Submitted: 27th April 2022 DOI: 10.26775/OP.2022.09.08
Published: 8th of September 2022 ISSN: 2597-324X

# Testing the Race of the Mother Hypothesis: Does Mother's Involvement Matter for The Cognitive Development of Interracial Children?

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**Abstract**

Extensive research has been conducted on the effect of mothers' socialization on their children's cognitive test scores. But less is known about the relation between mothers' race/ethnicity and the performance of children from interracial families. It has been proposed by Willerman et al. (1974) that cognitive scores of interracial children will be more similar to those of the mother's race/ethnic group. This is because the mother is the main agent of socialization in youth and adolescence and, as such, the mother provides most of the environmental stimulation. Using the Collaborative Perinatal Project (CPP), the National Longitudinal Study of Adolescent Health (Add Health) and the High School Longitudinal Study of 2009 (HSLS: 2009) data, the current study re-analyzes Willerman et al. (1974)'s observation that mother's race is a strong determinant of the child's cognitive ability. In those datasets, we did not find consistent support for the mother's involvement hypothesis. Furthermore, in the CPP, which was analyzed prior by Willerman et al. (1974), it was found that the earlier superior cognitive scores of interracial children of White mothers at age 4 partially fade out at later age 7. Alternative theories are considered.

**Keywords:** Cognitive ability, race, maternal involvement

## 1 Introduction

Over the past decades, there were many opportunities at raising children's intelligence over time. These measures include education and training programs, and adoption into wealthy families. A large body of evidence shows that educational induced gains often do not have a lasting effect on intelligence test scores (Brody 1992, pp. 174–185; Besharov et al. 2011; te Nijenhuis et al. 2015; Protzko 2015; Ritchie et al. 2015) or questioned whether sustained gains are related with the *g* factor of intelligence (Ritchie & Tucker-Drob, 2018). This conclusion is relevant to the discussion of the impact of cognitively stimulating environments on intelligence. Especially among minority groups, as often these education programs involved minority children. The mother's socialization effect was proposed by Protzko (2015) as an explanation for this fade-out effect. They suggested that mothers must encourage their children to seek more cognitively demanding environments in order to sustain their improved cognitive gains.

This mother's socialization effect was mentioned prior by Willerman et al. (1974) who proposed what we call the "race of the mother hypothesis". They argued that if racial differences in intelligence test performance are determined by additive genetic factors, then test scores for children of interracial matings should be independent of the maternal race. But if, on the contrary, test differences between races have an environmental basis, then the children of interracial matings should more closely resemble the mother since she is the primary agent of socialization during the early years. Willerman et al. (1974) reported that the interracial infants tested at 8 month of age did not show any deficits related to having a Black mother but that the interracial children of Black mother tested at age 4 show a deficit of 9 IQ points. They interpreted this outcome as supporting

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the hypothesis that White mothers provide superior postnatal environments compared to Black mothers. In this case, mother's race is used as a proxy for mother's involvement. A large body of research (Seginer, 1986; McBride et al., 2009; Boonk et al., 2018) indicates indeed that parent involvement in the children's education, especially mother involvement, is associated with improved children's academic achievement. With respect to interracial groups, Arcidiacono et al. (2015) tested the mother's race effect among Black and Hispanic minorities in the Add Health data and found support for Willerman's hypothesis. As these findings are scarce, it is of interest to investigate further the mother's socialization effect on cognitive development among interracial families.

The competing hypothesis is what Jensen (1998) termed as the Spearman's hypothesis, which states that between-group differences are a function of the cognitive test's *g*-loading, which is tied to complexity. The *g* factor, specifically, is known for having impactful social outcomes (Gottfredson, 1997). According to this theory, one should expect environmentally induced cognitive gains for either group being inversely correlated with the *g* factor due to such cognitive gains fading away as the children are transitioning to adulthood as complexity increases at a time when the true level of *g* reasserts itself (Spitz, 1991). One interpretation of this pattern is that *g* has a strong genetic basis when it comes to group differences (Lasker et al., 2019; Fuerst et al., 2021).

