Does the Birth Order Affect the Cognitive Development of a Child?

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Abstract

We investigate the effects of birth order on child cognitive development, using large child and sibling samples obtained from the mother-child data of the National Longitudinal Survey of Youth 1979. Controlling for various determinants of cognitive development we find that having a high birth rank is detrimental and that the gap between adjacent siblings is larger for children early in the birth sequence. The pattern is strongest for non-Hispanic white and Hispanic children. Among African-American children no difference between the first- and the second-born child is found. The negative birth order effects are robust to specification that control for family fixed effects, use a sibling first difference approach, or account for subsequent siblings.

Keywords: Birth Order, Family Size, Cognitive Development, NLSY79

1 Introduction

Children in the United States are growing up with fewer siblings than ever before. Between 1960 and 2002, the average number of children in all families with children under age 18 decreased from 2.33 to 1.83 (U.S. Census Bureau, 2003). This development reflects a trend towards smaller families. Between 1976 and 2002, the fraction of mothers who had given birth to three or more children by age 40 to 44 decreased from 65.1% to 36% (U.S. Census Bureau, 2003). These percentages represent a dramatic change in the family structure that children experience. Yet despite numerous studies on the topic, there is still no census whether being late in the birth order or growing up in a larger family is detrimental for a child's intellectual development and achievement. Most of the existing evidence suggesting that being late in the birth order is detrimental for child cognitive development rests on simple descriptive analysis or on multivariate analysis in small cross-sectional samples. Specifically, no systematic research on the effect of birth order on the cognitive development of young children using large representative child and sibling samples exists.

We investigate the role of birth order and family size in the development of young children (ages 3 to 14) using mother-child data from the National Longitudinal Survey of Youth 1979 Cohort (NLSY79). This large nationally representative survey has been following young individuals and their children since 1979. It is ideal for the study of how older and younger siblings affect the development a child since most women in the sample will have completed their fertility by 1998 — the last round of the survey used in the analysis. The survey provides good measures of possible inputs in the child development process such as family structure and socio-economic conditions in the household since birth. Due to the fact that child assessment data are available for all children born to a women in most cases, we are able to present evidence based on samples of all children (6,036 cases), samples by ethnicity/race of the mother of the child (up to 2,736 cases), and sibling samples (up to 2,926 cases).

We find that higher birth order is associated with slower child cognitive development based on the revised Peabody Picture Vocabulary Test. Being the second child instead of being the first-born reduces the outcome by 1/6 of standard deviation. However, the achievement differences between adjacent siblings diminish with higher birth order. Among children of African-American mothers the effects are less pronounced. In particular, no difference between first- and second-born children is observed for this group. The findings are robust to specification that control for family fixed effects, use a sibling first difference approach, or account for subsequent siblings.

In the next section, we present explanations for birth order and family size effects and review the findings in the existing literature in that light. We conclude that there are several reasons to expect that growing up in a larger family and being late in the birth order has a negative effect on a child's development. However, the current literature contains little, if any, systematic evidence. In section 3, the sample of matched mother-child data from the NLSY79 used in the analysis is discussed. Section 4 presents the empirical specification and the estimation results. Section 5 provides a discussion of the results and concludes.

2 Background on Birth Order Effects and Previous Evidence

We start by reviewing the theoretical arguments for birth order effects.

2.1 Theories of Birth Order and Family Size Effects

(1) Quantity Dilution Hypothesis

The resource quantity dilution model suggests that growing up in a larger family is detrimental because a smaller share of the resources available at the family level at the time is allocated to the child (Blake 1981; Leibowitz 1977; Becker 1965; Becker and Lewis 1973). This model implies that being early in the birth order may be beneficial for attainment since a child that is early in the birth order lives in a smaller family for a longer time, hence may receive a larger share of the family resources when young than its later-born sibling(s).

(2) Quality Dilution Hypothesis

The dilution may not be limited to amounts invested in a child but may also occur with regard to the quality of the investments received by a child. If the parent cannot provide the same quality in the interaction with each child upon the arrival of another child, then the latter reduces the quality of the parental services provided to older or all siblings. If older siblings become jealous of the younger sibling, they may affect his or her development in a negative way. In this case, being in a larger family is detrimental but the relative effect of being a certain birth rank depends on the exact nature of the interactions. For example, Zajonc and Markus (1975) argued in their 'Confluence Model' that being in a larger family is detrimental due to less quality interaction with the parent.

(3) Quantity Accumulation Hypothesis

The investments received by children may also differ between siblings if the resources in the household increase over the family life course. For example, the parents' child-rearing ability may increase with experience or maturing. Individual's earnings' profiles are increasing with age (e.g., Card 1994), suggesting that the family level income available for consumption may be greater when a later-born child enters the family. Also, older siblings may benefit from having access to both new and existing goods, such as toys and books previously purchased for an older sibling. In addition, children later in the birth order may receive more stimulation overall since they have more siblings around. However, older siblings may benefit from a larger family size as well since they have more opportunities to learn by instructing others. Overall, the investments per child may be greater later in the family life, implying that children late in the birth order may be better off than their older sibling(s).

(4) Quality Accumulation Hypothesis

Interaction between siblings may benefit the younger sibling as well as the older sibling. Zajonc and Markus (1975) argue in the context of their 'Confluence Model' that older siblings benefit from teaching their younger siblings. At the same time, later-born children benefit from the presence of older siblings since the latter are intellectually more mature.

(5) Differential Investment/Preference Hypothesis

Differences (or similarities) in development and attainment of siblings may be the result of parental preference for certain characteristics such as the rank in the birth order, the sex of the child, or the child's neediness. Historically, parents had an incentive to invest more in the first-born (male) child. However, nowadays parents may be more likely to invest towards achieving similar achievements across siblings (Becker and Tomes 1975; Behrman and Taubman 1986; Hanushek 1992).

(6) Endowment Heterogeneity Hypothesis

Birth order effects may also be the result of differential natural endowments of the child. Since later-born children are born to older mothers, higher birth order might be associated with birth defects and poorer health that may adversely affect other developmental outcomes.

Summarizing the predictions of the various hypothesis, we note that the *a priori* sign of the birth order effect is uncertain. The Quantity Dilution model (1), presents a strong argument for a negative birth order and family size effects since it suggests that older siblings exist who compete for scarce family resources. If Quality Dilution (2) is at work, then being later in the birth sequence is detrimental since the quality of the services depletes as the family increases in size. The popular confluence model (cf. Zajonc and Markus 1975 and Zajonc 2001) can be viewed as a combination of both quantity and quality dilution since it conjectures that stimulation from the parent is substituted by less stimulating interaction with siblings upon arrival of a new siblings. Quantity and Quality Accumulation, (3) and (4), on the other hand, provide reasons why being late in the birth order may be beneficial. Hypothesis (5) suggests no strong systematic birth order effects in the context of contemporary families in the United States and explanation (6) suggests a negative association between birth order and development as a result of the correlation between birth order and mother's age.

2.2 Existing Evidence

An extensive multidisciplinary literature studies the role of birth order or family size on child development and achievement. This literature can be divided into three groups based on the empirical strategy adopted.

