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Mechanisms of Effects of an Early Intervention Program on Educational Attainment: A Gender Subgroup Analysis

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Abstract

The purpose of the study was to explore whether the processes that account for the link between participation in the Chicago Child-Parent Center (CPC) Program and educational attainment differed by gender. Five mechanisms derived from previous studies, i.e., cognitive advantage, family support, social adjustment, motivational advantage, and school support, were investigated.

The study sample included 1,334 youth (682 females and 652 males) from the Chicago Longitudinal Study. Structural equation modeling was used to investigate pathways of effects of preschool participation on educational attainment.

Findings suggest that cognitive advantage played a more important role for males than for females, and family support played a more important role for females than for males. Motivational advantage and social adjustment hypotheses were not significant mediators for either females or males, although they contributed to the overall model fit. Motivational advantage seemed to play a more important role for males. Findings provide directions for future investigation of the two groups.

Keywords

pathways; long-term intervention effects; early intervention programs; gender difference; educational attainment

Early intervention programs have been linked to positive developmental outcomes, such as better school achievement, higher educational attainment, and lower rate of delinquency (Barnett, 1995; Campbell, Helms, Sparling & Ramey, 1998; Reynolds, Temple, Robertson & Mann, 2001; Yoshikawa, 1995). In the past decade, a new research focus has emerged: how are those programs associated with long-term effects? However, such pathways have only been studied recently (Barnett, Young, Schweinhart, 1998; Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997; Ramey, Campbell, & Ramey, 1999; Ou, 2005; Reynolds, Ou, & Topitzes, 2004).

Among few studies, the Chicago Child-Parent Center (CPC) program is the only large-scale program that was examined for its pathways to long-term outcomes. Mechanisms of long-term effects of the CPC Program on academic performance and educational attainment have been

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examined in several studies (Ou, 2005; Reynolds, 1992, 2000; Reynolds, Mavrogenes, Bezruczko & Hagemann, 1996; Reynolds et al., 2004). Built on the findings from previous studies, the present study further explored the differences between gender subgroups.

Child-Parent Center (CPC) Program

The Child-Parent Center (CPC) Program is a center-based early intervention funded through Title I. It serves three- and four-year-olds who come from families in high-poverty neighborhoods that are not being served by Head Start or other early intervention programs. The CPC program is designed to promote children's school competence, especially school readiness and academic achievement. The services provided are from preschool to early elementary school. The components of the CPC Program include parental involvement, a child-centered focus on the development of reading/language skills and comprehensive services (Reynolds, et al. 1996; Sullivan, 1971). The comprehensive services include (a) attending to children's nutritional and health needs (i.e., free breakfasts and lunches and health screening), (b) coordinated adult supervision, including a CPC head teacher, parent resource teacher, school-community representative, and a teacher aide for each class, (c) funds for centralized in-service teacher training in child development as well as instructional supplies, and (d) emphasis on reading readiness through reduced class size, reading and writing activities in the learning center, and reinforcement and feedback (Reynolds, et al. 1996). See Reynolds (2000) for more information regarding the CPC program.

Pathways of Effects of Early Intervention Programs

Many studies have demonstrated significant associations between participation in early intervention programs and positive outcomes. However, only a few studies examined mechanisms that explain the long-term effects of early intervention programs (Barnett et al., 1998; Berrueta-Clement, Schweinhart, Barnett, Epstein & Weikart, 1984; Schweinhart, Barnes & Weikart, 1993; Schweinhart & Weikart, 1997; Reynolds et al., 2004). See Ou (2005) for a review on mechanisms of long-term effects of early intervention programs.

Researchers suggested some hypotheses concerning pathways of effects (Barnett et al., 1998; Campbell et al., 1998; Campbell, Pungello, Miller-Johnson, Burchinal & Ramey, 2001; Reynolds, 2000; Royce, Darlington & Murray, 1983). Incorporating program theories and literature, Reynolds (2000) proposed five hypotheses for pathways of long-term effects of early intervention programs. The five hypotheses include cognitive advantage, family support, school support, motivational advantage, and social adjustment hypotheses. The first two hypotheses were mentioned most in other studies. According to the cognitive advantage hypothesis, positive effects of preschool on cognitive development at school entry launch children toward positive scholastic development and commitment that facilitates improved developmental outcomes in adolescence and beyond. As the rationale behind early intervention, the cognitive advantage hypothesis has been consistently supported (Barnett et al., 1998; Campbell et al., 2001).

According to the family support hypothesis, long-term effects of interventions will be more likely to occur if family functioning and behavior have been improved, including parenting skills and attitudes, and involvement in children's education. The cognitive advantage and family support hypotheses, suggest that cognitive enhancement and parent involvement are important components of early intervention programs, which may account for long-term effects. The school support hypothesis predicts that the program will increase the probability of children's attendance in high-quality schools and reduce the probability of school mobility, and then affect educational attainment. The motivational advantage hypothesis predicts that the program will boost children's achievement motivation, including task persistence, self-efficacy, perceived competence, or other self-system attributes, and that motivation will

influence educational attainment. The social adjustment hypothesis predicts that the program will influence children's social development, such as socioemotional adjustment, and then social development will improve the ultimate child outcome-educational attainment.

The five hypotheses were tested for their associations between participation in the CPC Program, and school achievement, high school dropout and high school completion (Ou, 2005; Reynolds, 2000; Reynolds et al., 2004). Recent results indicated that the family support and cognitive advantage hypotheses significantly mediated the effects of the CPC program, which is consistent with findings from previous studies. The school support hypothesis moderately mediated the effect, but the social adjustment and motivational advantage hypotheses did not significantly mediate the effects of the CPC program. The five hypotheses were used as a framework in the present study.

Gender Differences

Many theories have been applied to the processes of gender socialization (Fagot, Rodgers, & Leinbach, 2000). Environmental influences (e.g. family, peers, and caregivers) are important for children's gender socialization because such influences serve different function for males and females. For instance, school environments may have opposite effects on the academic performance of boys and girls. Research indicates that school environments serve more of a social function than an educational purpose for boys and social influences can have negative effects on boys' desire for academic success, leading them to disdain or disengage from academics. In contrast, no such effect has been found for girls. By getting good grades and performing difficult assignments, girls gained status from their classmates (Adler, Kless, and Adler, 1992; Coleman, 1961).

