care effects.

A cumulative familial risk index was created as the standardized mean of maternal education (reflected), mean income/needs from 6–54 months (reflected), proportion time with single parent 6–54 months, mean HOME total score 6–54 months (reflected) and mean maternal sensitivity 6–54 months (reflected). Families in the top quartile (high risk), middle 50%, and bottom quartile were compared to test hypotheses about compensatory effects and lost resources. Families in high risk group had, on average, mothers with less than a high school education, an income to needs ratio of less than 1.3, CES-D depressive symptoms of 15.5, and a husband-partner less than 50% of the time. The low risk group had, on average, mothers with a B.A. or more, income to needs ratio, of 6.7, a husband/partner 99% of the time, and CED-D depressive symptom scores of 5.1.

A multi-group SEM allowed for different path between child care experiences and 15-year outcomes for the three risk groups. Due to the complexity of the multiple group SEMs for the three risk groups, separate models tested risk as a moderator for the behavioral outcomes and for the cognitive-achievement outcomes. The high correlation between hours of nonrelative care and time in center care prevented the multi-group analyses from converging so separate models were run to look at hours and center care as moderators

The overall Likelihood-Ratio test between the model with and without separate paths from child care experiences to behavioral outcomes was not reliably different among the three risk groups for the model that included hours and quality ( $\chi^2(724) = 28.72$ ,  $p = 0.99$ ) or for the model that included center care and quality ( $\chi^2(838) = 58.26$ ,  $p = 0.14$ ), suggesting no support for the compensatory hypothesis (i.e., stronger positive paths for high-risk children) or the lost resources hypothesis (i.e., stronger negative paths for low-risk children).

Similarly, no evidence emerged in the analysis of the cognitive-academic achievement outcomes supporting either the compensatory or lost resources hypotheses.

A similar strategy was used to test whether gender moderated associations between the child care variables and age 15 outcomes. Again, the Likelihood-Ratio test between the model with and without gender specific paths from child care experiences to child outcomes was nonsignificant, Likelihood-Ratio test  $\chi^2(206) = 243.8, p = 0.13$ , suggesting that gender did not moderate these associations.

## DISCUSSION

This latest installment in a 15-year longitudinal study of the effects of early child care on academic and behavioral development addressed three questions: (1) Are early child care quality, quantity, and type related to adolescent functioning (cognitive-academic achievement and behavior problems) at age 15? (2) Are pathways from early child care to adolescent functioning mediated through prior functioning? and (3) Are relations between early child care and adolescent development moderated by either child gender or familial risk? Results pertaining to cognitive-academic achievement at age 15 are discussed first, followed by those pertaining to behavior problems.

### Cognitive-Academic Achievement at Age 15

A relatively consistent finding across 40 years of child care research is that quality and type of care are related to cognitive, academic, and language functioning in young children (Belsky & Steinberg, 1978; Lamb & Ahnert, 2006; Vandell, 2004). Previous findings from the NICHD SECCYD are consistent with this conclusion. At 4½ years, higher quality care predicted higher levels of pre-academic skills ( $d = .16$ ) and language ( $d = .10$ ), while more exposure to center-type care predicted better language ( $d = .11$ ) and memory ( $d = .11$ ) (NICHD ECCRN, 2002). In this report of adolescent functioning measured more than 10 years after the children had left child care, we find early child care quality continues to predict cognitive-academic achievement. The size of the effect ( $d = .09$ ) is similar in magnitude to that detected at 4½ years.

This evidence of long-term effects of early child care quality is noteworthy because it occurred in a large economically and geographically diverse group of children who participated in routine nonrelative child care in their communities. Previous long-term studies have focused on high-quality interventions aimed at children at risk because of poverty or low birthweight. The current findings suggest that the quality of early child care experiences can have long-lasting (albeit small) effects on middle class and affluent children as well as those who are economically disadvantaged.

In addition to a linear relation between child care quality and adolescent cognition, we detected a significant quadratic relation at age 15 (effect size = .07). This quadratic effect indicated that child care quality was linked to academic outcomes for those adolescents whose care, on average was of moderate quality or better, with the magnitude of the quality effects being larger at higher levels of quality. Intriguingly, similar findings have been reported in an 11-state PreK evaluation that examined concurrent associations between child care quality and academic outcomes (Burchinal, Vandergrift, & Pianta, 2009). That study also reported escalating effect sizes linked to quality in the moderate to high quality range.

These two studies, taken together, underscore two points: that larger gains in cognitive-academic outcomes appear to accrue when children experience care of high quality, and that improvements in child care quality in the moderate to high range may be needed to yield measurable long-term benefits.