The first group of studies (primarily in the developmental psychology literature) directly analyzes aspects of the family processes characteristic of sibling and parent relationships. These studies typically use data that consist of sibling pairs from small surveys with an observational or experimental design. This literature provides evidence consistent with some of the reasons presented under the quality and quantity accumulation hypothesis, i.e. (3) and (4): the younger sibling benefits from observing the older sibling (Wishart 1986; Hesser and Azmitia 1989) and learns faster when helped by an older sibling than when alone (Cicirelli 1973). There is also evidence that the benefits to the younger sibling increase with the age-difference (Cicirelli 1973). One may also expect that older siblings benefit from instructing their younger siblings as proposed by the quality accumulation hypothesis, i.e. (4). The work by Dunn suggests that having a younger sibling may sharpen the social awareness of the older child (e.g., Dunn 1989), and that the mother can improve the older child's ability as a caregiver by discussing the younger sibling's needs with him (cf. Dunn and Kendrick 1982). Stewart and Marvin (1984) suggest that older siblings often assume care-giving responsibility and younger siblings seek attachment to older siblings with care-giving qualities in the absence of a parent.

Nevertheless, there appears to be no agreement in this literature on the significance of the role of sibling teaching (Teti 2002, p. 203). One reason for this ambiguity may be that sibling care-giving is not very common in North American middle-class families. However, it is found more frequently in working-class families (Zukow-Goldring 1995), in families with children with special needs (McHale and Pawletko 1992), and in rural-agrarian societies (Weisner 1989).

Evidence consistent with a quality dilution effect (2) of having another sibling is provided by recent studies using the NLSY79. Baydar, Greek, and Brooks-Gunn (1997a) and Baydar, Hyle, and Brooks-Gunn (1997b) find that the birth of a sibling increases the chance that the mother adopts more controlling parenting styles and that it can result in lower levels of verbal ability and behavioral problems of the older sibling. Confirming the importance of parenting style using a more careful statistical methodology, Hao and Matsueda (2000) show that authoritarian control based on force increases the likelihood that a child develops behavioral problems.

This literature illuminates the nature of the family processes through which changes in the family size may affect child development. Since the evidence mostly comes from case studies with few observations that focus on one aspect of a family process based on one child (or sibling pair) per family, it may not generalize and it is not clear to what extent it is indicative of the overall effect of siblings on development.

The second group of studies presents evidence of birth order effects based on cross-sectional data. Using cross-tabulations or simple correlation, they report negative association between rank in the birth order and cognitive ability (e.g., Belmont and Marolla 1973; Blake 1981; Zajonc 2001). Some studies have provided evidence for a mediating role — as opposed to a causal role — of birth order in the formation of cognitive ability (e.g., Page and Grandon 1979; Steelman 1985), and educational attainment and earning power (Olneck and Bills 1979; Behrman and Taubman 1986; Kessler 1991).

Another group of studies employs family fixed effect models (also called sibling model or within family models) to analyze both short-run and long-run implications of birth order. Since family fixed effect models are identified based on the variation between children of the same family, they require a sample of siblings. The advantage of this approach is that it controls for all constant unobserved characteristics at the family level that may affect child development and achievement such as family endowments and preference. Consequently, the family fixed effects approach purges the birth order coefficients of a wide range of possible sources of omitted variable bias. Interestingly, using sibling samples, recent findings did not support a negative association between birth order and development (Retherford and Sewell 1991; Rodgers et al. 2000). However, the evidence remains controversial. Lindert (1977) found that being early in the birth order is beneficial for educational attainment using sibling data. He argues in support of the dilution model citing evidence from time budget surveys that show that the amount of child-care time received by a child is decreasing in the birth rank.

To date no study exists that systematically analyzes the effect of birth order on child development using a large nationally representative sample of children and siblings. Rodgers et al. (2000) use a small sibling sample from the NLSY79 but do not conduct a multivariate regression analysis. Guo and VanWey (1999) use a sample from the NLSY79 and family and child fixed effects regression models to test the effect of changes in the family size on cognitive outcomes. Their findings suggest that there is no causal effect of the number of siblings during childhood on intellectual development. However, they focus on family size and do not investigate the potential role for birth order. While there is an increasing number of studies on developmental outcomes using large samples — some of which also employ fixed effects (e.g. Joyce, Kaestner and Korenman 2000 and Waldfogel, Han, and Brooks-Gunn 2002) — these studies typically control only for family size and/or whether a child is first-born. Often the estimated effects are not even reported because birth order and family size effects are not the focus of these studies.

In summery, the role of birth order in development is controversial. Previous evidence from the NLSY79 is limited by small sample sizes (e.g., only 272 families for whites in Guo and VanWey 1999) and the estimates are unlikely to be representative of the experience of the average child since many children of NLSY-women could not be included in the earlier studies since they were not born yet. The present study attempts to close this gap by systematically analyzing the role of birth order in the early childhood development process using large representative child and sibling samples.

3 Data

The data used in this study are from the women of the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79) and their children. The survey collects detailed information about schooling, employment, marriage, fertility and health for $12,686$ men and women of ages 14-21 as of January 1979 in annual (biennial since 1994) interviews from 1979 until 1998. In addition to comprehensive longitudinal socio-economic data at the individual and household level, the NLSY79 contains detailed child assessment data (collected biennially since 1986). By 1998 most women in the sample are in their late 30s, so that childbearing has been mostly completed, ideal for a study of birth order and family size effects since such analysis requires information on the existence of older and younger siblings.

3.1 Sample Selection

The survey contains three sub-samples: 1) a nationally representative core sample; 2) military sample; and 3) a supplemental over-sample of Hispanics, blacks, and economically disadvantaged whites. We use all civilian female respondents who are in the sample as of 1998 and the over-samples for blacks and Hispanics.[1,2] The core sample contains 2,477 white non-Hispanic, 405 black non-Hispanic, and 226 Hispanic women after attrition. The sample sizes of the supplements are 1,067 black and 751 Hispanic women. To obtain a more homogenous sample with respect to the mothers' child-rearing experiences, women with twins are removed from the sample and we only consider biological children of the women. We also limit the sample to children of mother's who have up to 6 children. We exclude observations that have missing values due to missing or incomplete records on the child assessment data. However, cases where data on family background or parental inputs and characteristics — such as mother's Armed Forces Qualification Test (AFQT), educational attainment, mother's weight, mother's faith, number of siblings of the mother, and low birth-weight — are missing are included in the analysis in order not to reduce the sample size. For these variables, an indicator variable is created that equals to 1 if the data are missing and 0 otherwise. The observations with missing values are set to 0. Assessment data are often available for all children born to a women. Also, repeated outcomes are available since many children have

[1]The low-income white over-sample is choice-based and is therefore excluded from the analysis. Interestingly, Blau (1999) found identical results with and without the low-income white over-sample in his study.

[2]Since the low-income whites over-sample is excluded we do not use the sample weights in the analysis – as recommended by the Center for Human Resource Research (1992).

taken the same test at different ages. The samples used below employ the earliest available test result for a child. Table 2 states the variable definitions.