Close interpersonal relationships appear to be more important for girls than for boys (Gore, Aseltine, & Colten, 1993; Hankin, Mermelstein, & Roesch, 2007; Maccoby, 1990). Males may be more individualistic whereas females are more likely to develop connections with others (Miller, 1990). Features that distinguish adolescent females' social relations from those of males include intimacy, emotional support, and self-disclosure (Rose, 2002; Rose & Rudolph, 2006), while for males, their relationships may be characterized by companionship and shared activities (Maccoby, 1990). Social relationships seem to be a more important element in the lives of females than those of males, and this interpersonal orientation may put females at greater risk for depression when they encounter interpersonal difficulties (Aube, Fichman, Saltaris, and Koestner, 2000; Hankin & Abramson, 2001; Kaplan, 1986). Adult females are known to have higher rates of depression than adult males (Kuehner, 2003; Nolen-Hoeksema, 1987). See Eckes and Trautner (2000) for more on gender differences. Given these differences in gender socialization, it is expected that the mechanisms underlying the long-term effects of early intervention might vary by gender.

Differential Processes by Gender

Researchers have examined whether the magnitude of the effects of early intervention differed by subgroups (Lally, Magnione & Honig, 1988; Oden, Schweinhart & Weikart, 2000; Reynolds, 2000; Schweinhart et al., 1993; Seitz, Apfel, Rosenbaum & Zigler, 1983), and gender subgroup was examined most frequently. Although most findings showed that associations between participation in early intervention and school related outcomes were larger or lasted longer for females than for males (Barnett et al., 1998; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Lally et al., 1988; Oden et al., 2000), findings from the CPC Program have consistently favored males (Ou & Reynolds, 2006; Reynolds, 2000; Reynolds et al., 2001).

Magnitudes of associations on non-school outcomes, such as arrests and earnings, were larger for males than for females in some studies (Schweinhart et al., 1993; Reynolds et al., 2001). Some studies, however, found no difference in magnitudes of associations by gender (Campbell et al., 1998; Lazar, Darlington, Murray, Royce & Snipper, 1982; Royce et al., 1983). Nevertheless, Barnett et al. (1998) suggested that completely different causal models of long-term effects of early intervention programs on cognitive development and school success might be justified for females and males.

Because findings from the CPC Program have consistently shown that males benefited more from the CPC program than females (Reynolds, 2000; Reynolds et al., 2001; Ou & Reynolds, 2006), and given the known male/females differences in the process of gender socialization, it is important to examine if the pathways of long-term effects of early intervention vary by gender. A gender subgroup analysis of the CPC data is conducted in the present study for the first time. The research question addressed in the present study is whether the 5 pathways hypothesized to link early intervention to educational attainment within the CPC (cognitive advantage, family support, social adjustment, motivation advantage, and school support hypotheses) vary by gender.

Significance of the Present Study

The present study advanced knowledge in the field in several ways. First, a gender subgroup analysis of the mechanisms of long-term effects of early intervention has not been conducted previously due to limitations in sample sizes in intervention studies. Second, since the early 1950s the educational attainment of women has increased more than that of men, reversing the historical educational attainment advantage obtained by men (Charles & Luoh, 2003; Cohen & Nee, 2000). Some investigators suggested that differential socialization processes by gender might explain women's higher educational attainment (Pomerantz, Altermatt & Saxon, 2002). The present study provided insight on how predictors of educational attainment account for the link between program participation and educational attainment vary by gender. Third, the present study used a more comprehensive set of mediators that better reflect the conceptual framework of the mediational process of intervention effects established in previous studies.

A Hypothesized Model

Figure 1 presents the hypothesized model, a framework based on the five hypotheses: cognitive advantage, social adjustment, family support, motivational advantage, and school support hypotheses. These hypotheses represent concepts of five mediators between preschool participation and educational attainment, shown in the center boxes. Indicators of the hypotheses are shown under each mediator. Those indicators are further described in measures section. The boxes on the extreme left and right represent covariates, preschool participation, and educational attainment. Overall, program participation is expected to be associated with all concepts in the model, and all other concepts are associated with the ultimate outcome—educational attainment. Covariates are associated with all concepts in the model as well. However, to simplify the model, the paths are not shown except the path from covariates to preschool participation.

Method

Sample and Data

The study sample was drawn from the Chicago Longitudinal Study (CLS, 2005), an ongoing investigation of the school adjustment of a panel of low-income minority children growing up in high-poverty neighborhoods in Chicago. The original sample ($N = 1,539$) included 989 children who entered the CPC program in preschool and graduated from kindergarten in 1985-86 from 20 Child-Parent Centers, and 550 children (a comparison group) who came from

five randomly selected Chicago public schools with kindergarten programs in 1985-86 without CPC preschool experience. Because they lived in Title I eligible neighborhoods, all children in this cohort were eligible for and participated in government-funded early childhood programs. Continuously promoted children graduated from high school in 1998. The sample in the present study included 1,334 youth (86.7% of the original sample) for whom educational attainment could be determined by May 2002 (mean age = 22.0). Data have been collected by the CLS from various sources, such as children, parents, teachers, and school records. Data on educational attainment were obtained from administrative records in all schools youth attended and were supplemented by interviews with family members.

Table 1 shows the similarity of the study sample (N=1,334) attributes for the preschool group and the comparison group at the time of program entry or as soon afterwards as possible. Attributes include background information, such as gender, race/ethnicity, family risk status, parents' educational attainment and family structure. The *p*-values for the original sample are provided for comparison between the original sample and the study sample.

There was no significant difference between the CPC and the comparison groups in most of the attributes, but there were significant differences in some characteristics, such as gender, parents' education, family size, and percentage of children in the school area in which 60% or more of children resided in low-income families. In the original sample, there were also significant differences between groups in those attributes except gender. In the present study sample, the CPC preschool group had a greater proportion of females than the comparison group, but numbers of females and males were evenly split in the original sample. Parents were more likely to have completed high school at child's age 8 in the CPC group than the comparison group. The CPC group had a smaller average family size than the comparison group. Also, the CPC group participants were more likely than children in the comparison group to live in a high poverty neighborhood, and the parents were more likely to be not employed by child's age 8.

