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A quasi-experimental analysis of the association between family income and offspring conduct problems

Brian M. D'Onofrio[1,2], **Jackson A. Goodnight**[1], **Carol A. Van Hulle**[3], **Joseph Lee Rodgers**[4], **Paul J. Rathouz**[3], **Irwin D. Waldman**[5], and **Benjamin B. Lahey**[3]

[1] Indiana University

[3] University of Chicago

[4] University of Oklahoma

[5] Emory University

Abstract

The study presents a quasi-experimental analysis of data on 9,194 offspring (ages 4–11 years old) of women from a nationally representative U.S. sample of households to test the causal hypotheses about the association between family income and childhood conduct problems (CPs). Comparison of unrelated individuals in the sample indicated a robust inverse association, with the relation being larger at higher levels of income and for male offspring, even when statistical covariates were included to account for measured confounds that distinguish different families. Offspring also were compared to their siblings and cousins who were exposed to different levels of family income in childhood to rule out unmeasured environmental and genetic factors confounded with family income as explanations for the association. In these within-family analyses, boys exposed to lower family income still exhibited significantly higher levels of CPs. When considered in the context of previous studies using different designs, these results support the inference that family income influences CPs, particularly in males, through causal environmental processes specifically related to earnings within the nuclear family.

Keywords

income; conduct problems; externalizing problems; causality; quasi-experimental approaches

In the United States, one child in six lives in dire economic poverty (DeNavas-Walt, Proctor, & Mills, 2006; Proctor & Dalaker, 2003). In addition, an additional 20% of children live just above the poverty threshold but experience almost the same degree of material deprivation, including insufficient food, utility shut offs due to nonpayment, and residential instability (Gershoff, Aber, Raver, & Lennon, 2007). These statistics are deeply concerning at many levels. Directly relevant to the present paper, many studies show that there is a strong inverse correlation between family income level and child and adolescent conduct problems (CPs) (Blau, 1999; Lahey et al., 2006; McLeod & Shanahan, 1996; Miller et al., 1999; NICHD Early Child Care Research Network, 2005).

The inverse correlation between family income and CPs tells us that children living in poverty will have the greatest need for services to prevent and treat CPs. By itself, however, the

[2]All correspondence should be sent to: Brian D'Onofrio, Department of Psychological and Brain Sciences, Indiana University, 1101 E. 10th St., Bloomington, IN 47405. Phone: 812-856-0843. Fax: 812-856-4544. bmdonofr@indiana.edu.

correlation does not reveal *why* family income and child CPs are related. Conger and Donnellan (2007) have provided a cogent review of three prevailing models of the relation between adverse child outcomes and aspects of socioeconomic status (SES), including family income. The *social selection* hypothesis is that characteristics of individuals, such as lower intelligence, antisocial behavior, and substance abuse cause their SES to be as low, or lower, than their parents (Mayer, 1997). According to the social selection hypothesis, income and other aspects of SES have no causal impact on risk for negative child outcomes. In contrast, the *social causation* hypothesis is that income and other aspects of lower SES exert an indirect causal effect on child outcomes by increasing stress on parents that interferes with parenting and limits resources for investing in their children (Bradley & Corwyn, 2002; Conger, Elder, Lorenz, & Simons, 1994; Duncan & Magnuson, 2003). *Interactionist* models acknowledge the role of social selection into poverty but hypothesize that poverty nonetheless exerts causal influences on child outcomes (Conger & Donnellan, 2007; Miech, Caspi, Moffitt, Wright, & Silva, 1999).

Evidence for Causal Effects of Family Income on Offspring Conduct Problems

From the perspectives of both public policy and prevention science, it is extremely important to know if family financial resources exert an independent *causal* influence on risk for CPs in children. This is particularly important during the present period of rising costs and stagnating wage income. After a decade of decline, there has been a steady rise the percent of children living in poverty in the U.S. (Chau & Douglas-Hall, 2007). Therefore, if lower family income influences risk for CPs, there has been a recent sharp increase in an environmental factor that fosters CPs. For this reason, it is of the utmost importance to determine if family income actually contributes to CPs through causal processes.

The finding that family income is a reliable correlate of child and adolescent CPs does not mean, of course, that income is causally related to offspring CPs (Kraemer et al., 1997). Income is associated with a plethora of other risk factors for CPs that are confounded with family income (see Evans, 2004). In addition, genetic factors influence the exposure of children and families to many of these covarying risk factors (Rowe & Rodgers, 1997). In order to support the causal hypothesis, it is necessary to demonstrate that an association between income and CPs remains when genetic and environmental confounds are controlled and plausible alternative causal hypotheses can be ruled out (Rutter, Pickles, Murray, & Eaves, 2001).

A number of recent studies have used experimental and quasi-experimental designs to control unmeasured family background characteristics in an effort to test the causal effects of income on CPs. Although each design is subject to threats to internal and external validity, they are subject to different threats. Therefore, it would be possible to place confidence in the causal hypothesis if it is confirmed using several different designs. Using data from the National Longitudinal Survey of Youth (NLSY) collected from 1979 through 1990, Blau (1999) used sibling and cousin comparisons to test the association between income and a broad measure of children's internalizing and externalizing problems and cognitive abilities. The analyses statistically controlled many measured confounds, including race-ethnicity; mother's, spouse's and mother's parents' education; household structure; child age and sex; mother's cognitive abiliy; family size; marital status; and spouse's education. Blau found that average income across assessment periods was consistently associated with child CPs (total n=7,658), regardless of analytical approach used, but that mother's cognitive ability reduced the effect of income substantially. Nevertheless, the inverse association between income and CPs remained significant. In contrast to other research (e.g., Votruba-Drzal, 2006), Blau (1999) did not find that the inverse relation between income and CPs was stronger at lower ranges of income. In addition, Blau did not find consistent evidence for an association with shorter-term measures of income in cousin- and sibling-comparison models.

Hao and Matsueda (2006) also conducted an analysis of income for children between the ages of 6 and 14 years, using NLSY data collected from 1986 to 1996 (total n=5,808). While statistically controlling for intact family, living in grandparent home, receiving welfare, and several parenting characteristics including use of physical punishment, cultural activities, positive parenting, father's time, and reading activities, a sibling-comparison, fixed-effects analysis showed that low levels of income before age 6, but not concurrent income, was associated with higher levels of internalizing and externalizing behavior problems. In addition, Strohschein (2005) used NLSY data collected from 1986 to 1998 on children age 4 to 14 years to study income effects on antisocial behavior over time (total n=7,143). She used a longitudinal analytic approach in which youths were used as their own controls, and included age, family structure, household size, sex, ethnicity, maternal education, and maternal age at birth of first child as covariates. She found that low initial income was associated with greater initial antisocial behaviors, and that improvements in income were associated with improvements in antisocial behaviors over time. Longitudinal analyses of the NICHD Study of Early Child Care and Youth (n=1,132) also found similar results (Dearing, McCartney, & Taylor, 2006).