3.2 Measure of Cognitive Development

We use the Peabody Picture Vocabulary Test-Revised (PPVT-R). It is a well-documented and widely used measure of verbal intelligence and scholastic aptitude of a child. It is highly correlated with subsequent scholastic achievements and (verbal) intelligence measures (Center for Human Resource Research 1992, p.16; Dunn and Dunn 1981). Since its cultural fairness is being debated (Washington and Craig 1999), caution needs to be exercised when comparing outcomes across race and ethnicity.

Every other year from 1986 on, the PPVT-R was administered by the interviewer to children from age three on (four and above in 1990, 1996, 1998) who did not previously take the test (or repeatedly for an index group). Consequently, for most children's PPVT-R is available at age three or four as shown in Table 1. However, because children born prior to 1982 are older than four years, the sample contains children who took the test at older ages. Specifically, the average age when the test is taken for all children is about five years (Table 3). Standardized PPVT-R scores below 40 are not available in the official tables accompanying the test material. Hence, for children with a missing score or a score of less than 40, a child's next valid available score was used.

3.3 Sample Descriptives

Descriptive statistics on the developmental outcome at the earliest available assessment date and the set of explanatory characteristics used in the analysis below are presented in Table 3. Due to the over-sampling of minorities in the NLSY79 and the fact that white women have smaller families, white women's children constitute only about 45% of the sample; 33% are black and the remaining 22% are of Hispanic background as shown in Table 3. As shown in Table 3, the oldest mothers observed are age 38 at the time of birth, and the mean age at birth is 24 years. The sample covers most of the reproductive span of a women and our results do not only represent the situation in families of young women.

Child Achievement

The PPVT-R scores range from 40 to 160 with a mean of 87.7 and a standard deviation of 19 (Table 3). We note that both African-American and Hispanic children score substantially lower than the average white child in the sample. As it has been pointed out before, these differences remain significant in multivariate regression analysis controlling for a variety of socioeconomic factors (cf. Center for Human Resource Research 1992, p. 16). Since the test is based on receptive hearing of standard American English, Hispanic children are disadvantaged since English is not their parents' mother tongue. Therefore, Hispanic children could take the test in Spanish after the 1986 survey if they preferred to do so. The cultural fairness of the PPVT-R based on the comparison of the scores of black and white children has been debated. A comparison study of the PPVT-R and its successor version that became available in 1997 (not available in the NLSY79) suggested that the items in the updated version are culturally less biased (cf. Washington and Craig 1999). Children who are later in the birth order have a lower cognitive ability. In particular, as shown in Tables 3-4, the average first child scores 9 points higher on the PPVT-R than the average third child.

Inputs and Endowments

The average child in the sample is a second-born child (Table 3). About 43.5% of the children in the sample are first-born, 34.1% second-born, and 15.5% third-born. A large fraction (44.7%) of children experience the arrival of a younger sibling before they take the test. Since most women in the data will have completed their reproductive life course as of the last round of the survey used here, we construct measures of birth order by (ultimately) completed family size. As shown in Table 3, the majority of children grow up in either a two-child (36%) or a three-child (30%) family. Only about 9% of the children in the sample grow up as an only-child, and about 25% of all children have three or more siblings.

The environment that children enter at birth and grow up in can differ greatly between children even if they are siblings. Children of young mothers are more likely to grow up in the grandparent's household, without a father and a mother who is still enrolled in school. About 12% of the children are born while the women lives in her parents' household. As can be seen from Table 3, for the average child a father (husband) is present about 65% of the time between birth and before the PPVT-R assessment. The average child's mother is enrolled in school (high school, college, or university) during 5% of that time.

Mother's time spent with the child is likely to depend inversely on her labor force participation and labor supply. Measures of women's time spent in the labor market are constructed from data on weeks employed during the time between birth and the assessment.[3] The average child experiences a mother who works about 45% of the time before the test is administered.

The economic situation of the families also varies substantially. The mean total net family income earned during the period before the child is tested is about $\$23,000$ with a standard deviation of $\$32,000$.[4] Since it reflects all incomes earned in the household in which the women currently resides, it is necessary to control for whether or not the mother lives with her parents. Also, information on family income is unavailable for a 20% of the children.

Not only the physical presence of the likely caregivers in the household is of interest but also their ability to nurture and stimulate the child during infancy. The ability to provide services that foster the child's development is proxied by the amount of education acquired by potential caregivers. The average child's mother ultimately completes 12 years of schooling (cf. Table 3). We also utilize the educational attainment of the mother's spouse who is present in the household when the child is born (hence who will typically be the biological father of the child). The average years of schooling completed by the mother's spouse at that time is also 12 years (not shown). The average shown in Table 3 is lower than that since this measure of educational attainment of the spouse equals zero if there is no spouse present. The NLSY79 also provides information on the mother's parents' educational attainment: the average parent of the mother completed 10 years of schooling. Information on the child's grandparents' educational attainment may also proxy

[3]The employment spells in the data include periods of vacation, paid sick leave and paid maternity leave.
[4]The income measure is deflated using the Consumer Price Index (1982-84; all urban consumers).

for preferences and tastes that help to purge other inputs that are potentially endogenous such as schooling and labor supply of potential omitted variable bias.

The characteristics of the child's and the family's endowments may capture important aspects about the child development production technology. Male children typically develop slower than female children. In the analysis, male children constitute about 51% of the overall sample. Low birth-weight is used as an indicator of poor health at birth. Birth-weight information is available for most children (95%; Table 2). About 8.1% of the children with complete data weighed 2,500 grams or less at birth.[5] Fortunately, AFQT, a measure of mother's own cognitive ability, is available for most mother's in the sample (for 96.7% of the children). Because this intelligence test is administered to respondents during the same interview year, it may reflect variation of ability that can be explained by differences in age. To derive an ability measure that is age-corrected and hence better reflects family endowments, we regressed the original AFQT score on age dummies. The summary statistics of the residuals are reported in Table 3. Other potential endowment factors are the mother's age at birth (24 years on average) and her weight (130 pounds on average). We account for mother's belief and family size preference by including an indicator for the child's mother being Catholic (35% on average) and the number of her siblings, respectively.

4 Empirical Analysis

4.1 Model Specification

We now turn to the empirical analysis. To test for birth order and family size effects, we estimate child/sibling development production functions assuming that the outcome of the ith child in family k relates to inputs in the following linear form:

$$\text{Outcome}(i,k) = u(k) + \beta_0\{\text{Birth Order Indicators}\}(i,k) + \beta_1\{\text{Child Characteristics}\}(i,k) \quad (1)$$

[5] Notice that the measure may confound determinants of low birth-weight at due date and behavior that affects the length of gestation.

$$+\beta_2\{\text{Quality of Inputs}\}(i,k)+\beta_3\{\text{Inputs}\}(i,k)+\beta_4\{\text{Market Inputs}\}(i,k,t)+\varepsilon(i,k),$$

where $u(k)$ is a family specific unobserved effect that may be correlated with other regressors, and $\varepsilon(i,k)$ is a child and family specific error term.