Measures

Educational Attainment

High school completion: This dichotomously coded variable indicates whether youths completed their secondary education with an official diploma or were awarded a General Education Development (GED) credential. All others, including those who remained in high school, were coded as non-completers. The reliability was set at .95 in the model.

Highest grade completed: Highest grade completed by participants was coded as a continuous variable, ranging from 7 to 16. College attendance and GED attainment were taken into account in this variable. Obtaining a GED was coded 12, and college attendance was coded depending on credits that one earned. Thirty credits were treated as a year of college attendance. For example, 30 earned credits was coded 13, and 60 earned credits was coded 14. The sample size was 1,315 due to missing values. The reliability was set at .90 in the model.

Explanatory Variables

Indicators of cognitive advantage hypothesis: Researchers have used intellectual performance and test scores to measure cognitive skills. In the present study, measures for cognitive-scholastic development included three parts: cognitive skills in kindergarten, grade retention, and later school achievement. Cognitive skills in kindergarten were measured through scores on the Iowa Test of Basic Skills (ITBS) word analysis and ITBS math subtest scores at age six (Hieronimus, Lindquist, & Hoover, 1980). The word analysis scale contained 35 items evaluating prereading skills, such as letter-sound recognition and rhyming ($\alpha = .87$). The math subtest scale included 33 items assessing numbering, classification, and

quantification ($\alpha = .82$). Research has confirmed the measure's predictive validity for later achievement (Reynolds, 1991, 2000). The two indicators were significantly correlated to each other ($r = .601$).

Grade retention was defined as whether participants were ever retained from kindergarten through grade 8 (ages 5 through 14), and was treated as a later indicator of cognitive advantage. Children who had ever been retained during this period were coded 1, and those never retained (continuously promoted) were coded 0. Later school achievement was measured through ITBS reading and math scores in eighth grade (Hieronymus et al., 1980). The reading test contained 58 items and emphasized understanding of text passages ($\alpha = .92$). The math test contained 117 items assessing conceptual domains, computation, and problem solving ($\alpha = .95$) (Reynolds, 2000). The two indicators were significantly correlated with each other ($r = .779$).

Indicators of family support hypothesis: Factors in the family environment that can facilitate children's development are used as indicators of family support. In the present study, measures for family support included parent involvement and incidences of child abuse/neglect. The two measures represent two concepts of family support, one positive and one negative, so they were treated separately in the model rather than two indicators of one latent variable.

Two indicators were used for parent involvement, parent participation in school and parents' interest in child's progress. The correlation between the two indicators was significant ($r = .603$). First, for parent involvement in school, both teacher and parent ratings between grades 2 and 6 were used to minimize reporter bias. The total scale ranged from 0 to 5. Teacher ratings were based on the item "parent's participation in school activities" in each of grades 2 to 6. The item was rated from poor/not at all (1) to excellent/much (5). For the analysis, the frequency of "average or better" ratings (a score of 3 or higher; Min. = 0, Max. = 5) was used. The parent-reporter indicator was the average rating of the item "How often do you participate in school activities?" in grades 2, 4 and 6. These parent survey items were coded from less than monthly (1) to weekly or more (3). For parents, the dummy measure was a rating of more than monthly. For parents who did not return surveys for one year, their single rating was used. Second, for parents' interest in the child's progress, teacher ratings on the item "parent's interest in the child's progress" in each of grades 1 to 5 were used. The item was rated from poor/not at all (1) to excellent/much (5). For the analysis, the frequency of "average" or better ratings (Min. = 0, Max. = 5) was used.

Another measure of family support was whether there was a substantiated juvenile-court report of abuse or neglect during ages 4 to 12 (from 1984 to 1992). Data were collected through record searches at the juvenile court without knowledge of youths' program participation. Searches were repeated twice for 5% random samples, and verified against computer records.

Indicators of social adjustment hypothesis: Social adjustment was measured as social-emotional adjustment to the school context through a scale of classroom adjustment rated by teachers at grades 3 and 4. The scale included six items: "concentrates on work," "follows direction," "is self-confident," "participates in group discussion," "gets along well with others," and "takes responsibility for actions". They were coded from poor/not at all (1) to excellent/very much (5) ($\alpha = .91$). Missing scores were due to teachers' non-response, and were nonsystematic in the study sample. The average score of the third and fourth grade was used.

Indicators of motivational advantage hypothesis: Motivation was measured through a 12-item school commitment scale rated by students at grades 5, 6, and 10. The same items were included in the scale in these years (e.g., "I try hard in school", "I like school", "I give up when school work gets hard"). The items were rated on a four-point scale coded from strongly disagree (1) to strongly agree (4) ($\alpha = .74$ for 5th grade, $\alpha = .78$ for 6th grade, $\alpha = .79$ for 10th

grade). The average score of 5th grade and 6th grade was used mainly. If one was missing from both, the 10th grade score was then used.

Indicators of school support hypothesis: The concept of school support was extended to factors regarding schools that might influence students' educational attainment. In the present study, measures included school quality and school mobility. School quality was measured through two indicators, any attendance of magnet school from grades 4 through 8, and school characteristics in fifth grade. These two measures formed a latent variable of school quality. The quality of magnet schools is expected to be better than those of other regular types of schools. Attendance of magnet school was a dichotomous variable. The other indicator, school characteristics, was measured by the average percentage of low-income families, mobility, and truancy at the school level in fifth grade. The school-level data were matched to individual students of the school. Because the three items were negative features of school, the variable was coded in reverse to match the direction of the other indicator of school quality (attendance of magnet school).

School mobility was measured by the number of times participants changed schools between grades 4 and 8. It was obtained from a grade-by-grade analysis of school system records. School mobility was found to predict educational attainment and mediated the effect of an early intervention program (Temple & Reynolds, 1999). Thus, it was used as an indicator of the school support hypothesis.