The present study provides a follow-up analysis of Willerman on the CPP public dataset, using IQ test scores at age 7, and by extending the analysis to Asian and Hispanic (Puerto Rican) groups. Furthermore, the Add Health and HSLS public datasets are also analyzed in a similar fashion, by comparing the cognitive scores of minority children (Blacks, Asians, Hispanics) of interracial families. Our expectation is that Black and Hispanic mothers provide less stimulating cognitive environments to their children compared to White mothers, whereas Asian mothers provide more stimulating cognitive environments (Kim et al., 2013), hence providing a cultural explanation for their score differences, as they are used as a proxy for mother's involvement. Our analyses take into account SES as a control variable since, according to Willerman, the mother's effect should be significant above and independent of SES. However, because controlling for environmental factors also confounds genetic factors (Trzaskowski et al., 2014; Marioni et al., 2014; Krapohl & Plomin, 2016), we also provide results without environmental controls.

## 2 Method

### 2.1 *Collaborative Perinatal Project*

#### 2.1.1 *Data*

The Collaborative Perinatal Project (CPP) is a national multi-site prospective cohort study that recruited 48,197 pregnant women at 12 university-affiliated medical centers between 1959 and 1966. The CPP is a longitudinal data which followed women and their offspring through pregnancy, delivery, and the first 7 years of the children's life (Broman, 1984) and was carefully conducted with a follow-up rate of 79 % at age 7 (Niswander & Gordon, 1972). The study aimed at understanding how biomedical, environmental (socioeconomic factors), and genetic factors interact to influence pregnancy outcomes and child health.

Out of the 41,911 children who were followed and underwent neurological examination at age 7, those who had no or inadequate intelligence test results were excluded as well as children whose mothers did not report socioeconomic data. The study sample (N=174 at age 4, N=149 at age 7) included offspring with complete data on the variables of interest.

#### 2.1.2 *Cognitive Test and Demographic Variables*

The 4-year assessment was based on the Stanford–Binet IQ scale. Full scale Intelligence Quotient (FSIQ) was assessed using the Wechsler Intelligence Scale for Children (Wechsler, 1949), which contained 7 subtests that evaluate different areas of cognition including verbal (VIQ) (information, comprehension, digit span, vocabulary) and performance intelligence (PIQ) (picture arrangement, block design, coding). The Information, Comprehension, and Vocabulary subtests of Verbal IQ tap verbal comprehension, and the Digit Span subtest taps working memory. The Picture Arrangement and Block Design subtests of Performance IQ assesses perceptual reasoning/organization, whereas the Coding subtest assesses processing speed. The Wechsler full-scale IQ includes a combination of both the verbal and performance IQ measures.

Demographic variables used in the analysis include sex, race, marital status, parents' years of education, and socio economic index. The socio-economic index (SEI) variable is based on an average of a set of rankings of paternal (or other head of household) education, occupation, and family income. With respect to the marital status variable, we treated this one as a dichotomy variable in which the categories "married" and "common law" are coded as 1 and any other category such as "single", "widowed", "divorced", "separated" and "unknown" as 0.

## 2.2 Add Health

### 2.2.1 Data

The National Longitudinal Study of Adolescent Health (Add Health) is a school-based longitudinal study of a nationally-representative sample of adolescents in grades 7-12 within a randomly sampled set of 80 communities across the United States in 1994-95, which investigates social, economic, psychological and physical well-being among multiracial adolescents. The first wave of the data, collected in the academic year 1994-95, attempted to survey all individuals at the selected schools. The in-home interviews provide information on the race of the mother as well as assessments from the Add Health Picture Vocabulary Test (AHPVT). Follow-up surveys were conducted in 1995-96, 2001-2, and 2008. Wave III (2001-2) includes transcript data, along with current education and labor market participation and wages. Wave IV (2008) provides information on completed education and labor market activity. The respondents were aged 12-19 during Wave I and were aged 18-26 during Wave III. Harris et al. (2019) reported that the patterns of attrition did not produce significant biases to estimates of survey outcomes and that the response rates were high across Waves. The present study, using the public-use version of the Add Health, includes a subsample of students whose parents also filled the parental survey.