We control for a large set of characteristics of the child and the family environment it experiences. 'Child Characteristics' includes race, gender, religion, number of mother's siblings, whether the child was a low birth-weight baby, and the mother's cognitive ability measured by AFQT as a proxy for genetic endowments. 'Quality of Inputs' controls for mother's, mother's spouses (father), mother's grandmother's and grandfather's educational attainment, mother's age at birth, and indicators of mother's health. The percentage of the time the mother's spouse was present in the household before the child took the test, the average school enrollment status of the mother, the percentage of time she lived in her parents' household, and her average labor supply during that period are 'Inputs' in the production of child development. Finally, 'Market Inputs' contains the average total net family income during which proxies for quantity and quality of market-purchased goods and services.

Notice that all measures are based on the entire period from birth to assessment. This type of specification is also known as the Cumulative Model (cf. Todd and Wolpin 2003) and is widely used when the appropriate data are available (e.g., Blau and Grossberg 1992).

4.2 Identification

The objective is to estimate β_0, the coefficient vector associated with birth order. The birth order coefficients capture the effect of the existence of older siblings on the PPVT-R score of the child. The birth order and family size effects are identified from the variation that exists between children of the same order in different families and between children of different ranks in the same family. Given the variables available in the data, we are confident that we are accounting for important elements of endowment heterogeneity (via birth weight, mother's AFQT) and elements of quality and quantity of the services a child receives (via income, age, maternal employment, father's presence, education). The birth order effects are the otherwise unmeasured changes in quantity and quality of inputs a child receives with a change in family size. Since we do not observe amounts and quality at the child level, the birth order effects may be driven by parents' differential investment behavior. Since it appears to be that parents invest to obtain similar achievements across their children (cf. Becker and Tomes 1975; Behrman and Taubman 1986; Hanushek 1992), such behavior would offset any detrimental effects from being late in the birth order. In other words, the estimated birth order effects would present conservative estimates (or lower bounds) of the true effects.

To investigate the role of younger siblings in the development process, we test for the effect of younger siblings that are born before the assessment of the older sibling. In addition, we investigate the robustness of the birth order effects. One potential source of bias in the birth order measures is heterogeneity in ultimately completed family size. For example, if parents who will ultimately have a larger families also provide fewer inputs to each child during its childhood, birth order may pick up a spurious correlation between family size and development. To purge the birth order coefficients of such potential omitted variable bias due to unobserved factors at the family level that are correlated with the position in the birth order and the child outcome, we estimate — in addition to Ordinary Least Squares (OLS) and Family Random Effects (RE) models — Family Fixed Effects (FFE) and Sibling First Difference (FD) models and models that control for ultimately completed family size.

OLS and RE estimators exploit the variation that exists between and within families whereas FFE and FD estimators only use the variation between children in the same family.[6] The RE estimator is more efficient than OLS in the presence of family-specific unobserved effects, $u(k)$. To test between the OLS and RE specification, we performed Breusch and Pagan Lagrange Multiplier Tests (1980). The First Difference approach uses the difference of all variables (except birth order indicators) for siblings adjacent in the birth sequence. While the FFE controls for family-specific effects that are constant across all siblings, FD is more general because it controls for sibling-pair

[6]To address the problem of clustered correlation in errors that is likely to exist for children from the same family, robust OLS standard errors are computed using the appropriate Huber-White correction.

specific effects.[7] Of course, one of the limitations of FFE and FD is that — by construction — they are only identified based on families with two or more children which may systematically differ from one-child families.

4.3 Results

Tables 4-6 present results obtained using four approaches to estimate (1). Table 4 and 6 present all coefficients based on the pooled sample using different specifications. Table 5 presents the coefficients of main interest by race/ethnicity. The model fit the data reasonably well as indicated by coefficients of determination (R^2) of up to 40% in the pooled sample. For all specifications and samples, the more general error structure that accounts for heterogeneity between families, i.e. RE, was preferred to the OLS specification (results available upon request). Hausman specification tests (1978) were performed to test between the RE and FFE/FD. As indicated by large values of the Hausman test statistic, treating $u(k)$ as family-level random effects that are uncorrelated with the explanatory variables may be incorrect.[8] In other words, the birth order effects based on the RE specification may be subject to omitted variable bias and a comparison to the FFE and FD results is highly warranted.

Birth Order Effects

Overall, the results suggest that being late in the birth order is detrimental for child development. Moving one rank down in birth order has a large and statistically significant detrimental effect on the PPVT-R in all models as shown in Table 4. Also, the order effects are jointly statistically significant different from zero for the OLS, the RE, and the FE models. Based on OLS and RE in the pooled sample, being second-born compared to first-born reduces the score by 3.4 points or more than 1/6 of a standard deviation of the PPVT-R. The results indicate that the magnitude of the gains from being born earlier depend on the position in the birth order. The largest difference

[7] Since FD differences between siblings by order, the order indicators enters the specification in levels. Their coefficients need to be interpreted as conditional order effects.

[8] One can reject the RE specification in favor of FFE and FD at the 5% significance level in the overall sample.

is found between the first and the second child, the smallest between the fourth and the fifth (or higher) child. Specifically, being third compared to second reduces the outcome by about 2.4 points (Table 4, OLS: $-3.4-(-5.8)=2.4$) compared to 3.4 points from first to second.

Table 4 also shows that there is some evidence that not only the number of older siblings matters — as captured by the birth order indicators — but also the presence of a younger sibling that is born before the assessment (cf. Table 4). The arrival of a younger sibling is found to reduce the cognitive achievement of a child. This effect holds across specifications and samples with maximum reductions of close to 3 points, i.e. 3/19 of a standard deviation, on the standardized scale for the PPVT-R in the overall sample.

The evidence of a negative association of rank in the birth order and developmental outcome provided by OLS and RE is supported by the FFE and FD estimates from the pooled sample (cf. Table 4).[9] FFE and FD control for family level respectively sibling-pair level constant unobserved factors. The birth order effects based on FFE and FD are smaller than the OLS and RE results but the pattern is preserved and the coefficients are statistically significant. The FD results show an average difference of 2.8 points between the first-born and second-born, a 1.7 point difference between second and third, a 0.8 difference (statistically insignificant) between the third and no difference between the fourth and higher order siblings. Comparable magnitudes can be computed based on the FFE results.

Table 5 reports the birth order coefficients based on separate estimates of the developmental production process (1) for the White, African-American, and Hispanic subsamples.[10] Unlike the pooled results, these estimates are not constrained to be the same for the different groups, hence they allow differences between these groups to be uncovered. The cost of this approach is that the results are obtained from smaller samples, which makes statistical inference more difficult. Table 5 shows that the same negative association between birth rank and PPVT-R score as in the pooled sample is found in the subsamples. The differentials by rank are largest for children of white (non-

[9]Notice the interpretation of the coefficient in the First Differencing model: the order effect refers to the change in a child's performance relative to the preceding sibling. To make a comparison between children of rank one it is necessary to sum the coefficients up to the rank of the child of interest.

[10]The complete results are available from the author upon request.