CPC Preschool Program Participation and Covariates—Participation in the Child-Parent Center Preschool Program one year or two years was coded 1; children who did not attend the CPC Preschool Program were coded 0. Covariates include race/ethnicity and family risk status. For race/ethnicity, Black children were coded 1, and Hispanic children were coded 0. Family risk status was measured through a 6-item composite index. Items included were (1) single-parent family status by the child's age 8, (2) parent unemployment by the child's age 8, (3) attendance at a kindergarten program in a school in which 60% or more of children in the attendance area reside in low-income families, (4) eligibility for a subsidized lunch, (5) parent a non-graduate of high school by the child's age 8, and (6) four or more children in the household. These risk factors have been found to be consistently associated with children's school success and educational attainment in prior studies (Alexander, Entwisle & Kabbani, 2001; Masten & Garnezy, 1985). The family risk index ranged from 0 to 6, and the mean was 3.05.

Descriptive Statistics—Table 2 presents the descriptive information for the measures described above. The maximum valid N is 1,334, and the minimum N is 1,172 for school commitment. Missing values of variables were not significantly correlated with preschool participation or educational attainment except school commitment. The missing values of school commitment were examined through a regression analysis with covariates, and it was not significantly associated with educational attainment.

Data Analysis

Structural equation modeling (SEM) has been used increasingly in social science research because of its capacity to handle more complicated research questions. It is especially important for studies regarding mechanisms that SEM allow researchers to designate relations among variables based on theories. The method also offers several advantages over other methods, such as taking into account measurement errors and constructing latent variables (Hoyle, 1995; Kline, 1998). Therefore, SEM was used in the present study through the computer software Linear Structural Relations 8.8 (LISREL8, Jöreskog & Sörbom, 1996).

Researchers have developed various statistics to evaluate the fit of models. Two indicators of model-fit were used in the present study: the root mean square error of approximation (RMSEA) and the adjusted goodness of fit index (AGFI). The RMSEA takes into account the error of approximation in the population (Browne & Cudeck, 1993). A RMSEA value that is less than 0.05 indicates a good fit, and values as high as 0.08 represent reasonable errors of approximation in the population. A value of GFI or AGFI close to 1.00 indicates a good fit (Byrne, 1998). The path coefficients are standardized partial regression coefficients, which show the change measured in standard deviation units while controlling other variables in the model. The significance of path coefficients is judged by the same way as a z statistic, so a path coefficient has to exceed 1.96 to be considered reliably different from zero (Hoyle, 1995). These coefficients aid in the interpretation of the size of the effect, because they correspond to effect-size estimates (Hoyle, 1995). See Byrne (1998), Kline (1998), and Loehlin (1998) for more information on SEM.

The correlation matrices for females and males were obtained through PRELIS 2.5, which is a preprocessor for LISREL used to screen and transform raw data into the appropriate measure of association for LISREL estimation. The matrices were then used to fit the model consist of the five hypotheses. See Appendix 1 for the correlation matrices. Two approaches of analyses were conducted. First, multi-group estimations were conducted for the hypothesized model to test the equality of structures between males and females. In other words, the coefficients in the relations were tested to see whether the coefficients for one group should be assumed to be the same or different from the other group. The model fit statistics from the two models were compared. Second, the model was estimated separately for males and females. The model fit statistics and significant path coefficients were compared between the models.

Separate models were estimated for several reasons. First, multi-group estimations suggest that males and females should be estimated separately. Second, different developmental and socialization processes for males and females have been well noted (Golombok & Fivush, 1994). Gender differences have been found in other studies of early intervention (Campbell et al., 2002; Lally et al., 1988; Oden et al., 2000), and estimation of separate models is recommended (Barnett et al., 1998). Third, although multi-group estimation provides information about whether the structures of factors among groups are different or not, it does not provide information on how the data fit groups differently. Separate model estimation allows examination and comparison of model fit statistics and coefficients between subgroups.

Results

Main Effects of the CPC Preschool Program on Educational Attainment

There were significant differences in educational attainment between the preschool group and the comparison group after adjustments for different sets of demographic factors. For example, after adjusting for differences in covariates, the rate of high school completion for the preschool group was 66.9%, and 55.3% for the comparison group, a difference of 11.6 points ($p < .001$). Similar results were found on highest grade completed. Highest grade completed for the preschool group was 11.33, and 10.93 for the comparison group, a difference of 0.4 ($p < .001$).

To emphasize the gender differences, Table 3 shows the adjusted rates of educational attainment by program and gender groups. More males who had preschool experience completed high school than males who did not have preschool experience (61.1% vs. 41.5%, $p < .001$). This difference of 19.6 percentage points was much larger than for females. There were also significant differences between groups for males in rates of graduation and GED, and highest grade completed (11.13 vs. 10.50, $p < .001$).

Multi-group Estimations

Two models were tested in multi-group estimations: equal structures and separate structures between males and females. The model of separate parameters for males and females ($df = 131$, $\chi^2 = 383.075$, $RMR = .0294$) fit better than the model of equal parameters between males and females ($df=212$, $\chi^2 = 616.310$, $RMR = .0425$). The difference between the two models is significant ($\Delta df = 81$, $\Delta\chi^2 = 233.235$). Results suggested that the coefficients are different for males and females and they should be estimated separately. We note however that because only for males was a main effect on educational attainment detected, model estimates for females reflect indirect pathways of effects rather than mediators of the effects of preschool.

Separate Models by Gender

Highest Grade Completed—The goodness-of-fit statistics indicated that the model fit the data better for females ($RMSEA = .051$, $AGFI = .93$) than for males ($RMSEA = .060$, $AGFI = .91$). The model explained 28 percent of variance for females on highest grade completed, and 29 percent for males.

Females: Figure 2 displays the significant standardized path coefficients for females.

Cognitive advantage was a significant mediator. Preschool participation was associated with greater ITBS scores in kindergarten ($b = .29$), which was associated with a lower rate of grade retention ($b = -.43$). Grade retention was in turn associated with later achievement ($b = -.45$), and later achievement was associated with a higher grade completed ($b = .31$). Some selected paths are briefly described. There were mediators launched by ITBS scores in kindergarten and incidence of abuse/neglect. The higher ITBS scores in kindergarten were associated with better classroom adjustment ($b = .47$), greater parent involvement ($b = .29$), and a higher rate of attending better quality schools ($b = .22$). These mediators then led to a higher grade completed, or led to greater later achievement and was then associated with a higher grade completed. Also, the mediator initiated by a lower rate of abuse/neglect was associated with a higher possibility of attending better quality schools ($b = -.19$), which then led to a higher grade completed ($b = .18$).