Other studies have investigated the effects of income by taking advantage of "natural experiments" in which increases in income occurred that were uncorrelated with individual family characteristics or efforts. These natural experiments have provided unique opportunities to estimate the causal effects of income while avoiding bias due to covarying family background characteristics. Costello, Compton, Keeler, and Angold (2003) analyzed the effects of income supplementation provided by the opening of a casino on an American Indian reservation. Before the casino opened, "ex-poor" children (whose families were initially poor but later received income supplementation from the casino) initially showed oppositional defiant and conduct disorder symptom levels similar to "poor" children (whose families did not receive later income supplementation). Four years after the casino opened, however, the "ex-poor" children showed reduced levels of oppositional defiant and conduct disorder symptoms that brought them to the level of children who had never been poor. The beneficial effects of increased income were not found for internalizing symptoms, suggesting that the association between family income and internalizing and externalizing symptoms should be analyzed separately. In addition, although the finding that income in adolescence influences CP levels is in disagreement with Hao and Matsueda (2006), other studies (e.g., McLeod & Shanahan, 1996; Votruba-Drzal, 2006) have found that income in later childhood predicts differences in behavior problems even when income in early childhood does not.

The hypothesis that family income has a casual impact on risk for offspring CPs has been tested in an experimental study involving random assignment to conditions that was conducted during the reform of welfare of the 1980s. Gennetian and Miller (2002) and Morris and Gennetian (2003) used data obtained from the Minnesota Family Investment Program (MFIP) to evaluate the effects of increased income on children's behavior problems. The MFIP randomly assigned a selected group of single-mother welfare recipients with young children to one of two conditions; the control group received only standard Aid for Dependent Children and the MFIP group provided employment training and financial incentives that insured that employment would increase family incomes. Modest increases in employment and income in the MFIP group were associated with significantly lower scores on externalizing problems in the children, controlling for race-ethnicity, family size, maternal education, and marital status. This study alone, however, cannot disentangle the effects of income from beneficial factors associated with maternal employment.

If family income exerts a causal effect on CPS, the effect is almost certainly distal in nature, with income impacting children indirectly through more proximal causal influences such as the choices and actions of their parents (Conger & Donnellan, 2007; Linver, Brooks-Gunn, & Kohen, 2002). Indeed, several studies have provided evidence that aspects of the home environment are significant mediators of income effects on behavior problems (e.g., Costello et al., 2003; NICHD Early Child Care Research Network 2005; Vortruba-Drzal, 2006). Therefore, if support is found for causal effects of income on CPs, that knowledge could lead to reductions in CPs in two possible ways. First, future studies that elucidate the causal pathways from increased income to reduced CPs could aid in the design and implementation of prevention efforts by identifying modifiable proximal factors. Second, state and federal programs and policies that increase lower family incomes (e.g., provision of job skill training, increases in employment, and increases in the minimum wage) could indirectly yield reductions child CPs by leading to changes in the relevant proximal influences.

The quasi-experimental studies and natural experiments just reviewed have clear advantages over conventional correlational analyses of income effects. The fixed effects studies of NLSY data evaluated the hypothesized causal effects of income while controlling for the confounding effects of family background. However, these studies were vulnerable to other biases. In particular, the samples of the NLSY fixed-effects studies cited above were conducted using early waves of data, when a disproportionately large proportion of the offspring who were old enough to have their behavior problems assessed were the offspring of young, economically disadvantaged mothers. Thus, because maternal age at first birth and income are correlated (D'Onofrio et al., submitted), there was a sharply restricted range of income in these studies of the first NLSY offspring to reach childhood. In addition, because of this bias in these samples, their findings may not be generalizable to the U.S. population. These studies also failed to statistically control for highly relevant characteristics of the mothers, particularly their own histories of substance abuse and delinquency, which are some of the strongest predictors of offspring externalizing problems (e.g., Hicks, Krueger, Iacono, McGue, & Patrick, 2004; Lahey et al., 2006; Rutter et al., 1997). The study by Morris and Gennetian (2003) evaluated the putative effects of income while excluding the effects of family background, but increased income was confounded with other important changes in the family. In addition, demonstrating that income supplementation can *reduce* existing childhood CPs is not equivalent to demonstrating that low levels of income cause higher levels CPs to develop in the first place. Thus, the existing experimental and quasi-experimental studies of income provide support for a causal inference, but important questions remain about the causal effects of family income on risk for CPs.

The current study improves upon past research efforts in several important ways. First, we use NLSY data collected from 1986 through 2004. Because the great majority of NLSY mothers had neared or come to the end of their childbearing by 2004, our findings will be more generalizable to the U.S. population than previous studies of income effects using the NLSY sample. In addition, because the sample includes many more mothers than previous studies using the NLSY sample, our analyses will benefit from increased statistical power. Second, the current study improves upon previous studies by statistically controlling for important selection factors that were not included in previous analyses, including maternal delinquency and substance use problems. These factors are highly confounded with income and have potential to give the false impression of a causal effect of income on childhood behavior problems (Hicks et al., 2004; Lahey et al., 2006).

Third, the current paper improves upon previous within-family analyses of NLSY sample by comparing *full* siblings who were exposed to different levels of income when they were the same age, which controls for both maternal *and* paternal selection factors. The disadvantage of this approach is that full siblings who were exposed to different family incomes during childhood may not be representative of all children. This disadvantage can be offset, however, by conducting complementary analyses using larger segments of the sample including both (a) comparisons of cousins, and (b) comparisons of all siblings differentially exposed to levels of family income. Because cousin and sibling comparisons have different advantages and disadvantages, the use of both strategies permits stronger causal inferences if their findings converge.

Finally, the present study used a more specific measure of CPs than the broad measures used in previous within-family analyses of the NLSY sample, which conflated internalizing and externalizing behaviors. The findings of Costello et al. (2003) that changes in income predict changes in externalizing, but not internalizing behaviors, strongly suggest that these outcomes may be differentially linked to income. CPs are defined as overt and covert actions aimed at cheating, breaking rules, destroying objects, disobeying authority figures, and hurting others. In conclusion, by conducting multiple within-family comparisons, using a much more representative sample of mothers and offspring, including important statistical controls of measured covariates that were omitted in previous studies, and by analyzing CPs apart from internalizing behaviors, the current study provides a more rigorous test of the causal effects of income on CPs than previous studies in the NLSY.