Hispanic) mothers. Overall, the pattern among Hispanic children more closely resembles that of Whites than that of African-Americans. In particular, it is interesting that no (statistically significant) achievement gap between the first and the second child is found among African-American families. In fact, FFE and FD indicate that the second child may be marginally better off than the first child; however, the coefficient is not statistically significant different from zero. Among Hispanics, the evidence suggests that a fifth or higher order child does significantly worse than his or her closest older sibling.

We have seen that a negative association between birth order and PPVT-R exists and the differences appear to be decreasing in rank. The fact that this pattern holds across ethnic/racial groups suggests that it is a robust finding. The effects are also visible using FFE and FD, however, they are smaller than OLS and RE, which may be due to systematic but unmeasured differences in childrearing between parents of large and small families. To investigate this aspect further, we also estimated models controlling for birth order by ultimately completed family size. The latter reflects all children born to a women in the sample, including those born after the assessment of a given child. We note that the mother's preference for family size — which may be inversely related to the opportunities to nurture each child — may already be proxied for by the mother's number of siblings measure (cf. Table 4). Table 6 shows the estimates for the specification that interacts birth order and completed family size for all children in the pooled sample. The reference group is the one-child family in the OLS and RE models and the first child in each family type (of two children or more) in the FFE and FD models. In the enriched specification, the effects are still mostly jointly different from zero, thus confirming the importance of the birth order effects (test results not shown). The estimates are consistent with the unconditioned birth order effects in Table 4: being second is worse than being first in all family types. There is also evidence that the third child scores lower than the second child in families of four and five (or more) children. However, the last child's performance is found to be quite similar to the second-to-last child in families of ultimately three or four children.

The results show that it is the child's birth order — i.e. the number of older siblings he or she grows up with — that matters for cognitive development. There is no evidence that the ultimate number of children born in the family of the child is negatively related to each child's performance. For example, the second child of a mother who eventually has two children scores about the same on the PPVT-R as a child in the same rank in a family of (ultimately) three or four children (Table 6).

Other Determinants of Child Development

In this section we briefly summarize the results for the other determinants of child development. The remaining input and quality measures in the regression mostly display the expected signs (Tables 4 and 6).[11]

As found before (cf. Washington and Craig 1999; Center for Human Resource Research 1992), substantial difference between white non-Hispanic (reference category) and minority children exist. Also, on average, a male child scores between 0.9 and 1.3 points lower on the PPVT-R than a female child and poor health endowments of the child — proxied by low birth-weight — is associated with a reduction in cognitive achievement according to OLS and RE.[12,13] Even though the PPVT-R is age-standardized, the child's age at the time of the test is positively related to the test score.

Consistent with previous findings by Geronimus et al. (1994), age of the mother at birth does not have an independent effect on child development. Mother's weight (at the upper part of the scale a proxy for poor health and possible unhealthy life style), on the other hand, is found to have a negative association with development. The mother being Catholic has a small positive and the mother having many siblings has a small negative but statistically insignificant effect on development.

[11] See Edwards and Grossman (1979) for one of the first comprehensive studies of the determinants of child development.

[12] The within-family variation is insufficient to identify this effect in the FFE and FD models.

[13] Since low birth-weight is generally found to be a strong predictor of a range of health conditions in a child's later development, it is an important child endowment. A discussion of the long-term developmental problems of low birth-weight children can be found in Hack et al. (1995). Currie and Gruber (1999), Corman (1995), and Corman and Chaikind (1998) provide evidence that low birth-weight children are more likely to display poorer health, and scholastic performance compared to their normal birth-weight peers.

The mother's cognitive ability, as well as her parents', her spouse's, and her own educational attainment, are strong predictors of the child's verbal development. The child's grandmother's and the spouse's attainment are found to have a larger effect on development, which is consistent with the idea that they are likely alternative caregivers for the mother. The effect of mother's schooling is substantial. The score increases by around 0.4 points for each grade level completed (OLS and RE).

A positive and marginally significant effect of maternal labor supply between birth and test date is found in the OLS and RE model in Table 4. However, the effect is small and not significant in many specifications. This may be the result of opposing effects of employment and labor supply by developmental stage of the child. Recent studies find that maternal employment or the amount of time mothers spent in the labor market may be detrimental early in the child's life but beneficial later (cf. Baydar and Brooks-Gunn 1991; Blau and Grossberg 1992; Ruhm 2000; Han et al. 2001; Waldfogel et al. 2002; Baum 2003; Heiland 2003).

Consistent with previous findings (e.g., Cooksey 1997), the presence of the spouse (typically the father) is beneficial to a child as a result of the additional physical and time resources associated with the father and his family network. The results show that there appears to be a positive association between mother's enrollment in school during the time after birth and child development. This is opposite of what was expected if time spent on learning and in school reduces the time available to a child. However, school enrollment may be associated with better infrastructure to provide non-maternal care to the child. In any case, the spousal and the enrollment effects are mostly not statistically significant at standard significance levels.

Finally, the average annual amount of family income available between birth and assessment is positively associated with child cognitive development. The effects are consistent with evidence of small effects of contemporary income and somewhat larger effects of permanent income on development by Blau (1999).

5 Conclusions

Using data from the National Longitudinal Survey of Youth 1979 (NLSY79), we constructed large child and sibling samples to investigate the relationship between birth order of a child and his or her cognitive development. Controlling for various determinants of cognitive development, we find that having a high birth rank is detrimental and that the gap between adjacent siblings narrows for later-born siblings. The pattern is strongest for non-Hispanic white and Hispanic children. While among African-American children no difference between first- and second-born child was found, the negative relationship was confirmed for the third or higher-parity child. The negative birth order effects are robust to specification that control for family fixed effects, use a sibling first difference approach, or account for subsequent siblings. We also find that not only older siblings but also younger siblings lower the verbal achievements of a child.

Explanations consistent with the negative birth order coefficients are provided by the Quantity Dilution Hypothesis (Blake 1981; Leibovitz 1977; Becker 1965; Becker and Lewis 1973) as well as the Quality Dilution Hypothesis (Zajonc and Markus 1975; Zajonc 2001). Dilution models suggest that being early in the birth order is beneficial for attainment since a child that is early in the birth order may receive a larger share of the family resource or the services received are of better quality compared to a later-born sibling who faces more competition. Since we use a verbal ability scale as measure of cognitive development, we expect that the quality and the amount of verbal communication between the parents that the child overhears, between the parents, and the children and between children play an important role in the developmental process that is reflected in the birth order effects. We note that it is not possible to identify to what extend the birth order effects are the result of quantity or quality dilution. While the quality dilution model stresses the quality of the intellectual environment and of the interaction between siblings, the amount of verbal interaction may be equally important.

It is important to note that we find differences in the birth order pattern by ethnicity and race. In particular, the absence of a developmental difference between the first-born and second-born child among African-American families raises interesting question regarding the mechanisms that are in place in African-American families that yield similar conditions for the first and second-born. An explanation may lie in the increased economic hardship that a first-born to a (often single) African-American mother must face (cf. McLoyd 1990).