Table 4 presents the percentage mediators contributed to the indirect effect, by gender, of preschool participation on highest grade completed and high school completion. ITBS scores in kindergarten, combined with other mediators contributed most to the indirect effect of preschool participation on highest grade completed for females (53.7%), and then were abuse/neglect combined with other mediators (9.7%). With mediators in the model, the standardized coefficient between preschool participation and highest grade completed reduced significantly ($b = .12$ vs. $b = .01$), which indicated the mediators reduced 91.7% of the main effect of preschool on highest grade completed for females.

Males: Figure 3 displays the significant standardized path coefficients for males. Cognitive advantage (ITBS scores in kindergarten combined with grade retention and later achievement) and school mobility were significant mediators. The cognitive advantage mechanism is described first. Preschool participation was associated with higher Iowa Test Basic Skills (ITBS) scores in kindergarten ($b = .43$), which led to a lower risk of grade retention ($b = -.51$). Grade retention was in turn associated with lower later school achievement ($b = -.44$), and later school achievement was associated with a higher grade completed ($b = .19$).

There were 3 mediators launched by ITBS scores in kindergarten: a) a higher rate of attending better quality schools ($b = .16$), and then greater later achievement ($b = .12$), which then led to a higher grade completed ($b = .19$), b) higher level parent involvement in school ($b = .25$), and then fewer school moves ($b = -.27$), and then led to a higher grade completed ($b = -.19$), or c) better classroom adjustment ($b = .42$), and then greater school commitment ($b = .38$), which

was then associated with a higher grade completed ($b = .10$). School mobility, one indicator of school support, was also a significant mediator. Another indicator, school quality, was a mediator through ITBS scores in kindergarten. Preschool participation was associated with fewer school moves ($b = -.11$), which was then associated with a higher grade completed ($b = -.19$).

Although the cognitive advantage hypothesis was supported in both models for females and males, the magnitude of associations was different. The association between preschool participation and ITBS scores in kindergarten was larger for males than for females ($b = .43$ vs. $b = .29$), but the association between later achievement and highest grade completed was larger for females than for males ($b = .31$ vs. $b = .19$). The association between preschool participation and abuse/neglect was larger for females than for males ($b = -.25$ vs. $b = -.06$). ITBS scores in kindergarten, combined with other mediators, contributed most to the indirect effect of preschool participation on highest grade completed for males (37.2%). School mobility made the second largest contribution (16.1%) (Table 4). With mediators in the model, the standardized coefficient between preschool participation and highest grade completed reduced significantly ($b = .18$ vs. $b = .05$). The finding indicated that the mediators reduced 72.2% of the main effect of preschool on highest grade completed for males. The percentage reduction of the main effect for males was less than that for females.

High School Completion—Similar to the models for highest grade completed, the goodness-of-fit statistics indicated that the model (RMSEA = .051, AGFI = .93) fit the data better for females than for males (RMSEA = .060, AGFI = .91). The model explained 33 percent of variance in high school completion for females; it explained 38 percent for males. Figure 4 and 5 display the significant standardized path coefficients for males and females, respectively. The overall pattern of paths was similar to those for highest grade completed, but some paths were different. For example, school mobility was a significant mediator in the model for females on high school completion, although it was not a significant mediator in the model for females on highest grade completed. Cognitive advantage and school mobility were significant mediators in the models for both females and males, with different magnitude. For instance, the association between preschool participation and school mobility was larger for females than for males ($b = -.21$ vs. $b = -.11$).

The most important difference between the models for females and males was that preschool participation was associated with high school completion directly in the model for males ($b = .18$). In addition, two associations related to school achievement were larger for males than females: the association between preschool participation and kindergarten achievement ($b = .43$ vs. $b = .29$), and the association between later achievement and high school completion ($b = .42$ vs. $b = .24$). Moreover, two associations related to school mobility were also larger for males than females: the association between grade retention and school mobility ($b = .26$ vs. $b = .10$), and the association between parent involvement and school mobility ($b = -.27$ vs. $b = -.13$). On the other hand, the association between parent involvement and high school completion was larger for females than for males ($b = .27$ vs. $b = .12$).

Figure 6 displays the standardized total effects of explanatory variables for high school completion by gender. The largest differences between males and females were the total effects of preschool and later achievement on high school completion, which were far larger for males than for females. The total effect of preschool on high school completion for males was twice the effect for females ($b = .27$ vs. $b = .09$), which is consistent with the findings of main effects by gender reported in previous section.

For females, ITBS scores in kindergarten combined with other mediators contributed most to the indirect effect of preschool participation on high school completion (39%), followed by

school mobility (15.9%) (Table 4). The mediators through abuse/neglect contributed to 8.5% of the indirect effect. With mediators in the model, the standardized coefficient between preschool participation and high school completion reduced (from .09 to .05). The mediators reduced 44.4% of the main effect of preschool on high school completion for females. For males, 87.3% of the indirect effect of preschool on high school completion was contributed by those mediators (Table 4). With mediators in the model, the standardized coefficient between preschool participation and high school completion changed from .27 to .18. The mediators reduced 33.3% of the main effect of preschool on high school completion for males. Preschool participation remained significantly associated with a higher rate of high school completion for males, even with all mediators included in the model.

Additional Analyses for Males—To further explore why the association between preschool participation and high school completion remained significant in the model for males, additional analyses were conducted. First, expectation of attending college was used as the indicator of motivation instead of school commitment. Because the expectation was measured later than school commitment, it had stronger correlation with high school completion than school commitment. The rationale behind this was to test if motivational advantage had been underestimated for males. If this was the case, the coefficient between preschool participation and high school completion would decrease in this model. However, the path coefficient between preschool participation and high school completion did not change. Therefore, underestimation of motivational advantage was ruled out.