This report is the first paper from the SECCYD data set to report this nonlinear quality effect, which raises the question of whether the effect was present at earlier ages but not detected because of different analytic strategies or whether this is a “new” finding (“a sleeper effect”). To address the first possibility, we examined relations between the quadratic term and earlier cognitive-academic functioning using the same models and operational variables as the current study. We found no evidence of a quadratic relation at earlier ages. So, the quadratic relation may be viewed as a sleeper effect. It remains to be seen whether this nonlinear effect carries forward to late adolescence and early adulthood or is found for other developmental domains.

Additional research is needed to better understand *why* the longer term effects in adolescence were evident only when early quality was in the moderate to high range. One possibility is that high school students bear much greater responsibilities for their own academic progress whereas instruction for younger students is more closely monitored and supervised. Students who had attended higher quality programs (and who had excelled cognitively and academically) may be better positioned to oversee their own achievement in high school.

### Mediated Pathways

An additional issue examined in the current report was the mechanism or processes that might mediate the long-term relation between early child care and age 15 functioning. It was anticipated that the cognitive-academic benefits of child care quality observed at 4½ years would be carried forward to age 15 through functioning during middle childhood. As hypothesized, this mediated pathway was significant, accounting for 47% of the linear path and 29% of the quadratic path from child care quality to adolescent cognitive functioning. These results are consistent with theory and empirical evidence that emphasize developmental continuities whereby competencies in one period set the stage for and are then carried forward to later periods (Bronfenbrenner & Morris, 2006; Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Campbell et al., 2001). Because school achievement is largely cumulative, it is not a surprise to find that higher achievement in adolescence is linked to higher achievement in earlier periods.

### Behavior Problems

Another consistent finding in the literature is that more hours in child care and more center-type care are related to higher levels of behavior problems in young children (Belsky, 2001; Lamb & Ahnert, 2006; Loeb et al., 2007). Previous findings from the SECCYD support this observation. At age 4½, caregivers reported higher levels of externalizing behaviors for children who were in care for more hours ( $d = .16$ ) and who had more center-type experience ( $d = .11$ ) (NICHD ECCRN, 2002). In this paper, surprisingly similar relations were detected between child care hours and problem behaviors at age 15. Higher hours predicted reports by the adolescents of more risk taking ( $d = .09$ ) and greater impulsivity ( $d = .13$ ). These effect sizes are similar in magnitude to the relation between hours and caregivers' reports of externalizing behavior problems originally detected at 4½ years.

We then sought to determine the extent to which associations between child care hours and age 15 problem behaviors were mediated by behavior problems at 4½ years that were carried forward. Although we found statistically significant evidence of mediation, this mediated path accounted for only 3–4% of the effect of child care hours on adolescent problem behaviors. This modest level of mediation is likely due to two factors. The informant who reported the behavior problems changed from the caregivers in early childhood and teachers in middle childhood to the adolescent in the current report. In addition, two of the three measures at 15 years assessed somewhat different aspects of

behavior problems, ones that are particularly pertinent to adolescence: risk taking and impulsivity. Thus, although there is a large literature documenting continuity in behavior problems between childhood and adolescence (Farrington, in press), we suspect that the very modest levels of mediation detected in the present analyses are due to these changes in measurement.

Our age 15 analyses also revealed a relation between higher quality nonrelative child care and less externalizing behavior. This relation harkens back to findings detected when children were toddlers, when higher quality child care predicted fewer behavior problems at age 2 years and age 3 years according to caregivers (NICHD ECCRN, 1998). We did not, however, find similar associations at 4½ years or middle childhood (Belsky et al., 2007; NICHD ECCRN, 2002, 2003, 2005c). Because the current analyses varied in a number of ways from those conducted at earlier ages, follow-up analyses examined externalizing at age 4½ years and middle childhood using the same SEM models conducted for all analyses in this paper. Some modest associations were found in these re-analyses, indicating that the link between higher quality of nonrelative care and fewer externalizing problems may not be as “new” as it might otherwise appear.

### Small Enduring Effects

Although the obtained child care effects on cognitive-academic outcomes and problem behaviors are small by conventional standards, we would argue that they should not be dismissed. First, they endured over a 10-year period at roughly the same size, suggesting a consistent pattern of relations. Second, as observed by McCartney and Rosenthal (2000), it is useful to benchmark effects against those reported in other studies that have been judged to be important or meaningful. A useful comparison to the current study is the 18-year follow-up of the participants in the Infant Health and Development Program (McCormick et al., 2006), an intensive early intervention program for low birthweight children that included home visits in the first 3 years and high-quality center care for 1–3 years. The IHDP reported significant effects for the heavier babies: effect sizes of .34 on math achievement and .27 for (reduced) risky behaviors at the 18-year follow-up, and no effects for the smallest of the low-birthweight babies. The long-term effects associated with quality and quantity of child care in the SECCYD after 10 years are 29% to 44%, respectively, as large as those found for the heavier infants in this *intensive* experimental intervention.