METHODS

Sample

The NLSY79 is a longitudinal study funded by the Bureau of Labor Statistics that has followed a group of adolescents and young adults (originally between the ages of 14 and 21) since 1979 (review in Baker & Mott, 1989). The original sample included a group of individuals that were representative of the U.S. population (n=6,111), using a stratified and clustered probability sample, and an over-sample of minority youth. Of note, the NLSY79 included all siblings in each household if they were within the targeted age range. The study assessed the participants annually from 1979 to 1994. Since then the participants have been assessed biennially. The NLSY79 has had high response rates throughout the study; 90% responded to the initial assessment, with retention rates being above 90% during the first 16 waves of data collection.

Details concerning our sample are available elsewhere (D'Onofrio et al., 2008; D'Onofrio et al., 2007). Briefly, the study includes 4,912 women from the original NLSY79. Women were included if they had at least one child who was four years old or older by 2004. The sample is racially diverse: 17.1% are Hispanic, 25.9% are African American, and 57.1% are non-African American, non-Hispanic. The study includes probability weights so that the sample can be weighted to more accurately produce population-based estimates.

In 1986 researchers started to assess the offspring of women in the NLSY79, with an initial response rate of 95% (Chase-Lansdale, Mott, Brooks-Gunn, & Phillips, 1991). The biennial assessments of the offspring, referred to as the CNLSY sample, have response rates averaging 90%. The current study relies on maternal report of her children's characteristics assessed between the ages of 4 and 11 (total n=9,349 children, although 155 were not included in the analyses due to insufficient information on their family income during the age range; see below). To date, many studies of the CNLSY have been plagued by selection bias due to the fact that the available children were necessarily born to younger mothers. Because the overwhelming majority (well over 95%) of the expected childbearing was completed by the 2004 survey (the last completed wave of data available for inclusion in this study), and because we are studying outcomes in childhood, the selection bias due to maternal age at childbearing for the current analyses is relatively small.

Measures

Family Income—The total family income reported by mothers in each assessment was converted to 1986 inflation-adjusted dollars. The measure at each wave consists of all income received by the household, including government support and food stamps, from the NLSY women and their spouses. Income received from a cohabiting partner was not included in the measure. Quantifying financial support from non-married cohabitating partners is problematic, and previous studies that estimated it in the NLSY found few substantive differences in their conclusions when comparing measures of income with and without financial contributions of cohabiting partners (Avellar & Smock, 2005). The mean total family income specific to each child during childhood (averaged across all ages from birth to 11 years) was calculated to estimate the family's financial resources available for each specific offspring during childhood within each family. For children who had not reached age 11 years, the average family income for all available ages was used. Sensitivity analyses found that neither the oldest age nor the number of waves of data available for each child influenced the results (see below).

Because of the clustered nature of the NLSY and CNLSY datasets (multiple adults from the original NLSY households and multiple children per mother), intraclass correlations (dividing the variation in income shared by each cluster by the total variation) can estimate how much variability in family income is shared with extended family members (cousins), shared with siblings within the same nuclear family, or unique to each individual child within a family. The amount of variation in income during childhood shared with cousins in one's extended family was ICC=.45, suggesting that almost half of the variation in family income during childhood is similar to the experience of one's cousins. Approximately 36% of the variation in income was shared with one's siblings, and 16% of the total variation in family income was unique to children within a family.

The characteristics of the sample are presented in Table 1. To explore possible sensitive periods early in development, the average family income also was calculated for each child across 0–3 years. A measure of family income when the women were approximately 30 years old also was calculated to examine whether family income in early maturity is independently predictive of offspring CPs. If family income was not available at the age of 30, income reported at the next closest age ± 3 years (27–33 years old) was used; age differences within this restricted period were not related to family income. Family income at the age of 30 may be more indicative of long-term earning potential than measures of income at earlier maternal ages because reports of family income during adolescence and early adulthood include support from parents and during periods of schooling. An overwhelming majority of women in the NLSY had completed their formal education by the age of 30. Mother's average income between the ages of 30 and 40 was also calculated to explore the relative stability or instability of family income across different ages. As expected, the measures of family income increased as the women and offspring each got older.

Consistent with other analyses of the NLSY and their children (Lahey et al., 2006), the analyses capped annual family income at $200,000 to account for outliers. The measure of family income was still positively skewed. As a result, income was transformed using the standard approach of taking the natural log. Of the 9,349 offspring assessed through 2004, 155 offspring were not included in the current analyses because the average family income was either missing or estimated to be less than 4 standard deviations from the average level of family income (below approximately $1,400/year). Family income was converted to standardized z-scores to facilitate interpretation. Table 2 presents correlations among the measures of family income at different points in time.

Maternal and Familial Covariates—Table 1 also includes information about the maternal and familial covariates. For the covariates complete data was available in 76%–100% of the 4,912 mothers. In 1980, the NLSY participants completed the Armed Services Vocational Aptitude Battery, a measure that assessed knowledge and skill in 10 areas. A composite score was calculated, which was used to assess general cognitive ability. The raw scores were standardized, summed, and converted to percentile scores for a measure of maternal cognitive ability. Years of completed education by the year 2004 were also assessed.

During the initial assessment, the NLSY mothers also reported on their engagement in 12 delinquent behaviors during the previous year via the Self-reported Delinquency (SRD) interview (Elliott & Huizinga, 1983). The SRD is reliable and valid and is the benchmark measure used in contemporary delinquency research (e.g., Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998; Moffitt, Caspi, Dickson, Silva, & Stanton, 1996). For more details about the SRD in the NSLY see Rodgers, Buster, and Rowe (2001). Symptom counts were regressed on the woman's age at which she completed the survey to control for the age differences when the measure was completed.

The 1994 wave of the NLSY included a thorough assessment of the mothers' alcohol use. The assessment included the number of binge episodes in the previous month. Twenty-five items assessing lifetime symptoms of alcohol abuse and dependence were also included in the survey (D'Onofrio et al., 2007). The number of symptoms was used in analyses to control for problematic drinking. Mothers reported on the biological father of each offspring in the sample. As such, the analyses were able to code the relatedness of the CNLSY siblings of a mother (full or half).