Another potential reason for such association might be due to moderators, such as family characteristics, rather than unmeasured mediators. Therefore, additional regression analyses were conducted for males on high school completion. When family risk index was used as the covariate, no matter how many mediators were included in the regression model, preschool participation always remained significant. When family risk index was replaced with individual indicators of the family risk index, preschool participation became non significant when mediators were included in the regression model. Single-parent status was significantly associated with high school completion in several models, which indicated that single parent families were likely to have an additional impact for males on high school completion. The additional analyses shed light on the relation between preschool participation and high school completion for males, and suggested that family resources might play an important role for males.

Discussion

Historically, men were more educated than women. However, the educational attainment advantage of men has been reversed in the past five decades (Charles & Luoh, 2003). The trends are evident across different racial and ethnic groups. Women have higher rates of enrollment in college than men. The gender difference is especially large among African Americans (Cohen & Nee, 2000). In the study sample, females without intervention have higher educational attainment than males with intervention. As literature has shown, children grew up in poverty and economically disadvantaged urban areas are at risk of school failure and warrants great concern (Carnoy, 1994; Wilson, 1987). African American males, in particular, are at high risk of school failure, special education placement, suspensions, and violence (Davis, 2003; Ferguson, 2000; Gibbs, 1988; Noguera, 2003). Studies have indicated that Black males are more likely to be labeled with behavior problems and to be excluded from rigorous classes and prevented from accessing educational opportunities that might benefit them (Hilliard, 1991; Oakes, 1985). Majority of the participants in the present study are African Americans, growing up in high poverty areas in an inner-city, which might place males in greater risk than females. This might explain why males have lower educational attainment than females even with intervention. This phenomenon requires more attention in the future.

Overall the separate models indicated the model fit the data better for females than for males. Although the cognitive advantage was a significant mediator for both females and males, the association was larger for males than for females. Cognitive advantage, school mobility, and school commitment seemed to play more important roles for males, while parent involvement played a more important role for females. Factors related to schools seemed to have larger influence on males, while factors related to family seemed to have larger influence on females. This matches findings on gender socialization in the literature (Bandura, 1989; Golombok & Fivush, 1994). School mobility was a significant mediator for males on both outcomes, but was a significant mediator for females on high school completion only. Abuse/neglect was a mediator for females, but not a mediator for males. School commitment and classroom adjustment were not significant mediators for either females or males. However, they contributed to the indirect effects of preschool program on educational attainment. School commitment seemed to play a more important role for males.

The association between preschool participation and high school completion was far larger for males than for females, which corresponded to the findings from previous analyses of the CPC data; males benefited more from the preschool program than females in relation to high school completion (Ou & Reynolds, 2006; Reynolds et al., 2001). A potential explanation for this phenomenon might involve moderators (such as single parent family and number of siblings) that were not included in the model. This suggests a need to investigate models for different subgroups within males. It is also worth examining other predictors of educational attainment for males, and exploring other potential mechanisms of influence.

Some other explanations could be considered for the strong correlation between preschool participation and high school completion but not between preschool participation and highest grade completed for males. First, living in an inner city might present a stronger financial need than living in rural area, so higher education is not as important as earning one's living. Males might perceive more pressure from families to earn their livings than females. Second, gender gap in college schooling might be a reason. Males have lower rates of participation in postsecondary education than females (Charles & Luoh, 2003). High school completion could be a threshold for males. Education beyond high school might be affected by other culture and environmental factors. It is worth exploring further in the future.

Limitations

Although the present study overcame many limitations because of its improved method and longitudinal design, the findings should be qualified in several respects. First, this study investigated correlations among variables with a quasi-experimental design. Although the longitudinal design, the theory-driven approach, and structural equation modeling, used in the present study strengthened the validity of findings, the relations in the model can be viewed as predictors but not causes. Causal inferences can be made only after further replication and extension. The second limitation concerns the constructs. A single indicator was used for some of the mediators, such as social adjustment and motivational advantage. Social adjustment and motivation are abstract concepts, and they may be best measured through multiple indicators. However, they were defined narrowly in the present study, which might be one of the reasons that they were not significant mediators. The chance of altering findings by using different indicators might not be large, because measurement errors were taken into account; nevertheless, the possibility should not be ruled out. The third limitation concerns alternative models. Alternative models might include other alterable predictors of educational attainment, such as children's attitude toward school, children's problem behaviors in school, and school discipline policies. These factors might also mediate the effects of preschool program, although no researchers have suggested that. They were not included in the analysis, either because the focus of the present study was on the five hypotheses or because the data were unavailable.

The final limitation is generalizability. The majority of the study sample was comprised of African Americans living in an inner city. Therefore, the findings should not be generalized to other populations or other contexts, although the study supports findings from other early intervention programs conducted in other locations. An inner city sample might differ from other samples from a rural area or medium-sized town, which might affect the mechanisms of long-term effects of early intervention programs. For the generalizability of the model, other replications are needed. Similar findings about cognitive advantage have been reported in other studies despite differences between programs and contexts. The cognitive advantage hypothesis does not seem to rely on environmental factors as much as the school support hypothesis does. School support, especially school quality, was supported in other studies (Currie & Thomas, 2000; Lee & Loeb, 1995), and might be applied to other early intervention programs with caution. Overall, the findings regarding family support and school support might not be generalized, because the findings might be due to specific components of the CPC program, such as parent involvement.

The components of the CPC program are similar to those of Head Start, but the CPC program is more intensive and focuses more on family components than Head Start. CPC provides more literacy activities and intensive parent involvement. For example, each center has a parent room led by a parent resource teacher. Both are large-scale programs. Although being a public school program and having a large sample size enhanced the generalizability of the study, the identified mechanisms should only be applied to other programs that have similar components. In addition, the outcome in the study was educational attainment, and the identified mechanisms should only be applied to similar outcomes. Replication of the study to different outcomes in the future might increase its generalizability.

Implications

The findings of the study indicate that the sources of effects of early intervention programs are different for males and females. While cognitive and school support factors made greater contributions to the educational attainment of males, family support behaviors were more influential for females. Knowledge about the paths of influence from preschool to early adult well-being enhance understanding about the ways in which early childhood experiences are shaped by participants' social environment both directly and indirectly. In particular, the impact of preschool on females' educational attainment is largely indirect as we found no direct, main effect on their educational attainment.