A third reason not to discount the findings is that child care, often full-time care beginning very early in life, has become a normative experience for American children, meaning that the number of children directly affected by child care is large. Small effects distributed over many people may have cumulative influences. Indeed, recent evidence suggests that children without child care experience may be influenced by their classmates with early child care. Children in kindergarten classrooms in which there were higher proportions of children with child care experience evinced better academic achievement but also more behavior problems than children in less child-care saturated classrooms, even when the children themselves had not attended child care (Dmitrieva, Steinberg, & Belsky, 2007). Future research should more carefully examine such peer effects at older ages, especially as they may have implications for detecting child care effects over the longer term (Belsky, 2009).

### No Evidence of Moderation

Although two recent long-term follow-ups of early educational interventions have reported gender moderated effects (Anderson, in press; Belfield, et al., 2006), we found no evidence of differential child care effects as a function of child gender in either cognitive-academic performance or problem behaviors. This result is entirely consistent with findings discerned at earlier ages. Because our sample size is large and there is good variability in the measures

of child care experience and child functioning, it seems unlikely that the absence of significant gender-moderated child care effects can be attributed to lack of statistical power. Perhaps secular changes in the 1990s, when maternal employment and nonmaternal child care became normative (i.e., characteristic of the majority of households in the U.S.), contributed to the similar developmental pathways among males and females observed in the current study.

Evidence that high-quality care and/or center care are especially beneficial for economically disadvantaged children has emerged in a number of studies (Gormley et al., 2005; Loeb et al., 2007; Magnuson et al., 2007). We, however, did not detect any evidence that the effects of early child care (in quality, hours, type) on adolescent outcomes were moderated by familial risk, a pattern consistent with previous reports of the SECCYD (Belsky et al., 2007; NICHD ECCRN, 2002, 2005c). Our high-risk and low-risk groups were decidedly different from one another. However, the exclusion of adolescent mothers and non-English speakers from the study may have limited our power to evaluate adequately this differential effect.

### No Evidence of Long-Term Effects of Center Care

Robust center care effects have been chronicled in several large nationally representative surveys (Loeb et al., 2007; Magnuson et al., 2007), as well as evaluations of state pre-kindergarten initiatives (Gormley et al., 2005). Previous analyses of the SECCYD also have detected center care effects on both cognitive and social outcomes at every age through sixth grade. One of the most surprising findings of the current analyses was the failure to detect reliable associations between the proportion of time spent in center care and the age 15 outcomes explored in this report. One possible explanation is that children who experienced longer hours tended to have more center care ( $r = .51$ ), thereby masking unique center care effects. However, this explanation was ruled out when follow-up analyses failed to discern center care effects even when hours were excluded from the model. Interestingly, another recent analysis based on the SECCYD did detect relations between center-type care and other age 15 outcomes—more center-type care experience was linked to blunted awakening cortisol levels (Roisman et al., in press)—so it would seem misguided to conclude broadly that by mid adolescence type of care no longer predicts children's development. As we continue to follow the sample, it will be important to determine if center care effects on cognitive and social functioning re-emerge in late adolescence or early adulthood.

There are limitations to the study that should be noted. First, the study design is correlational, not experimental. So, analyses were tests of associations, not causation. Although extensive covariates were included in the analyses, omitted variables may account for the obtained effects. Second, although the sample was diverse economically and geographically, the study sample was not constructed to be nationally representative.

### Conclusion

Perhaps the most important findings of this report from the SECCYD is that the effects of early child care quality on cognitive-academic achievement and early child care hours on problem behaviors were evident in mid-adolescence, more than a decade after the children had transitioned from child care to elementary school. Effect sizes were small but comparable in size to those detected at earlier ages. These findings extend research from other projects that documented the impact of high-quality child care interventions for economically disadvantaged children into adolescence and adulthood. The current study is the first to document relations between routine nonrelative child care and adolescent functioning for children from economically diverse families.



It remains to be determined whether, as individuals develop from adolescence into adulthood, the apparent consequences of child care are sustained, dissipate, or increase. To the extent that early child care quality increases cognitive-academic skills, it will be important to learn whether subsequent educational attainment in high school and beyond is related to early child care experience. And, to the extent that early child care increases adolescent impulsivity and risk taking, it is important to follow individuals into late adolescence, when opportunities for engaging in risky behavior increase and the capacity for self-regulation is still not fully mature.