### 2.2.2 Cognitive Test and Demographic Variables

The AHPVT, used as a verbal IQ measure in this study, is a modified version of the Peabody Picture Vocabulary Test (Dunn & Dunn, 1981); it includes 87 items that ask the respondent to match words (read aloud by the interviewer) with pictorial representations. Scores were age-standardized to a mean of 100 and a standard deviation of 15. The AHPVT was administered a second time during Wave III interviews. The PPVT was found to be a reliable measure of verbal IQ among African Americans with reading difficulty (Pae et al., 2012). However for the present study, the new standardized PVT was used instead of the original AHPVT[1] for Wave I analyses whereas the cross-sectional standardized PVT was used for Wave III analyses. Owing to strong outliers in the PVT scores, cases falling 3 standard deviations below the total sample mean on either measure are removed first.

Demographic variables include respondents' sex variables, as well as parents' education, race and sex variables as well as their relationship to respondents (e.g., biological parent)[2]. The parent education measure was coded as follows: 1=8th grade or less 2=More than 8th grade, but did not graduate from high school 3=Went to business, trade, or vocational school instead of high school, 4=High school graduate, 5=Completed a GED, 6=Went to a business, trade, or vocational school after higher school, 7=Went to college, but did not graduate, 8=Graduated from a college or university, 9=Professional training beyond a 4-year college or university. The parent's race variable included White, Black, Hispanic and Asians. Upon closer inspection, almost half of the individuals in the Asian sample were not East Asians but Filipinos and "other Asians" instead.

To correct for oversampling of minority groups of the Add Health design, we use the sampling cross-sectional weight variables GSWGT1 and GSWGT3_2. While GSWGT1 is the recommended variable of use for analyses involving Wave I variables only, GSWGT3_2 is usually recommended when analyses involve Wave I and Wave III variables (Chen & Chantala, 2014). Therefore, GSWGT1 will be used when analyzing the PVT during Wave I whereas GSWGT3_2 will be used for the analysis of PVT during Wave III.

[1] According to the AHPVT documentation, the original variable could not account for sample weights and some respondents had incorrect ages. While the new PVTSTD1 variable had fewer cases, it produced more accurate scores. So it was used for the current study.

[2] In the parental questionnaire, The parent being interviewed was also asked to report their partners' characteristics such as sex, race, and education. The interracial family variables were constructed based on these surveys. The parents' highest education variable was also constructed based on the average of the parent filling the questionnaire for themselves and their partner whenever they did, that is, we also consider the education of the only one parent who filled the questionnaire for themselves but had missing values for their partners.

### 2.3 High School Longitudinal Study 2009

#### 2.3.1 Data

The National Center for Education Statistics (NCES)' High School Longitudinal Study 2009 (HSLS:09; Duprey et al., 2018)(National Center for Education Statistics, 2009; Duprey et al., 2018) is based upon a nationally representative sample of entering 9th-graders in the fall of 2009 who were selected from a nationally representative sample of high schools with 9th and 11th grades. The original sample was recruited based on a two-stage stratified random sample design with schools randomly selected in the first stage and then students randomly selected from the sampled schools in the second stage (Ingels et al., 2011). In 2009, 21,444 9th-grade students from 944 schools, their parents (or guardians), math and science teachers, along with their school administrators and counselors completed the base-year surveys. NCES conducted the first follow-up in 2012, followed by the 2013 update which included the collection of students' high school transcripts (collected after students were scheduled to graduate), and finally the second follow-up in 2016. The current study includes students' and parents' responses to the base-year and first follow-up questionnaires to obtain students' demographic data as they contain relevant data under investigation in this paper.