Table 2 also presents the correlations among the normally distributed maternal covariates, highlighting that family income is substantially related to many familial risk factors for offspring. The three measures of family income are highly correlated with other salient risk factors for offspring adjustment. Regression analyses predicting family income also indicated that African American children (b=−0.58 SDs, SE=0.03, p<.0001) and Hispanic children (b= −0.16 SDs, SE=0.04, p<.0001) were exposed to lower family income during childhood than non-African American, non-Hispanic children. Children of NLSY mothers with a history of binge drinking (b=−0.34 SDs, SE=0.04, p<.0001) had lower levels of family income than mothers without a history, and offspring from families with children with two or more fathers (b=−0.87 SDs, SE=0.03, p<.0001) had significantly lower incomes than families with offspring from one father.

Offspring Childhood Conduct Problems—At each wave of assessment in the CNLSY study mothers reported on their children's adjustment via the Behavior Problem Index (BPI). The BPI consists of 13 items that were selected from the CBCL, which is a standard assessment tool for children and adolescents (Peterson & Zill, 1986). Confirmatory factor analysis (D'Onofrio et al., 2008) confirmed that BPI items load on three, correlated factors: CPs, oppositional problems, and attention/impulsivity problems. The analyses in the current manuscript relied on the assessment of CPs. CPs is measured by seven items that overlap substantially with those used in other population-based longitudinal studies (Fergusson & Horwood, 2002; Moffitt et al., 1996). The average number of CPs between the ages of 4 and 11 years old is a stable measure; correlations between each wave and the mean across waves were quite high (r>.80 for each age) (D'Onofrio et al., 2007). Additionally, latent trajectory analyses using the CNLSY reveal that the average number of CPs during the ages of 4–11 represent are a valid measure that predicts convictions during adolescence, with no sex differences in the assessment of criterion validity while controlling sex, race-ethnicity, and family income (Lahey et al., 2006). The measure of CPs used in the current analyses was the mean calculated of z-scores at each assessment, standardized within each age.

Analyses

A series of hierarchical linear models (HLMs, Raudenbush & Bryk, 2002) was used to study the relation between family income and offspring CPs because the approach accounts for the three levels of nesting in the NLSY: offspring, mothers, and NLSY households (D'Onofrio et al., 2008). Probability weights for the sample are available for the sample of women at the NLSY household level, so all the analyses were weighted to yield population-based estimates of all parameters.

Initial models were fit to characterize the relation between family income, exploring possible non-linear associations, the role of each child's average family income during early childhood (ages 0–11), and the moderating influence of offspring biological sex (the baseline model will be referred to as Model One). The model tested the moderating role of offspring sex because previous research found that associations between family income and offspring externalizing problems in the NLSY differed in males and females (Blau, 1999). Model Two was then fit to the data to explore whether including measured covariates (characteristics of the mother and family) accounted for the statistical relation between family income and offspring CPs. A series of HLMs was subsequently fit to the data to explore the role of unmeasured selection factors by using methodological controls for confounds. Model Three compared cousins whose immediate nuclear families were exposed to different levels of family income (i.e., the average of the income for all siblings within each nuclear family), and Model Four compared siblings who were exposed to different levels of family income during childhood *within* their nuclear families (see the results section for specific details of each model). The comparison of siblings is a particularly powerful approach to study environmental risk factors because it controls for all measured and unmeasured environmental factors that make siblings similar to one another, as well as genetic risk passed down from mothers to children. Model Five fit a sibling-comparison approach while also controlling for the statistical covariates to combine the statistical and methodological methods of controlling for selection factors. Model Six combined the two methods of controlling for confounds and restricted the sample to only families with full-siblings. This model, therefore, also controlled for any genetic factors passed down from both mothers *and* fathers that were confounded with income and could give the false impression of a causal relation between family income and offspring CPs.

In models that controlled for maternal and familial confounds, the analyses were based on ten multiply imputed datasets using the MI and MIANALYZE procedures in SAS. Multiple imputation (MI) is a standard and well regarded approach for handling missing values (Little & Rubin, 1987; Schafer & Graham, 2002; Sinharay, Stern, & Russell, 2001). MI yields standard errors that account for uncertainty due to missing values and avoids bias arising from complete-record analysis, assuming that the missing values are missing at random or completely at random. The following variables were used to simulate the missing values for imputation: maternal cognitive ability, maternal years of education, maternal raw income at the age of 30, maternal raw average income between the ages of 30 and 40, presence of a non-spouse partner in the house when she was 30, marital status, maternal history of delinquency, maternal average age at childbirth, maternal depression, whether the woman had children with more than one man, maternal frequency of alcohol use, maternal quantity of alcohol use, maternal history of binge drinking, maternal history of alcohol abuse and dependence symptoms, mean maternal level of smoking during pregnancy across her pregnancies, mean maternal level of alcohol consumption during pregnancy across her pregnancies, mean offspring CPs, mean offspring oppositional problems, and mean offspring attention/impulsivity problems.

RESULTS

Relation between Family Income and Offspring Conduct Problems

A series of HLMs was fit to characterize the unadjusted association between mean family income across 0–11 years and offspring CPs. The results of the first models are not tabled. An initial model explored the linear association between each child's mean family income when he or she was 0–11 years of age and offspring CPs and found a robust negative association ($b = -.21$, $SE = .01$, $p < .0001$) that indicated that each one standard deviation difference in family income was inversely associated with a .21 standard deviation difference in offspring CPs. A second model explored whether a nonlinear model was a better fit to the data by including the influence of family income squared. Both the linear (b=−.27, SE=.02, p<.0001) and quadratic (b=−.06, SE=.01, p<.0001) terms for family income were both large and statistically significant. A model exploring a possible cubic relation found that the influence of a cubic term was neither large nor statistically significant (b=.002, SE=.003, p=.45).

An additional HLM was fit to explore whether early childhood was a particularly sensitive period for the influence of family income. Family income during 0–3 years was added to the model to determine if it predicted later CPs above and beyond average levels of family income across 0–11 years. Including average family income during the first three years of life revealed that early family income was not independently associated with CPs (b=.01, SE=0.01, p=.41), whereas the linear (b=−.28, SE=.02, p<.0001) and quadratic (b=−.06, SE=.01, p<.0001) term for income across 0–11 years were significant. This indicates that once average income across 0–11 years is included in the model, little additional variance in childhood CPs was explained by income across 0–3 years. The two measures of income (from 0–3 and from 0–11 years old) were highly correlated (r=0.79), suggesting that children exposed to low levels of income early in childhood were also exposed to lower levels of income through the entire period of 0–11 years.