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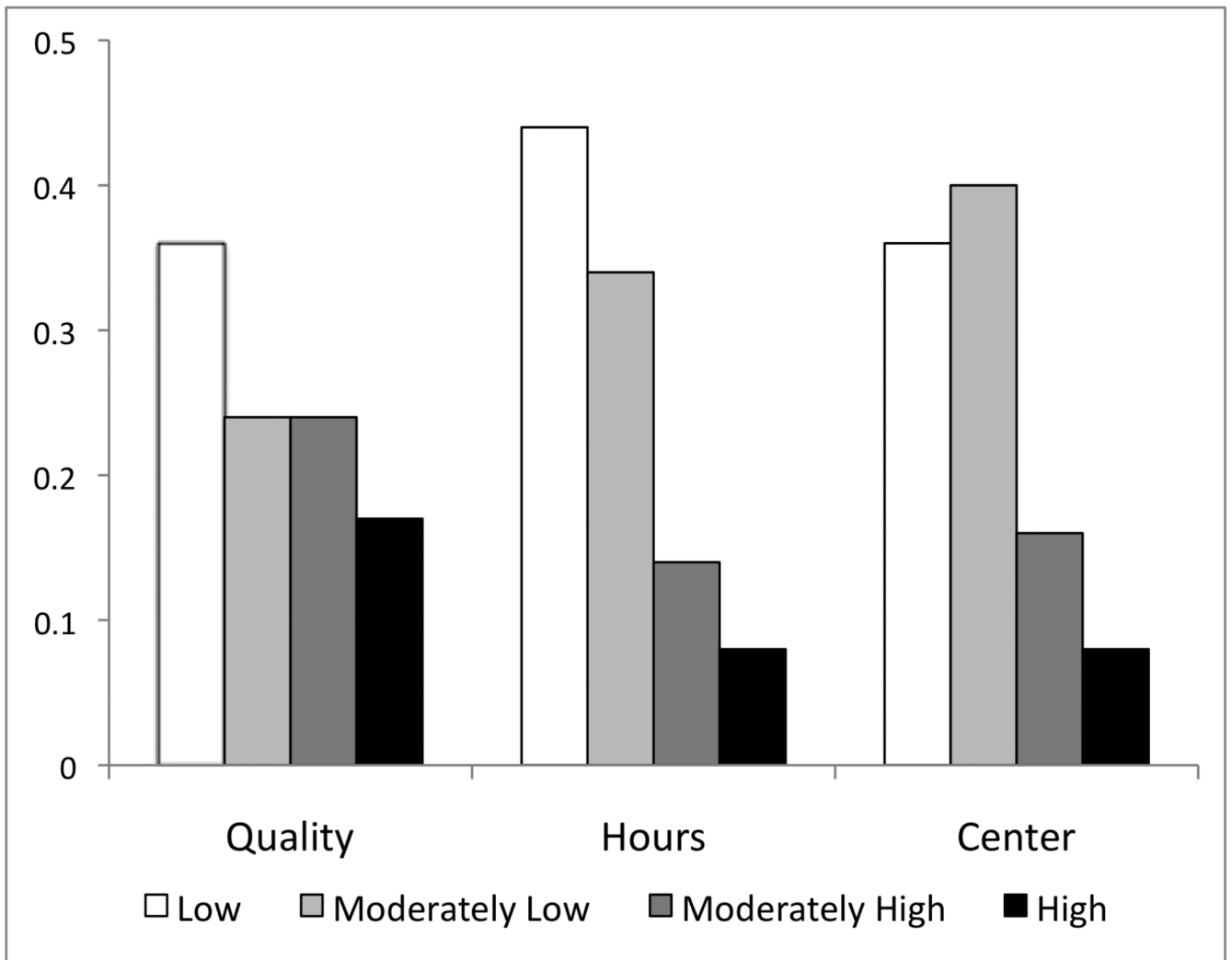
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**Figure 1.**