The association between program participation and cognitive abilities, and the association between program participation and incidence of abuse/neglect suggest that promotion of cognitive development and family supportive behaviors are two effective components of early intervention, and they should be addressed in the design of early intervention programs. Enhancement of cognitive skills, such as literacy, is one goal of early intervention programs. The curriculum of the CPC program emphasized the acquisition of basic knowledge and skills in language and math through structured learning experiences. Preschool is expected to affect children's cognitive skills, which then lead to greater achievement, lower grade retention, and later success. The findings indicate that the CPC program worked as expected. Therefore, in order to promote long-term effects of early intervention program, it is important to help children develop basic cognitive skills, such as literacy and numeracy skills. However, effects are more likely to be sustained if the program not only promotes children's school achievement but also enhances family support behaviors.

Family components, such as parent involvement and parenting practices, should be incorporated and addressed when designing effective early intervention programs. A central assumption of the CPC program is that parental involvement is an important socializing force

in young children's development. At least one-half day per week of parent involvement in the center is required. Involvement may include a wide variety of activities, such as parents volunteering as classroom aides, interacting with other parents in the center's parent resource room, participating in educational workshops and courses, attending school events, accompanying classes on field trips, and attending parent-teacher meetings on behalf of the child (Reynolds, 2000; Reynolds, et al. 1996). Early intervention programs may benefit from having teachers or social workers coordinate activities in a parent resource room and manage and plan activities in which parents can participate. In addition, it may be beneficial school-community representatives or social workers to perform outreach services. The findings indicate that these services might have contributed to the program effects. Therefore, both cognitive scholastic and family support behavior should be addressed in designing effective early intervention programs. Two-generation programs, such as Comprehensive Child Development Program (CCDP) and Child and Family Resource Program (CFRP), focused on both children and parents (St. Pierre, Layzer, & Barnes, 1995), should be more effective than child-oriented or parent-oriented programs. The principles can be applied to other early intervention programs that are undergoing revisions to help promote their effectiveness.

For policy makers, the findings provide information about factors that are associated with educational attainment by gender, which can help address effective components to maintain the advantage obtained through early intervention programs and increase the chance of obtaining higher educational attainment. For example, parent involvement is associated with higher educational attainment for females. Programs that engage parents in child's school activities can enhance parent involvement in school, and furthermore keep close interactions between parents and teachers. By increasing parent involvement, the chance of females obtaining higher educational attainment increases. School mobility is associated with lower educational attainment for males. Programs that help students deal with transition after changing schools might increase chances of obtaining higher educational attainment, especially for males.

The findings also have implications for future research in understanding different processes of educational attainment between males and females. Cognitive factors and school related factors play more important roles for males than for females, while family related mediators are more important for females than for males. Research exploring how specific factors have larger impacts on one gender than on the other will provide insights into the emergence of subgroup effects. The contributions of peer, neighborhood, and community factors to long-term effects also warrants further inquiry as they also may variable influences for males and females.

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Appendix 1

Correlation Matrix for Measures by Gender

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Preschool	1.00	.095	.017	.329	.344	.190	.167	.154	-.059	-.218	-.213	.168	.049
2. Race	-.015	1.00	.123	.018	.067	-.147	-.016	-.096	.022	.055	-.064	.034	.011
3. Risk Index	.030	.075	1.00	-.087	-.068	-.177	.009	-.091	-.004	.194	.070	-.100	-.183
4. ITBS Word Analysis (K)	.252	.043	-.094	1.00	.609	.334	.182	.180	.010	-.430	-.214	.120	.195
5. ITBS math scores (K)	.181	.075	-.148	.587	1.00	.325	.218	.200	-.097	-.434	-.187	.081	.120

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
6. Socio-Emot. Maturity(3-4)	.059	-.138	-.121	.317	.332	1.00	.402	.390	-.035	-.526	-.213	.069	.074
7. Parent Participation	.158	.135	-.057	.175	.177	.345	1.00	.689	-.203	-.234	-.329	.114	.045
8 Parent interests in child	.095	-.115	-.072	.201	.198	.374	.612	1.00	-.295	-.328	-.276	.007	.027
9. Abuse/ Neglect	-.230	.074	.122	-.105	-.082	-.026	-.263	-.284	1.00	.135	.195	-.090	-.016
10. Retention	-.193	-.002	.125	-.405	-.387	-.435	-.329	-.298	.066	1.00	.336	-.222	-.119
11. School Mobility	-.255	.111	.097	-.111	-.064	-.182	-.312	-.117	.226	.195	1.00	-.189	-.214
12. Magnet School Att.	.210	.062	-.105	.251	.138	.079	.113	-.149	-.179	-.208	-.149	1.00	.493
13. School characteristics	.083	.048	-.209	.235	.094	.090	.111	.005	-.158	-.123	-.229	.603	1.00
14. School commitment	.065	-.116	-.053	.135	.150	.070	.189	.179	.080	-.182	-.075	.037	.070
15. ITBS reading scores (8)	.145	-.137	-.196	.432	.426	.532	.309	.256	-.120	-.605	-.198	.247	.233
16. ITBS math scores (8)	.156	-.132	-.223	.478	.452	.544	.316	.265	-.108	-.668	-.226	.269	.248
17.Highest grade completed	.108	-.118	-.154	.250	.182	.294	.299	.232	-.119	-.304	-.210	.187	.252
18. High Schl. Completion	.083	-.158	-.175	.270	.210	.342	.342	.306	-.155	-.357	-.257	.210	.197
19. College attendance	.138	-.046	-.211	.134	.104	.205	.125	.098	.008	-.244	-.095	.117	.183

Note. The up diagonal matrix is correlation for males, and the down diagonal matrix is correlation for females. With the exception of race, magnet school attendance, and continuously variables (which were estimated as Pearson's correlations), correlations were estimated as polyserial/polychoric by PRELIS 2.5 with pairwise-present cases (minimum N = 563, maximum N = 682 for female; minimum N = 523, maximum N = 652 for male). Means and standard deviations were estimated by SPSS.