The analyses then investigated whether offspring sex moderates the association between family income from 0–11 years old and offspring CPs by including interactions terms between the family income variables (linear and quadratic) and offspring sex (coded male=0 and female=1). The results indicate that offspring sex moderates the linear (b_{int}=.08, SE=.02, p<.001) but not the quadratic (b_{int}=.01, SE=.01, p =.18) income terms. The results of a reduced version of this model are presented in Table 3 as Model One. This model, including the moderating influence of offspring sex on the linear influence (b_{int}=.07, SE=.02, p<.001) of income, suggests that family income (0–11 years old) is more strongly negatively associated with CPs in male children; the linear influence of income for males (b=−.30, SE=.02, p<.0001) was larger than for females [the parameter for the income effect in females is estimated by adding the income parameter for males and the interaction term between family income and offspring biological sex] (b=−.23=−.30 + .07). The relation between family income (0–11 years old) and CPs is presented in Figure 1 (Panel A). This figure illustrates that family income is more strongly associated with CPs at higher levels of income; at low levels of income males and females have high levels of CPs regardless of variations in income. The figure also illustrates the findings of higher overall levels of CPs in males and a greater negative association in males as the line is steeper for males than females.

Controlling for Measured Confounds

The next models account for possible selection factors (i.e., confounded factors that "select" families into higher or lower income). Model Two statistically controlled for relevant measured characteristics of mothers that could confound the association. The model indicated the relation between family income (0–11 years old) and offspring CPs was slightly attenuated when the statistical covariates were included, but the relation is generally independent of these factors. Again, there was a significant linear and quadratic association between family income and childhood CPs, which was stronger for males than females. Figure 1 (Panel B) presents the relation between family income and offspring CPs controlling for the measured statistical covariates.

Quasi-Experimental Approaches

The ability to define family structures in the NLSY (mother-generation) and CNLSY (offspring generation) datasets provides the opportunity to study income while holding constant all of the unmeasured fixed factors that vary between the mothers' families that are confounded with family income, such as parental marital status during childhood. This is accomplished by comparing offspring to other offspring within the same family who were exposed to different income levels during childhood, instead of comparing completely unrelated children with different family incomes. Because all siblings in the NLSY mother generation who were 14–21 years of age at the time of recruitment were included in the study, it is also possible to compare cousins whose sibling mothers had different levels of family income on average when their children were 0–11 years old. This allows us to determine if children who were exposed to less family income on average differ in their CPs compared to their cousins who were exposed to more family income on average during childhood. Such cousin comparisons control for many "third variable" explanations of the correlation between family income and child CPs. They control for unmeasured environmental (e.g., cultural and regional) factors that influence all members of the extended family similarly as well as some (but not all) confounded genetic risk factors that may be responsible for the correlation between family income and offspring CPs.

Traditionally, fixed effects models have been used to account for unmeasured shared family background factors (e.g., Geronimus, Korenman, & Hillemeier, 1994). The current analyses used an approach which yields identical results to fixed effects models, but that is computationally easier and allows more flexible analyses (Neuhaus & McCulloch, 2006). This statistical approach separates the between- and within-extended family effects by calculating mean and deviation scores for the average family income of each nuclear family within the extended family. The average of all family incomes when the children were 0–11 years within each nuclear family was calculated for all nuclear families in the entire extended family (all cousins). Then, the deviation between the average extended-family income and the mean income of the nuclear family (i.e., each mother and her children) was estimated. When both variables are included in the same analyses, the parameter associated with the grand mean level of income for all cousins in the extended family represents the between extended-family comparison of unrelated children. The parameter associated with the deviation of each mean nuclear family income from the grand mean level of income for all extended family members provides the within-extended family—effect the comparison of cousins. If family income is causally related to offspring CPs, the association would be found at all levels of analyses, particularly in the within extended-family parameter (e.g., J. Rodgers, Cleveland, van den Oord, & Rowe, 2000).

The within-extended family effects (the comparison of cousins) are presented as Model Three in Table 3. The comparison of cousins who were exposed to more or less average nuclear family income during their childhoods on average also suggests that the statistical relation is not spurious. The linear association for males ($b=-.24$, $SE=.06$, $p<.0005$) and females ($b=-.20=-.24+.04$) were both robust. The estimates of the association within extended families were similar to the comparison of unrelated individuals, which was also estimated in Model Three. As such, factors that make cousins within an extended family similar to one another do not account for a large proportion of the association between family income and offspring CPs.

Model Four extended the quasi-experimental approach by comparing siblings differentially exposed to levels of family income. This within-nuclear family comparison accounts for environmental factors that make sibling offspring of the same mother similar to one another. It also accounts for genetic factors that mothers pass down to their offspring (D'Onofrio et al., 2008). The comparison of siblings was estimated by calculating the average level of family income during childhood for all siblings within a nuclear family and deviation of each sibling from the nuclear-family average (Neuhaus & McCulloch, 2006). Full details are available elsewhere (D'Onofrio et al., 2008). The results suggest that the association between family income and offspring CPs was still robust in the comparison of siblings, especially for males, although the magnitude of the association was attenuated. The linear associations for males (b=−.15, SE=.03, p<.0001) and females (b=−.08=−.15 + .07) were similar to the estimates of association when comparing cousins and unrelated individuals in the model, albeit with somewhat smaller effect sizes.

Model Five combined the statistical controls for measured covariates and the quasi-experimental approaches to controlling unmeasured confounds by adding the maternal characteristics and birth order to the HLM that compares siblings and cousins. This is important as the association between family income and offspring CPs within the offspring of each mother could be due to the fact that, in general, families have more income as the parents mature (and have more children). Combining the two techniques for controlling for selection factors further reduced the magnitude of the association between family income, but the effect remained significant for male offspring (b_{linear}=−.07, SE=03, p<.05). CPs in female offspring were not associated with family income in Model Five (b=.00=−.07 + .07). Figure 3, Panel C, presents the association between family income and offspring CPs estimated in Model Five when comparing siblings differentially exposed to levels of family income and statistically controlling for maternal characteristics.

Model Six also controlled for genetic factors that are passed down from both their mother and fathers to their children. The same statistical model was fit as Model Five but the sample was restricted to the 4,570 offspring from families in which all of the siblings were full siblings. As shown in Table 3, the parameter estimates are commensurate with the results of Model Five, although the parameters associated with the sibling-comparisons could not be measured precisely (the standard errors around the parameters were large). Nonetheless, the magnitude of the association between family income and offspring CPs were robust, especially when comparing cousins differentially exposed to varying levels of family income. As such, Model Six provides preliminary evidence that the association between family income and offspring CPs is not completely confounded by genetic factors associated with parental socioeconomic status.