#### 2.3.2 Cognitive Test and Demographic Variables

Mathematics assessments were available and used as an approximation to cognitive tests, which provide a measure of achievement in algebraic reasoning. In both the base year and the first follow-up, the assessment was administered by computer using a two-stage design. In the first stage, each student took a common Stage 1 router test. On the basis of Stage 1 performance, each student was routed to a low, moderate, or high level of difficulty Stage 2 test. The scores were based on the IRT model which uses patterns of correct, incorrect, and omitted responses to obtain ability estimates that are comparable across different difficulty test forms. IRT scoring accounts for the guessing factor and treats the omitted responses as not administered, instead of incorrect answers, and uses the pattern of responses to estimate the probability of correct responses. The IRT-estimated reliability was 0.92 after sampling weights were applied (Ingels et al., 2011).

Demographic variables used as a control in this study are: race, gender, parents' highest level of education and their mutual interactions. The parents' highest education variable was coded as follows: 1=Less than high school, 2=High school diploma or GED, 3=Associate's degree, 4=Bachelor's degree, 5=Master's degree, 6=Ph.D/M.D/Law/other high lvl prof degree.

Because the study sample comprised respondents from the base-year survey and new respondents in the first follow-up survey, we averaged the corresponding variables of these two waves (e.g., math scores, parent education).

We used the sampling weights provided by NCES (Duprey et al., 2018) for the base year and the first follow-up. The use of sampling weights is often recommended for adjusting for sampling methods (e.g., oversampling bias and nonresponse) and producing representative estimates (Duprey et al., 2018; Ingels et al., 2011). Since the present analysis includes base-year as well as the first follow-up student data, the follow-up longitudinal weight (W2W1STU) is the recommended variable of choice.

The study sample only includes respondents with complete data on the variables of interest. We gathered a subsample of 567 respondents (N=71 for White-Black interracials; N=373 for White-Hispanic interracials; N=123 for White-Asian interracials). The subsample of the Black minority is small mainly because we considered respondents living with both parents. One possible explanation is that the number of households without a father in the U.S. is relatively high among Blacks, and this was evidenced in the data. Of a total black sample of 2,450, there were 1,001 respondents who lived with both of their biological parents, there were 114 who lived with only the father as biological parent, and there were 977 who lived with only the mother as biological parent.[3]

## 3 Results

### 3.1 CPP

We first disclose data on parent education by parent's race and look for patterns. In Table 1, we notice that the two parents in the White mother and Black father couple average almost one more year of education than the

[3] Because all analyses are done using listwise deletion, the results are not robust to data not missing at random.

parents in the Black mother and White father couple. The same pattern holds for the parents in the White mother and Asian Father couple who are both more educated than the Asian mother with White father. A surprising result comes from the White-Hispanic couples, as both parents in the Hispanic mother and White father couple have one more year of education than the White mother with Hispanic father. In general, the gap in education is greater among fathers.

**Table 1:** Parent Education Among Interracial Couples by Mother and Father's Race in the CPP.

| Interracial Mating | Race of Mother | Mother's Education | | | Husband's Education | | |
|---|---|---|---|---|---|---|---|
| | | Mean | N | SD | Mean | N* | SD |
| White-Black | White | 11.207 | 116 | 2.172 | 11.647 | 99 | 2.869 |
| | Black | 10.775 | 40 | 2.094 | 10.629 | 35 | 2.798 |
| White-Asian | White | 13.438 | 16 | 3.483 | 14.688 | 16 | 3.807 |
| | Asian | 13.000 | 17 | 2.784 | 13.882 | 17 | 3.998 |
| White-Hispanic | White | 9.128 | 78 | 2.349 | 9.515 | 66 | 3.119 |
| | Hispanic | 10.060 | 67 | 2.461 | 10.627 | 59 | 2.870 |

*Smaller samples for Fathers education are due to missing data.