Our findings on birth order effects also contribute to the discussion on whether the negative relation between birth order/family size and child achievement is causal. This debate started with the negative birth order-ability association found in cross-sectional data. We show that this relationship is also found in models that exploit within-family variation. Since this approach effectively controls for unobserved characteristics that affect development at all parity levels in the same way, a stronger case for the causal nature of the birth order-ability relation is made here. We note that Guo and VanWey (1999) did not find statistical evidence for a negative family size effect among whites using a similar approach and data. This may be, in part, due to the limited sample size available at the time of their study: 272 families in Guo and VanWey compared to 1,263 families in the present study. In addition, Guo and VanWey consider only variation in family size; i.e., they assume that the birth order effect is the same across siblings, an assumption that is inconsistent with the nonlinear effects that we find.

Future work may focus on the effect of birth order on dimensions of cognitive and behavioral development not discussed here (using outcome measures such as math ability, memorization, or behavioral problems indices). Evidence based on large and representative child and sibling samples would be helpful to determine what other aspects of child development - in addition to verbal ability - may be sensitive to these kind of family structure changes.

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Table 1: PPVT-R[a,d] Data Collection in NLSY79: 1979-1998

Survey Year	**Age Group**	**Validity**[b]	**Mean**[b,c]
1986	3+	86.9%	86.33
1988	3+ (repeat only 10-11)	88.3%	85.77
1990	4+ (repeat only 10-11)	85.5%	85.83
1992	3+ (repeat all)	89.7%	89.80
1994	3+ (repeat only 10-11)	85.2%	88.98
1996	4+ (repeat only 10-11)	89.0%	91.88
1998	4+ (repeat only 10-11)	85.9%	91.92

Note: [a]All Scores are reported on a Standardized Scale. [b]Fraction of valid responses in the original sample. [c]Based on valid responses in the original sample. [d]After 1986 children had a choice between the Spanish and the English version of the test. The test score is standardized using scores from a nationally representative sample of children in 1979.

Table 2: Sample: Variable Definitions

Variable	Definition
Child Outcome	
PPVT-R Score	child's Peabody Picture Vocabulary Test Revised standardized score
Child Characteristics	
Hispanic	equals 1 if Hispanic; 0 otherwise
Black	equals 1 if African-American; 0 otherwise
White	equals 1 if white; 0 otherwise
Boy	equals 1 if child is male; 0 otherwise
Low Birth Weight	equals 1 if child's birth weight is less than 2,500 grams; 0 otherwise
Child's Age at Test	child's age when test taken (in years)
Rank in Birth Order	equal to the rank of the child in the birth order
Younger Sibling	equals 1 if younger sibling is born before test is taken; 0 otherwise
Maternal Inputs[a]	
Mother's Age at Birth	mother's age at birth of child
AFQT	mother's Armed Forces Qualification Test - Age Corrected
Mother's Education	mother's highest completed grade level
Weight	mother's weight in pounds at fourth round of interview)
In School	fraction of years mother is enrolled in school
Lives with Parents	fraction of years mother is living in parents' dwelling unit
Weeks worked	fraction of weeks worked by the mother
Other Inputs[a]	
Education of Spouse	mother's spouse's educational attainment at birth (0 if unknown or no spouse)
Grandmother's Education	woman's mother's highest completed grade level (0 if unknown)
Grandfather's Education	woman's father's highest completed grade level (0 if unknown)
Spouse Present	fraction of years child spouse present
Total Family Income[b]	average net total annual income of mother's current household
Mother's Siblings	number of mother's siblings (0 if none/unknown, 1 if one or two, 2 if more than two)

Note:[a]Fractions are computed using non-missing data from birth to time of test administration. [b]In 1982-84 Dollars.

Table 3: Sample: Descriptive Statistics[a]

Variable[b]	**Mean**	**Std. Dev.**	**Min**	**Max**	**Sample**
Outcomes					
PPVT-R Score	87.62	18.90	40	156	6,036
Child's Age at Test	5.10	1.78	3	14.4	6,036
PPVT-R Score (Black)	77.78	15.90	40	136	1,976
PPVT-R Score (Hispanic)	81.59	19.05	40	156	1,324
PPVT-R Score (White)	97.65	15.56	43	160	2,736
PPVT-R Score (First Child)	91.45	18.56	40	156	2,624
PPVT-R Score (Second Child)	87.31	18.52	40	155	2,057
PPVT-R Score (Third Child)	82.45	17.65	40	160	935
PPVT-R Score (Fourth Child)	77.89	18.84	41	148	292
PPVT-R Score (Fifth+ Child)	74.17	17.36	40	123	128
Endowments of the Child					
Black	0.327	0.469	0	1	6,036
Hispanic	0.219	0.414	0	1	6,036
White	0.453	0.498	0	1	6,036
Boy	0.511	0.500	0	1	6,036
Low Birth Weight	0.081	0.274	0	1	5,760
Birth Weight Unknown	0.046	0.202	0	1	6,036
Mother's AFQT	-0.048	0.260	-.0429	0.633	5,778
Mother's AFQT Unknown	0.043	0.157	0	1	6,036
Mother's Siblings	1.691	0.502	0	2	6,026
Mother's Siblings Unknown	0.002	0.041	0	1	6,036
Quality of Home Inputs					
Mother's Education	12.11	2.244	0	20	5,903
Mother's Education Unknown	0.022	0.147	0	1	6,036
Education of Spouse	7.687	6.448	0	20	5,984
Education of Spouse Unknown	0.010	0.092	0	1	6,036
Grandmother's Education	10.28	3.25	0	20	5,644
Grandmother's Education Unknown	0.065	0.246	0	1	6,036
Grandfather's Education	10.20	3.99	0	20	5,027
Grandfather's Education Unknown	0.167	0.373	0	1	6,036
Mother's Age at Birth	24.3	4.2	14	38	6,036
Weight	129.88	22.62	80	300	5,894
Weight Unknown	0.024	0.152	0	1	6,036
Catholic	0.353	0.478	0	1	6,020
Catholic Unknown	0.003	0.051	0	1	6,036
Market Inputs					
Total Net Family Income[c,d]	23.04	31.86	0	496.31	4,842
Family Income Unknown	0.198	0.398	0	1	6,036

Table 3: Sample: Descriptive Statistics (continued)

Variable[b]	Mean	Std. Dev.	Min	Max	Sample
Home Inputs					
Spouse Present[c]	0.645	0.447	0	1	6,036
Enrolled[c]	0.050	0.165	0	1	6,025
Enrollment Unknown	0.002	0.043	0	1	6,036
Lives with Parents[c]	0.117	0.260	0	1	6,036
Weeks worked[c]	0.452	0.377	0	1	6,036
Child's Rank in Birth Order	1.886	1.000	1	6	6,036
First	0.435	0.496	0	1	6,036
Second	0.341	0.474	0	1	6,036
Third	0.155	0.362	0	1	6,036
Fourth	0.048	0.215	0	1	6,036
Fifth	0.021	0.144	0	1	6,036
Younger Sibling	0.447	0.497	0	1	6,036
First - Family of 1	0.092	0.289	0	1	6,036
First - Family of 2	0.190	0.392	0	1	6,036
Second - Family of 2	0.166	0.372	0	1	6,036
First - Family of 3	0.104	0.306	0	1	6,036
Second - Family of 3	0.114	0.318	0	1	6,036
Third - Family of 3	0.093	0.290	0	1	6,036
First - Family of 4	0.035	0.184	0	1	6,036
Second - Family of 4	0.042	0.201	0	1	6,036
Third - Family of 4	0.041	0.199	0	1	6,036
Fourth - Family of 4	0.029	0.169	0	1	6,036
First - Family of 5+	0.014	0.116	0	1	6,036
Second - Family of 5+	0.019	0.136	0	1	6,036
Third - Family of 5+	0.021	0.142	0	1	6,036
Fourth - Family of 5+	0.019	0.136	0	1	6,036
Fifth - Family of 5+	0.021	0.144	0	1	6,036

Note: [a]Statistics computed based on known observations only. Except from the outcome measures the summary statistics are based on the sample of children with a PPVT-R score.
[b]Measures refer to status at child's birth unless noted otherwise (cf. *c*).
[c]Average of non-missing values before test date.
[d]In 1,000s 1982-84 Dollars.