Sensitivity Analyses

An additional series of HLMs were fit to explore whether the choice of income variable, adding further covariates, or the methods used to account for missing values would substantially alter the substantive conclusions (results available upon request). To test whether a non-linear association was only due to our use of family income across ages 0–11 years, we tested the linear and nonlinear association between family income measured when the mothers were 30 year old and offspring CPs. The linear (b=−.22, p<.0001) and quadratic terms (b=−.02, p<.05) were commensurate with the results presented above. A similar pattern was found when we used a different transformation of the average family income across 0–11 years, a Blom transformation in SAS (van den Oord et al., 2000), instead of the natural log. Additional analyses explored the possible confounding roles of other covariates, including number of children per family, oldest age of the children in the study, and the number of waves of assessments included in the measure of CPs. Adding the additional covariates to Model Five did not substantively change the magnitude of results. Finally, analyses of the data using listwise deletion for cases with missing data and accounting for missing values using Full Information Maximum Likelihood Methods, another well validated statistical approach for handling missing values (Schafer & Graham, 2002), using Mplus (Muthén & Muthén, 1998–2006) resulted in comparable findings to those presented in the text. Thus, the findings appear to be robust to the measures of income used, data transformations, and the methods used to handle the missing data.

DISCUSSION

Due to limitations on traditional family designs for studying family income, researchers have relied on within-individual variation or extended family studies as quasi-experimental approaches. Because of the assumptions and limitations required in the various approaches, converging evidence is required before researchers can infer causal associations between risk factors and outcomes (Rutter et al., 2001). The current study tested the causal hypothesis that family income has a specific, environmentally-mediated causal effect on offspring CPs. This was done in an attempt to replicate the results of smaller randomized (Morris & Gennetian, 2003) and quasi-experimental studies (Costello et al., 2003). This is important because the designs of the studies are subject to different threats to validity. We also wanted to determine if the results of the previous studies of local samples generalize to the diverse U.S. population. Identifying the causal risk factors for early CPs is crucial because they predict adolescent and adult criminal activity (Lahey, Waldman, & McBurnett, 1999; Moffitt, 2003).

Quasi-experimental studies cannot prove causality (Shadish, Cook, & Campbell, 2002), but the current study, which used rigorous approaches to control for both measured and unmeasured confounds that may account for the association between family income and offspring adjustment, supports a causal inference of the role of family income in the development of offspring CPs, especially for males. The analyses controlled for family and maternal characteristics (history of delinquency and alcohol abuse/dependence) that were excluded from previous studies of the NLSY. This is an important advance, given that parental psychopathology is the strongest predictor of offspring psychopathology (e.g., Rutter et al., 1997). The analyses also utilized the family-based structure of the NLSY study to compare cousins, all siblings, and full siblings to account for unmeasured genetic and environmental factors that could act as selection factors. The current study is the first study to control for both maternal *and* paternal selection factors by restricting the analyses to compare differences only among full siblings. Although the findings from the restricted sample that only included full siblings cannot be generalized to children in all types of families (e.g., mixed families), the results imply that when genetic confounds are controlled (Rowe & Rodgers, 1997), the evidence still suggests that family income exerts a specific independent influence on male child CPs.

The model fitting suggests, consistent with Blau (1999), that controlling for both measured and nonmeasured selection factors greatly reduces the magnitude of the statistically significant association between family income and the child's CPs. Figure 1 illustrates the nonlinear inverse association between family incomes and CPs and shows how the use of statistical and methodological controls attenuates the association. It is important to note, however, that the present quasi-experimental analyses yield a very *conservative* estimate of the causal impact of family income on offspring CPs for a number of reasons. First, the analyses included many factors that could mediate the association between family income and offspring CPs (e.g., maternal alcohol problems), but that also could be a *result* of exposure of poverty in the adult generation. Thus, controlling these covariates could "over-control" and artificially attenuate parameter estimates for family income. Second, the reduced estimates of family income within families could be partly or wholly due to the marked restriction in the range of income that is typical within families. The use of within-family estimates is a powerful tool for exploring causal risk mechanisms, but it is likely that they minimize the estimates of income effects by a considerable extent. The variability within a nuclear family is much lower than the variability in the general population (as indicated by the high intraclass correlations), so there may not be enough variability between siblings to accurately assess the full influence of income. Indeed, the fact that the present conservative within-family analyses support the hypothesis of an independent causal effect of income is quite surprising. The results from the models fit to only full siblings not only depend on the limited variability in income within a nuclear family, they are based on intact families with higher levels of income on average than nonintact families. The goal of the current analyses was to explore whether there was any independent association between family income and offspring CPs when controlling for as many selection factors as possible. As such, the present findings provide a very conservative estimate of the association of family income and offspring CPs.

The results suggest the association between family income and childhood conduct problems remain for boys but not girls when using within-family comparisons. Costello et al. (2007) found that parental supervision partially mediated the effect of income on offspring disruptive behaviors. Considering that several studies have found parental supervision to be more strongly associated with CPs for boys than for girls (e.g., Storvoll & Wichstrom, 2002; Martens, 1997), it is possible than gender differences in the effects of supervision could explain the gender differences. The measure of CPs may have also influenced the findings; the assessment did not include items that might better index disruptive behaviors in females, such as relational aggression (e.g., Zoccolillo, 1993).

The present analyses suggest a non-linear association between family income and offspring CPs. Variations within the lowest range of incomes had much less of an effect than variations across the moderately low to high range of the income distribution. This was not due to the specific transformation technique that was used, the specific measure of family income, or the comparison group (unrelated individuals, cousins, and siblings). The current findings of a non-linear effect of income both confirm (e.g. Blau, 1999) and contradict previous research (Dearing, McCartney, & Taylor, 2001). Differences in findings may stem from the use of different definitions of income or the use of different measures of behavior problems.

The current study complements previous quasi-experimental studies of family income on offspring adjustment and expands knowledge about the role of family income by balancing concerns about generalizability and the specificity of findings. With respect to generalizability, the current analysis used the offspring of women from a nationally representative sample of households in the United States, adjusted for the sampling design, to assist in the population-based estimation of income effects. The present study also utilized a measure of offspring CPs and family income that were the average across the ages of 4 to 11 years old, which enabled the study to include many more offspring of the women than previous research using the NLSY dataset and reduced the bias present in previous studies that relied on offspring mostly born to very young and financially disadvantage mothers. The use of the average scores did not, however, hinder the interpretation of our findings, as previous research has shown that the measures are stable, reliable across childhood, and valid (D'Onofrio et al., 2007; Lahey et al., 2006). Finally, using multiple imputation and other advanced statistical methods (Schafer, 1997) to accommodate missing data meant that the findings are highly generalizable even if data were not missing completely at random.