Distribution of Quality, Hours, and Type of Nonrelative Child Care

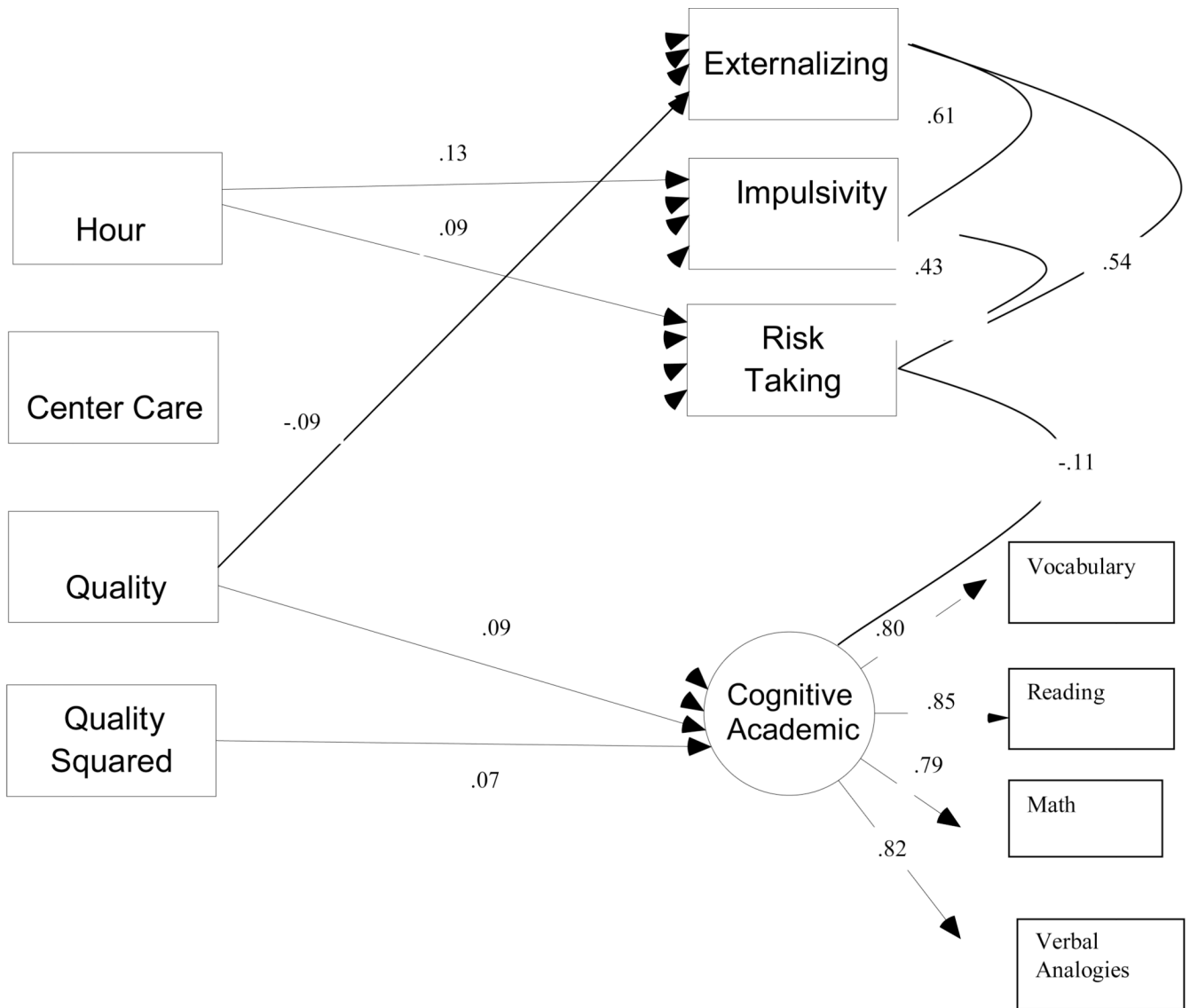
Note:

Quality categories: Low: ORCE = < 2.75; Moderately Low: ORCE = 2.75 to < 3.0;