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Figure 1.
Model of long-term effects of preschool participation on educational attainment

Figure 2.
LISREL mediation model for highest grade completed for females, coefficients are standardized and adjusted for measurement errors

Figure 3.

LISREL mediation model for highest grade completed for males, coefficients are standardized and adjusted for measurement errors

Figure 4.
LISREL mediation model for high school completion for females, coefficients are standardized and adjusted for measurement errors

Figure 5. LISREL mediation model for high school completion for males, coefficients are standardized and adjusted for measurement errors

Figure 6.
Standardized total effects of explanatory variables for high school completion by gender

Table 1

Characteristics of the Preschool Group and the Comparison Group (N=1,334)

Characteristics	N	CPC Preschool Group (N=869)	No- Preschool Group (N=465)	P- value	Original Sample P-value
Percent females	1334	53.0	47.0	.031 *	.100
Percent Black	1334	94.1	92.3	.187	.949
Family risk index (0-6) by child's age 8	1334	3.1	3.0	.565	.176
Percent either parent completed high school at child's age 8 ^{1 3}	1110	59.3	53.7	.044 *	.036 *
Percent single parent by child's age 8 ¹	1031	57.3	59.3	.542	.386
Percent parent not employed by child's age 8 ¹	1029	59.7	53.3	.053	.039 *
Percent ever reported receiving free lunch by child's age 8 ¹	1317	73.3	69.4	.130	.080
Percent having 4 or more children at home ¹	1281	32.5	41.0	.002 **	.002 *
Percentage children in school area in which 60% or more of children reside in low-income families	1334	77.2	71.8	.030 *	.037 *
Percent abuse/neglect report by child's age 4 ²	1334	1.04	0.86	.756	.704
Percent low birth weight	1273	7.1	9.8	.089	.084
Percent parent were teen at child's birth	1164	17.7	18.2	.851	.484

Note.

* Significant at .05 level,

** significant at .01 level

¹ Means reported before imputation for missing data.² Data were from court. The numbers for any indicated abuse or neglect from court or DCFS are as follows. Preschool group = 1.15%, comparison group = 2.58%, and *p*-value = .051.³ The numbers for percent either parent completed high school at child's birth are as follows: Preschool group = 62.8%, comparison group = 54.9%, and *p*-value = .006.

TABLE 2

Descriptive Statistics for Study Variables (N = 1,334)

Variables	N	Age	Females		Males		Total	Std. Dev.
			Mean	Mean	Mean	Mean		
Preschool participation	1334	5	.679	.623	.651	.48		
Race	1334	5	.941	.928	.935	.24		
Risk Index	1334	8	3.09	3.01	3.05	1.53		
Gender	1334	5	1.0	0	.51	.50		
ITBS Word Analysis (K)	1330	6	64.75	62.63	63.71	13.40		
ITBS math scores (K)	1330	6	57.58	55.68	56.65	14.89		
Socio-Emot. Maturity(3-4)	1169	9-10	20.02	17.69	18.88	4.94		
Parent Participation in school	1334	8-12	1.77	1.52	1.65	1.38		
Parent interests in child	1299	7-11	2.66	2.47	2.57	1.38		
Abuse/ Neglect	1334	4-12	.056	.051	.053	.22		
Retention	1334	15	.198	.348	.271	.44		
School Mobility	1268	10-14	.87	1.02	.95	1.0		
Magnet School Attendance.	1334	10-14	.135	.075	.106	.31		
School characteristics	1175	11	.015	-.010	.00	.72		
School commitment	1172	11-15	51.43	49.92	50.71	5.65		
ITBS reading scores (8)	1254	14	148.76	140.51	144.75	22.01		
ITBS math scores (8)	1254	14	150.02	144.70	147.43	18.38		
Highest grade completed	1315	By 22	11.46	10.90	11.19	1.71		
High school. Completion	1334	By 22	.695	.537	.618	.49		

* If missing ITBS reading and math scores in 8th grade, ITBS reading and math scores in 7th or 6th grade were used to estimate the scores in 8th grade.

Table 3

Educational Attainment by Age 22 by Gender in the Study

Educational attainment	N	Preschool group	Comparison group	P-value
		Mean	Mean	
Females				
High school completion, %	682	70.0	68.5	.712
Graduation, % of total sample (GED is excluded)	596	66.1	63.0	.484
GED, % of total sample	682	12.1	13.8	.571
Highest grade completed	680	11.50	11.38	.396
Males				
High school completion, %	652	61.1	41.5	.000
Graduation, % of total sample (GED is excluded)	567	53.2	37.0	.000
GED, % of total sample	652	16.8	6.8	.001
Highest grade completed	635	11.13	10.50	.000

Note. Adjusted for race, follow-on participation, and family risk index.

Table 4

Total Indirect Effects of Program Indicators on Educational Attainment by Gender

Key Pathways	Highest Grade Completed		High School Completion	
	Females	Males	Females	Males
Preschool Participation	.11	.13	.14	.09
Percentage due to:				
Family Support	9.7	--	8.5	--
Parent involvement	--	--	--	--
Parent involve. & school mobility	--	--	--	--
Abuse/neglect	--	--	--	--
Abuse/neglect & school mobility	--	--	2.7	--
Abuse/neglect & school quality	7.8	--	4.6	--
Abuse/neglect, school quality & later achievement	1.9	--	1.2	--
School Support	--	16.1	15.9	17.1
School quality	--	--	--	--
School mobility	--	16.1	15.9	17.1
Cognitive Advantage	53.7	37.2	39.0	70.2
ITBS scores in Kind. & parent involvement	18.3	--	16.2	14.3
ITBS scores in Kind., parent involve. & mobility	--	4.2	0.8	--
ITBS scores in Kind., adjustment & later achievement	9.2	5.3	5.6	--
ITBS scores in Kind., adjustment & commitment	--	5.3	--	--
ITBS scores in Kind. & quality	10.4	--	5.9	9.8
ITBS scores in Kind., retention & later achievement	15.8	14.1	9.6	46.1
ITBS scores in Kind., retention & mobility	--	8.3	0.9	--
Total	63.4	53.3	63.4	87.3

Note. Only significant coefficients are calculated.