With respect to specificity, the analyses were restricted to a focused outcome and children's CPs. Previous studies have typically relied on global measures of child mental health that either combined internalizing and externalizing problems (e.g., the full Behavior Problems Index) or analyzed all externalizing problems. Previous research based on the CNLSY sample has suggested that these dimensions of childhood adjustment, although correlated, are differentially sensitive to early risk factors (D'Onofrio et al., 2008; D'Onofrio et al., 2007). Moreover, there is evidence that changes in income are related in different ways to different types of mental health problems (Costello et al., 2003). The current results strengthen and clarify previous research that was ambiguous because the child measures combined externalizing and internalizing problems in a single scale. Further research is necessary to explore whether family income differentially predicts various aspects of psychopathology.

The existing literature on whether early childhood is a particularly sensitive period for the effects of family income is inconsistent (e.g., Hau & Matsueda, 2006; Costello et al., 2003). Our findings suggest family income early in childhood (0–3 years old) did not uniquely predict childhood CPs independent of family income throughout the age range (0–11 years old). Further research, however, is needed to further explore whether early childhood is a particularly sensitive period, because the null findings in the current research could be due to the limited number of offspring who experienced great variability in exposure to family income from early to late childhood.

There are numerous threats to the validity of the findings in the current manuscript. All quasi-experimental studies are limited in their ability to identify causal processes (e.g., Shadish, et al., 2002). Using within nuclear family variation provides a much stronger basis for causal inferences than the comparison of cousins or unrelated individuals, but this approach can detect associations only to the extent that that families that experience changes in their inflation-adjusted income from the childhood of one sibling to the childhood of another sibling. Furthermore, this approach is valid only if families that experience large changes in income are similar to families who do not experience such large changes in income. Fortunately, the comparison of cousins, which was also included in the current analyses, does not require variation in income over time within nuclear families; rather variation in income is required among adult siblings. As such, the use of sibling and cousin comparison provides converging evidence on the effects of income within the study.

In addition, the present analyses, which were focused on ruling out alternative explanations for the association between family income and offspring CPs, did not specifically test for mediators of the relation. Future quasi-experimental studies will need to test various mediation models, such as the home environment, neighborhood risk factors, and parenting quality (Duncan & Brooks-Gunn, 2000), in addition to the role of non-resident and cohabitating fathers (Manning & Lichter, 1996).

The current analyses, similar to all quasi-experimental design, is unable to rule out every possible confound (Shadish et al., 2002). The methodological approach that we utilized completely controlled for genetic risk that are passively passed from parents to offspring, a major limitation of most previous research on family income (e.g., Rowe & Rodgers, 1997). That is, the comparison of full siblings accounts for 100% of the passive genetic effects because meiosis randomly transmits alleles of polymorphic parental genes across siblings (Rutter, 2007). Sibling comparisons, however, do not completely account for all possible genetic and environmental differences among the children that could influence family income. It is possible each offspring's behavior could have influenced their parents' earnings when they were a child (e.g., by leading a parent to quit work to care for a difficult child). Only experiments based on random assignment can fully rule out all such active or evocative confounds. Fortunately, because the threats to the validity of the present study are different from the threats to other previous studies using different methods (e.g., Costello et al., 20003; Morris & Gennetian, 2003) that also found evidence that higher family income protects offspring from CPs, the present findings add support to the inference that family income influences risk for CPs through causal environmental processes. Collectively, these studies provide a strong basis for conducting randomized controlled trials to test the potential benefits of programs to increase family income.

Except for the sex of the offspring, we did not explore whether characteristics of the individual, mother, or family moderate the association between family income and offspring externalizing behaviors. Future research using the NLSY and other datasets will need to explore whether certain offspring or families are more sensitive or resilient to the effects of family income. As such, the current analyses suggest that interactionist models (Conger & Donnellan, 2007) may be most useful in understanding SES, as both processes appear to be present.

Overall, the current results are consistent with a causal association between family income and offspring CPs, especially for male offspring. These findings suggest that increases in family income during childhood would be expected to decrease offspring CPs. The results of the current and previous studies have important implications for the types of financial interventions that may be necessary to alter childhood CPs. In particular, the non-linear association between family income found in the present analyses and some previous reports suggest that small increases in family income that do not raise the family out of the low range of incomes may not be sufficient to reduce childhood CPs. For the reasons described above, however, our methods may underestimate the effects of income on CPs. Therefore, the potentially non-linear association between family income and childhood CPs is an important topic for future research, as it could set boundaries of the kinds of changes in social and economic policy that could be expected to decrease childhood CPs.

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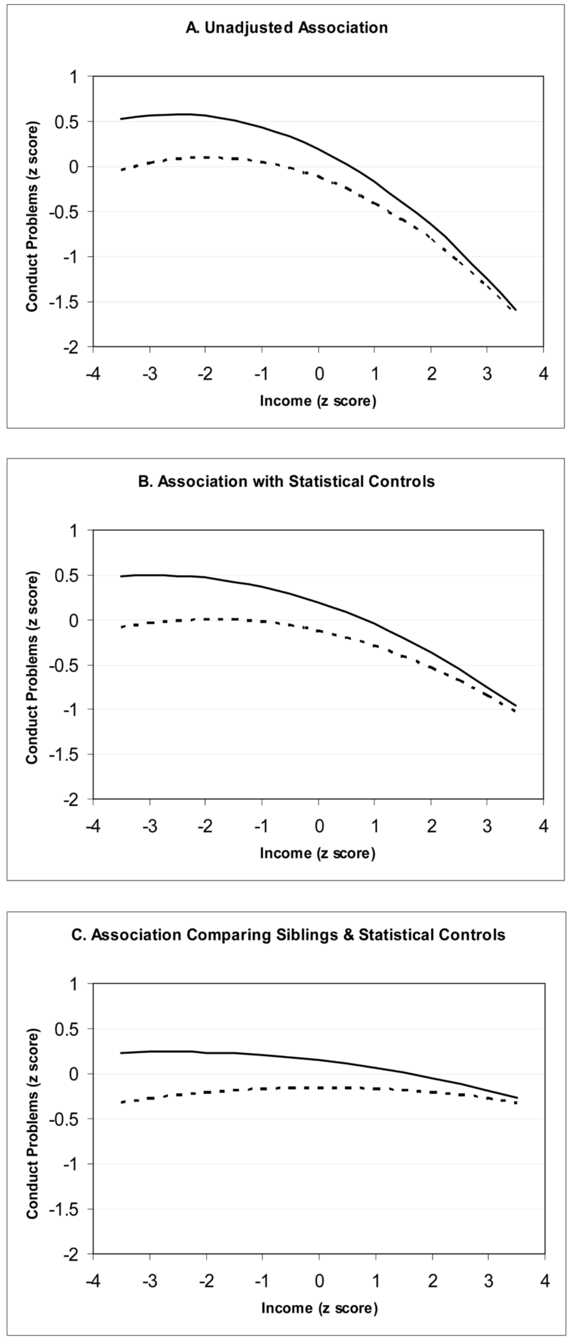