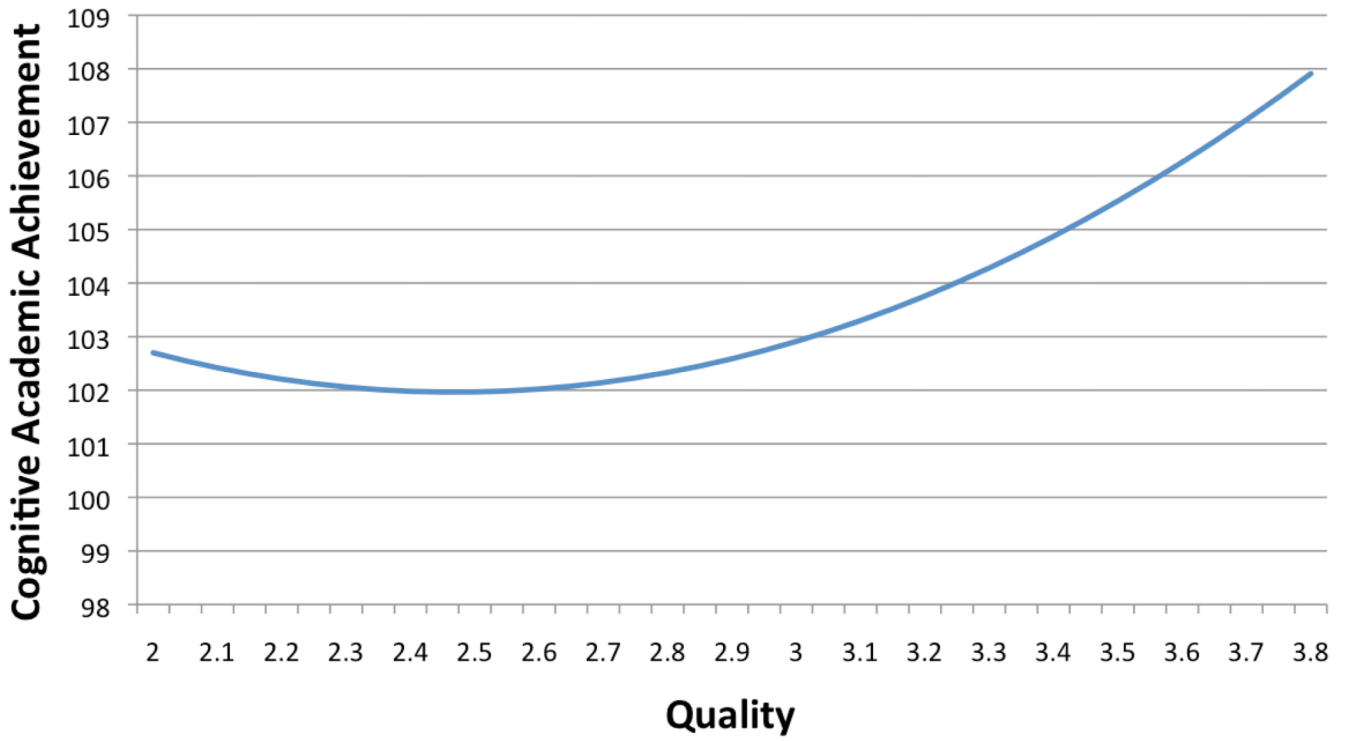
Moderately High; 3.00 to < 3.30, High: ORCE = 3.30 – 4.00

Hours categories: Low: <10 hrs., Moderately Low: 10 to <30 hrs; Moderately High 30 to 40;  
High >40

Center categories: Low = 0, Moderately Low: > 0 but less than 33%; Moderately High:  
33% to <67%; High: 67%–100%