Table 4: Basic Specification: PPVT-R - Pooled Sample

Variable	**OLS**	**RE**	**FFE**	**FD**
Child Characteristics				
Boy	-0.909**	-1.048***	-1.320***	-1.330***
	(0.390)	(0.365)	(0.453)	(0.493)
Low Birth Weight	-1.711**	-1.271*	-0.101	0.020
	(0.782)	(0.712)	(0.948)	(1.013)
Birth Weight Unknown	-1.169	-0.768	0.014	0.900
	(1.019)	(0.912)	(1.144)	(1.265)
Child's Age at Test	0.739***	0.856***	1.287***	1.394***
	(0.159)	(0.141)	(0.279)	(0.421)
Black	-10.786***	-11.057***		
	(0.705)	(0.701)		
Hispanic	-8.400***	-8.444***		
	(0.953)	(0.824)		
Mother's AFQT	13.304***	13.365***		
	(1.330)	(1.315)		
Mother's AFQT Unknown	-3.204**	-3.368***		
	(1.546)	(1.276)		
Mother's Weight	-0.044***	-0.042***		
	(0.011)	(0.010)		
Mother's Weight Unknown	-1.992	-1.302		
	(2.300)	(2.114)		
Catholic	0.885	0.914		
	(0.646)	(0.623)		
Faith Unknown	-0.776	-2.207		
	(4.298)	(4.664)		
Mother's Siblings	-0.732	-0.496		
	(0.479)	(0.471)		
Mother's Siblings Unknown	-6.555	-5.208		
	(7.264)	(5.901)		
Quality of Inputs				
Mother's Education	0.436***	0.357**	-0.274	-0.274
	(0.149)	(0.146)	(0.452)	(0.519)
Mother's Education Unknown	7.537***	5.688**	-2.806	-4.362
	(2.316)	(2.233)	(5.547)	(6.681)
Education of Spouse	0.204***	0.159***	0.072	0.033
	(0.052)	(0.047)	(0.064)	(0.069)
Education of Spouse Unknown	-1.160	-0.344	0.347	0.805
	(2.440)	(2.036)	(2.502)	(3.202)
Mother's Age at Birth	0.030	-0.064	-0.117	-0.458
	(0.621)	(0.556)	(0.832)	(0.999)
Mother's Age Squared	0.006	0.008	0.015	0.026
	(0.012)	(0.011)	(0.015)	(0.018)
Grandmother's Education	0.499***	0.491***		
	(0.101)	(0.100)		
Grandmother's Education Unknown	3.716***	3.827***		
	(1.359)	(1.372)		

Table 4: Basic Specification: PPVT-R - Pooled Sample (continued)

Variable	**OLS**	**RE**	**FFE**	**FD**
Quality of Inputs				
Grandfather's Education	0.173**	0.203**		
	(0.080)	(0.082)		
Grandfather's Education Unknown	0.877	1.097		
	(1.001)	(1.001)		
Inputs				
Spouse Present	0.595	1.069	1.579	1.277
	(0.737)	(0.716)	(1.152)	(1.269)
Enrolled in School	1.343	1.914	5.013**	4.982**
	(1.272)	(1.237)	(2.124)	(2.544)
Enrollment Unknown	1.429	1.309	0.275	2.250
	(3.429)	(4.715)	(7.536)	(4.180)
Weeks Worked	1.164*	1.167*	1.256	1.710
	(0.649)	(0.617)	(1.166)	(1.248)
Total Net Family Income	0.010	0.014*	0.030***	0.030**
	(0.008)	(0.007)	(0.011)	(0.013)
Total Net Family Income Unknown	0.086	0.116	0.056	-0.546
	(0.547)	(0.514)	(0.676)	(0.750)
Lives with Parents	0.053	0.221	-0.383	-0.800
	(0.943)	(0.896)	(1.390)	(1.638)
Younger Sibling	-2.253***	-2.174***	-1.644**	-1.237**
	(0.422)	(0.411)	(0.578)	(0.622)
Second Child	-3.427***	-3.389***	-2.903***	-2.791**
	(0.439)	(0.437)	(0.736)	(0.817)
Third Child	-5.855***	-5.690***	-4.758***	-1.726**
	(0.649)	(0.628)	(1.251)	(0.850)
Fourth Child	-8.207***	-7.372***	-5.404**	-0.801
	(1.035)	(0.973)	(1.767)	(1.183)
Fifth+ Child	-8.744***	-7.785***	-5.762**	0.005
	(1.715)	(1.422)	(2.378)	(1.561)
Constant	83.044***	83.411***	82.273***	
	(8.025)	(7.319)	(12.176)	
R^2	0.377	0.376	0.0826	0.0547
R^2 (between)		0.422	0.0709	
R^2 (within)		0.055	0.0659	
N	6,036	6,036	6,036	2,926

Notes: The dependent variable equals to the child's standardized PPVT-R score. Huber-White corrected standard errors in parenthesis for OLS and FD. All regressions also control for geographic residence around the birth of the child and interview year. *Statistically significant at the .10 level; **at the .05 level (two-tailed test); ***at the .01 level (two-tailed test).