Figure 1.
Unadjusted and adjusted associations between family income and offspring conduct problems in females (dotted lines) and males (solid lines). Note: Panel A represents the unadjusted associations (Model 1). Panel B. represents the association after controlling for the statistical covariates (Model 2). Panel C represents the association after controlling for statistical covariates and comparing siblings differentially exposed to varying levels of family income during childhood (Model 5). Because the centering of statistical covariates can influence the estimate of the intercept in regression-based models, intercepts for the models in Panels B and C were based on the intercepts for the unadjusted models.

Table 1

Sample Characteristics

Variable	*n*	*Mean*	*SD*	*Median*	*Min*	*Max*
Child-Specific Variables (total n=9,194)						
Family Income (0–11 years old)	9,195	18,703	17,493	14,216	263	200,000
Family Income (0–3 years old)	8,731	17,359	17,780	12,904	0	200,000
Mother-Specific Variables (total n=4,912)						
Family Income (at age 30)	4,372	28,347	26,912	23,010	0	200,000
Family Income (average 30–40 years old)	4,174	32,307	31,407	25,381	246	200,000
Cognitive Ability	4,659	37.99	27.25	32.00	1	99
Years of education	4,911	12.95	2.42	12.0	6.0	20.00
Adolescent Delinquency	4,631	1.12	1.49	1.0	0	7.00
Age at First Childbirth	4,765	23.30	5.39	22.18	11.67	43.44
Binge Drinking	3,740	0.16	.36	0	0	1
Alcohol Abuse/Depend.	3,741	0.18	.41	0	0	2

Note. Income is measured in 1986 inflation-adjusted dollars. The minimum values for the income measures are very low because the variables did not include funds from non-married, cohabiting partners [see Avellar & Smock (2005) for more details]. Cognitive ability, an assessment based on the Armed Services Vocational Aptitude Batter, is distributed as a percentile. Mother history of adolescent delinquency is the number of items endorsed on a 12-item assessment, the Self-Report Delinquency Interview. Binge drinking is number of binge episodes in previous month, and alcohol abuse/dependence is measure by number of lifetime alcohol abuse and dependence symptoms.

Table 2

Correlations among Measures of Family Income and Family Covariates

	1		2		3		4		5		6		7		8	
Measures	***r***	***N***	***r***	***N***	***r***	***N***	***r***	***N***	***r***	***N***	***r***	***N***	***r***	***N***	***r***	***N***
1. Family Income (Offspring Age 0–11)	-	-														
2. Family Income (Maternal Age 30)	.70*	9001	-	-												
3. Family Income (Maternal Age 30–40)	.74*	8825	.79*	3735	-	-										
4. Cognitive Ability	.52*	8795	.47*	3732	.51*	3618	-	-								
5. Years of education	.45*	9195	.39*	3885	.44*	3772	.55*	3863	-	-						
6. Adolescent Delinquency	−.12*	8735	−.12*	3706	−.12*	3593	−.08*	3753	−.09*	3845	-	-				
7. Age at First Childbirth	.44*	9010	.34*	3809	.36*	3696	.41*	3833	.45*	3950	−.07*	3801	-	-		
8. Alcohol Abuse/Depend.	−.01	8272	−.01	3441	.00	3451	.07*	3350	−.02	3491	.13*	3327	.03	3421	-	-

Note:

* $p<.05$. Sample sizes for family-level variables are based on unique mothers, which is smaller than the number of offspring.

See note for Table 1 for a description of the measures. See note on Table 1 (and the text) for a description of the measures.

Table 3

Relation between Family Income and Offspring Conduct Problems Using Quasi-Experimental and Statistical Controls

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6[a]	
Variable	**b**	**se**	**b**	**se**	**b**	**se**	**b**	**se**	**b**	**se**	**b**	**se**
Family Income (Ages 0–11)												
Unrelated Individuals												
Linear	−.30*	.02	−.21*	.02	−.34*	.03	−.34*	.03	−.27*	.03	−.29*	.05
Quadratic	−.06*	.01	−.04*	.01	−.06*	.01	−.06*	.01	−.04*	.01	−.03	.01
Linear*Child Sex	.07*	.02	.07*	.02	.09*	.04	.09*	.04	.09*	.04	.11	.07
Cousin Comparison												
Linear					−.24*	.07	−.26*	.06	−.23*	.07	−.24*	.09
Quadratic					−.04*	.02	−.04	.02	−.03	.06	−.04	.04
Linear*Child Sex					.04	.07	.05	.07	.07	.07	.10	.13
Sibling Comparison												
Linear							−.15*	.03	−.07*	.03	−.06	.05
Quadratic							−.04*	.01	−.02	.01	−.01	.01
Linear*Child Sex							.07*	.02	.07*	.02	.07	.03
Family Race/Ethnicity												
African-American			.15*	.04					.14*	.04	.12	.06
Hispanic			.05	.04					.04	.04	.11	.06
Maternal Covariates												
Cognitive Ability			.03	.02					.03	.02	.07	.03
Years of Education			−.02	.01					−.01	.01	−.01	.01
Adolescent Delinquency			.06*	.01					.06*	.01	.06*	.02
Age at First Childbirth			−.02*	.00					−.02*	.00	−.01*	.00
Binge Drinking			−.02	.04					−.03	.03	−.02	.06
Alcohol Abuse/Depend.			.11*	.03					.11*	.03	.13*	.05
Child-Specific Covariates												
Child Sex	−.31*	.02	−.31*	.02	−.31*	.02	−.31*	.02	−.31*	.02	−.29*	.03
Birth Order			−.07*	.01					−.08*	.01	−.09*	.01

Note: Parameters are raw regression coefficients. Family income and offspring conduct problems are distributed as z-scores.

[a]The model was fit to 4570 offspring from families that only included full siblings.

See note on Table 1 (and the text) for a description of the measures (maternal cognitive ability was converted to a z-score before the analyses, for easier interpretation of the regression coefficients).