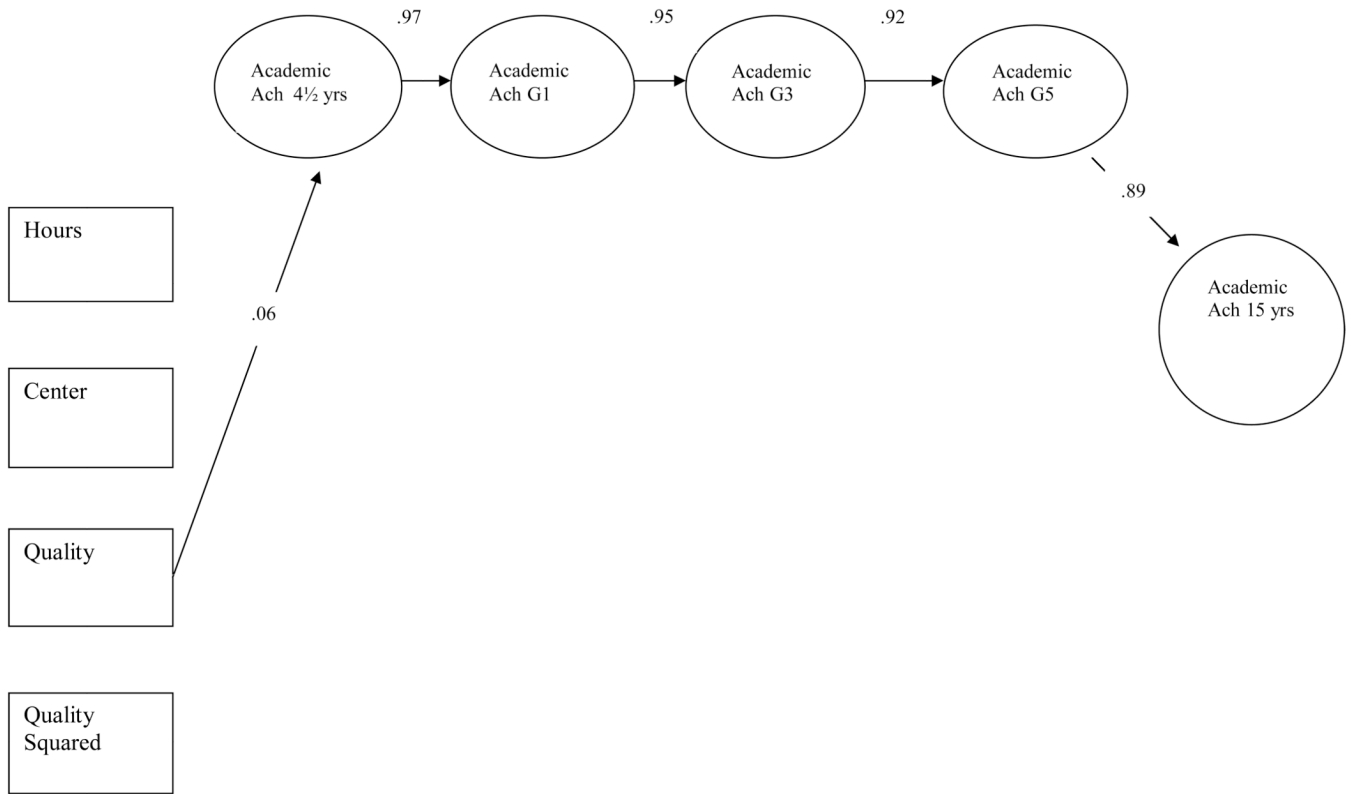


**Figure 2.** Standardized Path Coefficients in Structural Equation Models Relating Child Care Experiences to 15-Year-Outcomes  
 Note: Only statistically significant paths are shown. Covariates include site, gender, ethnicity, maternal education, maternal PPVT-R, maternal adjustment, elementary school classroom quality and repeated assessments from early childhood, middle childhood, and adolescence of family income, proportion time mother had a husband/partner, maternal depressive symptoms, and parenting quality.



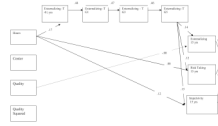
**Figure 3.** Predicting Cognitive-Academic Achievement from Child Care Quality using Quadratic Regression





**Figure 4.** Pathway Structural Equation Model Testing of Prior Academic-Cognitive Achievement as a Mediator of the Link Between Child Care Quality and Age 15 Academic-Cognitive Achievement

Note: Only significant paths are depicted. Covariates were site, gender, ethnicity, maternal education, maternal psychological adjustment, maternal PPVT-R, elementary school classroom quality, and repeated assessments of family income, proportion time mother had a husband/partner, maternal depressive symptoms, and parenting.



**Figure 5.**  
 Pathway Structural Equation Model Testing Teacher Ratings of Externalizing at Earlier Time Periods as a Mediator of the Link Between Child Care Hours and Quality and Problem Behaviors at Age 15  
 Note: Solid dark lines depict significant paths. Covariates include site, gender, ethnicity, maternal education, maternal PPVT-R, maternal psychological adjustment, elementary school classroom quality and repeated assessments of family income, proportion time mother had a husband/partner, maternal depressive symptoms, and parenting quality.

**Table 1**

## Descriptive Statistics for Child Care Variables and Covariates

		Early Childhood	Middle childhood	Adolescence
Child Care				
Hours	N	1214		
	M	16.48		
	(sd)	(14.16)		
Quality	N	1005		
	M	2.90		
	(sd)	(0.45)		
% Center	N	1214		
	M	0.21		
	(sd)	(0.26)		
Covariates				
Male	N	1364		
	%	52%		
Race	N	1364		
Black	%	13%		
Hispanic	%	6%		
White	%	76%		
Other	%	5%		
Maternal Education	N	1363		
	M	14.23		
	(sd)	(2.51)		
Maternal PPVT-R	N	1167		
	M	99.01		
	(sd)	(28.35)		
Maternal Adjustment	N	1272		
	M	59.00		
	(SD)	(13.95)		
Income/needs Ratio	N	1302	1140	924
	M	3.60	4.19	5.26
	(sd)	(2.85)	(3.37)	(5.79)
% Time 2-Parents	N	1305	1154	979
	M	84	81	77
	(sd)	(32)	(34)	(42)
Maternal Depression	N	1304	1123	973
	M	9.36	8.74	10.48
	(sd)	(6.76)	(7.32)	(9.83)
Parenting Composite	N	1306	1306	1306
	M	-.03	-.03	-.03
	(sd)	(.73)	(.73)	(.73)
Classroom Quality Composite	N		1100	
	M		3.27	
	(sd)		(5.79)	