Table 5: Basic Specification: Developmental Outcomes - Whites, Blacks, and Hispanics

Variable	OLS	RE	FFE	FD
Whites				
Younger Sibling	-2.440***	-2.352***	-1.523*	-1.095
	(0.630)	(0.595)	(0.875)	(0.943)
Second Child	-4.660***	-4.675***	-4.385***	-3.960***
	(0.626)	(0.609)	(1.111)	(1.149)
Third Child	-6.924***	-6.691***	-5.858***	-0.961
	(0.993)	(0.917)	(1.950)	(1.237)
Fourth Child	-9.749***	-8.508***	-5.966**	-0.138
	(1.848)	(1.562)	(2.826)	(2.217)
Fifth+ Child	-9.237***	-6.951**	-2.157	5.359
	(2.880)	(2.794)	(4.303)	(3.759)
R^2	0.187	0.185	0.059	0.096
R^2 (between)		0.195	0.042	
R^2 (within)		0.075	0.095	
N	2,736	2,736	2,736	1,263
Blacks				
Younger Sibling	-2.487***	-2.699***	-2.659***	-1.960*
	(0.711)	(0.704)	(0.992)	(1.080)
Second Child	-1.222	-1.071	0.671	0.865
	(0.764)	(0.779)	(1.280)	(1.451)
Third Child	-4.542***	-4.360***	-1.212	-1.724
	(1.061)	(1.059)	(2.097)	(1.357)
Fourth Child	-7.316***	-6.709***	-2.172	-1.223
	(1.420)	(1.557)	(2.952)	(1.765)
Fifth+ Child	-6.907***	-6.891***	-1.892	0.052
	(1.891)	(2.126)	(3.827)	(2.151)
R^2	0.207	0.205	0.023	0.083
R^2 (between)		0.249	0.011	
R^2 (within)		0.081	0.098	
N	1,976	1,976	1,976	985
Hispanics				
Younger Sibling	-1.484	-1.160	-0.635	-0.345
	(0.991)	(0.969)	(1.281)	(1.361)
Second Child	-3.435***	-3.406***	-3.359**	-3.479*
	(1.043)	(1.059)	(1.707)	(1.926)
Third Child	-5.235***	-5.047***	-5.195*	-2.165
	(1.491)	(1.497)	(2.831)	(2.062)
Fourth Child	-5.224**	-4.552**	-5.114	-0.437
	(2.386)	(2.178)	(3.889)	(2.323)
Fifth+ Child	-8.573***	-6.954**	-8.315	-4.091
	(2.700)	(3.024)	(5.072)	(3.133)
R^2	0.226	0.222	0.027	0.068
R^2 (between)		0.254	0.009	
R^2 (within)		0.055	0.078	
N	1,324	1,324	1,324	678

Notes: Huber-White corrected standard errors in parenthesis for OLS and FD. In addition to the controls detailed in Table 4, all regressions also control for geographic residence around the birth of the child and interview year. *Statistically significant at the .10 level; **at the .05 level (two-tailed test); ***at the .01 level (two-tailed test).

Table 6: Completed Family Size Specification: PPVT-R - Pooled Sample

Variable	OLS	RE	FFE	FD
Child Characteristics				
Boy	-0.910**	-1.050***	-1.320***	-1.333***
	(0.391)	(0.365)	(0.453)	(0.494)
Low Birth Weight	-1.628**	-1.220*	-0.153	-0.013
	(0.784)	(0.713)	(0.950)	(1.007)
Child's Age at Test	0.719***	0.847***	1.289***	1.399***
	(0.160)	(0.142)	(0.279)	(0.420)
Black	-10.707***	-10.947***		
	(0.706)	(0.702)		
Hispanic	-8.214***	-8.259***		
	(0.951)	(0.825)		
Mother's AFQT	13.357***	13.454***		
	(1.331)	(1.316)		
Mother's Weight	-0.045***	-0.043***		
	(0.011)	(0.010)		
Catholic	0.891	0.928		
	(0.645)	(0.622)		
Mother's Siblings	-0.677	-0.428		
	(0.482)	(0.471)		
Quality of Inputs				
Mother's Education	0.451***	0.369**	-0.290	-0.287
	(0.149)	(0.146)	(0.453)	(0.524)
Education of Spouse	0.206***	0.160***	0.070	0.031
	(0.052)	(0.047)	(0.064)	(0.069)
Mother's Age at Birth	-0.157	-0.194	-0.071	-0.388
	(0.627)	(0.560)	(0.834)	(1.003)
Mother's Age Squared	0.009	0.010	0.014	0.024
	(0.012)	(0.011)	(0.015)	(0.018)
Grandmother's Education	0.508***	0.499***		
	(0.101)	(0.100)		
Grandfather's Education	0.166**	0.196**		
	(0.080)	(0.082)		
Inputs				
Spouse Present	0.572	1.059	1.537	1.262
	(0.737)	(0.718)	(1.154)	(1.269)
Enrolled in School	1.212	1.794	4.965**	4.909*
	(1.275)	(1.237)	(2.126)	(2.556)
Weeks Worked	0.933	0.940	1.222	1.656
	(0.651)	(0.621)	(1.168)	(1.245)
Total Net Family Income	0.010	0.014*	0.029***	0.029**
	(0.008)	(0.008)	(0.011)	(0.013)
Lives with Parents	0.065	0.204	-0.383	-0.774
	(0.942)	(0.896)	(1.391)	(1.641)

Table 6: Completed Family Size Specification: PPVT-R - Pooled Sample (continued)

Variable	**OLS**	**RE**	**FFE**	**FD**
Younger Sibling	-1.083*	-1.205**	-1.490*	-0.847
	(0.582)	(0.561)	(0.766)	(0.826)
First - Family of 2	-0.896	-0.825		
	(0.885)	(0.878)		
Second - Family of 2	-3.727***	-3.689***	-3.067***	-2.504**
	(0.820)	(0.813)	(1.153)	(1.233)
First - Family of 3	-2.630**	-2.473**		
	(1.030)	(1.014)		
Second - Family of 3	-4.865***	-4.820***	-2.616***	-2.658***
	(0.944)	(0.944)	(0.923)	(0.999)
Third - Family of 3	-5.996***	-6.018***	-4.220**	-0.617
	(0.929)	(0.935)	(1.661)	(1.229)
First - Family of 4	-2.156	-2.247*		
	(1.323)	(1.326)		
Second - Family of 4	-5.011***	-5.101***	-2.750**	-2.050
	(1.277)	(1.231)	(1.297)	(1.256)
Third - Family of 4	-7.280***	-7.299***	-4.882***	-2.321
	(1.284)	(1.229)	(1.590)	(1.463)
Fourth - Family of 4	-7.868***	-7.128***	-4.281*	0.311
	(1.403)	(1.324)	(2.259)	(1.694)
First - Family of 5+	-5.726***	-5.174***		
	(1.933)	(1.834)		
Second - Family of 5+	-6.453***	-6.319***	-1.625	-1.548
	(1.727)	(1.639)	(1.917)	(2.090)
Third - Family of 5+	-8.949***	-8.971***	-4.346**	-3.188*
	(1.524)	(1.588)	(2.019)	(1.802)
Fourth - Family of 5+	-10.996***	-10.961***	-6.184***	-1.672
	(1.624)	(1.626)	(2.241)	(1.806)
Fifth - Family of 5+	-9.639***	-9.602***	-5.437**	0.364
	(1.436)	(1.576)	(2.646)	(1.675)
Constant	86.455***	86.158***	81.832***	
	(8.107)	(7.408)	(12.188)	
R^2	0.379	0.378	0.076	0.056
R^2 (between)		0.424	0.064	
R^2 (within)		0.057	0.067	
N	6,036	6,036	6,036	2,926

Notes: The dependent variable equals to the child's standardized PPVT-R score. Huber-White corrected standard errors in parenthesis for OLS and FD. All regressions also control for geographic residence around the birth of the child, interview year, and missing values for birth weight, AFQT, mother's weight, mother's siblings, education, enrollment, and family income. *Statistically significant at the .10 level; **at the .05 level (two-tailed test); ***at the .01 level (two-tailed test).