Table 2

Descriptive Statistics for Child Outcomes at Age 15 and Earlier Ages

Child Outcomes	Measurement Periods					
	Age 15	4½ yrs	Grade 1	Grade 3	Grade 5	
Cognitive-Academic Composite	N	1060	1026	1016	993	
	M (sd)	106.1 (13.1)	100.6 (12.5)	109.4 (13.1)	110.9 (13.2)	107.2 (13.2)
WJ Vocabulary	N	889	1060	1020	1014	992
	M (sd)	99.9 (14.8)	100.2 (15.3)	105.5 (15.6)	105.5 (14.8)	103.9 (14.8)
WJ Reading <sup>a</sup>	N	887	1056	1025	1011	993
	M (sd)	107.7 (15.7)	98.9 (13.5)	120.0 (15.8)	111.1 (14.0)	107.9 (13.9)
WJ Math <sup>b</sup>	N	887	1053	1023	1012	993
	M (sd)	102.9 (14.2)	102.9 (15.6)	110.8 (17.1)	116.3 (17.3)	110.7 (17.4)
WJ Analogies	N	891				
	M (sd)	113.7 (16.0)				
Externalizing <sup>c</sup>	N	956	705	1007	982	927
	M (sd)	49.3 (9.9)	50.2 (9.6)	50.7 (8.7)	51.5 (9.4)	51.0 (9.2)
Risk Taking	N	954				
	M (sd)	37.63 (19.5)				
Impulsivity	N	957				
	M (sd)	-35.1 (9.0)				

Note

<sup>a</sup>Reading measures were Woodcock-Johnson Passage Comprehension at age 15, Broad Reading in Grades 3 and 5, and Letter-Word Identification at 4½ years and Grade 1<sup>b</sup>Math measures were Woodcock-Johnson Applied Problems at 4½ years, Grade 1, and age 15, and Broad Math in Grades 3 and 5<sup>c</sup>Externalizing measure was Youth Self Report at 15 years and Teacher Report at all other ages

**Table 3**

Correlations Among Child Care Variables and Child Outcomes

Variable	Hours	Child Care Quality	Center
<u>Child Care</u>			
Hours	1.00		
Quality	-0.20	1.00	
Center	0.51	-0.18	1.00
<u>15 year Outcomes</u>			
Achievement Age 15	0.04	0.23	0.05
Externalizing Age 15	0.02	-0.11	-0.04
Impulsivity Age 15	0.08	-0.10	0.02
Risk Taking Age 15	0.04	-0.12	0.02
<u>Hypothesized pathways</u>			
Achievement 4½ yr	0.10	0.22	0.08
Achievement G1	0.11	0.16	0.11
Achievement G3	0.09	0.15	0.07
Achievement G5	0.08	0.18	0.05
Externalizing 4½ yr	0.20	-0.17	0.16
Externalizing G1	0.17	-0.11	0.11
Externalizing G3	0.10	-0.15	0.10
Externalizing G5	0.05	-0.11	0.04

Note. G1 = Grade 1; G3 = Grade 3; G5 = Grade 5

**Table 4**  
Path Coefficients from SEM Relating Child Care Experiences to 15-Year-Outcomes

	<u>Cognitive-Academic Achievement</u>			<u>Externalizing</u>			<u>Risk Taking</u>			<u>Impulsivity</u>		
	B	SE	D	B	SE	d	B	SE	d	B	SE	d
Hours	0.02	(0.03)	.03	0.03	(0.03)	.04	<b>0.008*</b>	(.003)	<b>.09</b>	<b>.08***</b>	( <b>0.03</b> )	<b>.13</b>
Center Care	1.11	(1.74)	.02	-0.95	(1.51)	.02	-0.15	(0.18)	-0.03	-1.39	(1.25)	-0.04
Quality	<b>2.62***</b>	( <b>0.99</b> )	<b>.09</b>	<b>-1.89*</b>	( <b>0.86</b> )	<b>-.09</b>	-0.10	(0.10)	-0.04	-0.97	(0.78)	-0.05
Quality Squared	<b>3.35***</b>	( <b>1.50</b> )	<b>.07</b>	-0.78	(1.30)	-0.02	-0.25	(0.15)	-0.06	-0.92	(1.17)	-0.03

*Note:* Model also includes as covariates site, gender, maternal education, maternal PPVT, maternal adjustment, early childhood risk index, ethnicity, elementary school classroom quality and repeated assessments of family income, proportion time mother had husband/partner, maternal depressive symptoms, and parenting.

A square root transformation was applied to risk taking due to its skewed distribution.

\* p < 0.05,

\*\* p < .01;

\*\*\* p < .001

*d* is analogous to the effect size measure Cohen's *d*, computed as  $B \cdot SD_{\text{predictor}} / SD_{\text{outcomes}}$ .