Before computing IQ mean scores controlling for the socio-economic variable, we start a preliminary analysis involving a regression of IQ at age 7, controlled for gender, race, marital status, socioeconomic variable, as well as all of the possible interactions among gender, race, and marital status variables, for all groups separately[4]. In the full model, the socioeconomic index had a large effect for all groups while race had a large effect only among Black and Hispanic groups.

For the comparison of IQ mean scores between groups, the regression equation included the socioeconomic and gender variables as controls. We convert the z-scores from this regression into IQ metrics after standardizing the original IQ variable by the White mean and SD. Table 2 displays the results controlled for socioeconomic index and gender at age 4 and 7 respectively. We confirm the mother's socialization effect among White-Black and White-Asian families, but not among White-Hispanic families since Hispanic mothers have children with an advantage of 6 IQ points, at both age 4 and age 7. Among White-Black families, the children of White mothers showed an advantage of 7 IQ points at age 4 and an advantage of 4 IQ points at age 7. With respect to White-Asian families, we observe a curious pattern since the children of White mothers and Asian fathers have almost the same score as children of Black mothers and White fathers. The depressed score of children with White mothers and Asian fathers, lagging by 8 IQ points behind children with Asian mothers and White fathers, was likely an outlier at age 4, as these children only lag by 2 IQ points at age 7.

Upon closer inspection, when data are disaggregated by marital status, we observe that among interracial Black families, the decline in the IQ gap at age 7 only occurred among the married mothers, not the unmarried mothers, for which the gap is still very large at age 7 (Results available in the Supplemental Material).

Generally, the data strongly suggest a fadeout effect among White-Black families and White-Asian families. It is worth noting that the pattern of the IQ gaps follows closely the pattern of parent education gaps: Within each interracial group, the interracial couples achieving higher education levels have children with higher IQ scores.

We then replicate the analysis without controlling for the socio-economic variable in order to account for a possible moderation. Table 3 displays the results after controlling for gender only. The same pattern holds at both ages for all groups. We still notice a decline of about the same magnitude in the mother's effect at age 7.

As a robustness check, we compare the interracial groups' scores to the mean score of the comparison groups. At both ages, we observe that the scores of interracial children on average fall in between the majority group and their own respective minority group, as one would normally expect. However, we also observe that the children of White mothers and Black fathers consistently score above the White group after controlling for the socioeconomic variable but not before. It seems the socioeconomic variable moderates the advantage of the interracial children of White mothers with Black fathers.

To further investigate the relationship between parents' contribution to respondents' score, separate multiple regressions using IQ at age 4 and then IQ at age 7 as the dependent variable are performed within each

[4] The analysis was motivated by the fact Willerman et al. (1974) performed the same analysis for IQ measured at age 4 only and therefore should be considered as merely a complement.

**Table 2:** IQ Scores For 4- and 7-years-old Children Among Interracial Families (Adjusted for SES and gender).

| | | Age 4 | | | Age 7 | | |
|---|---|---|---|---|---|---|---|
| Interracial Mating | Race of Mother | Mean | N | SD | Mean | N | SD |
| White-Black | White | 105.97 | 69 | 14.989 | 105.09 | 71 | 13.916 |
| | Black | 98.83 | 22 | 12.453 | 101.19 | 22 | 8.811 |
| White-Asian | White | 99.42 | 9 | 16.673 | 107.99 | 11 | 8.563 |
| | Asian | 107.43 | 11 | 15.518 | 109.78 | 12 | 12.180 |
| White-Hispanic | White | 96.82 | 37 | 12.902 | 99.28 | 28 | 12.868 |
| | Hispanic | 102.86 | 26 | 11.292 | 105.38 | 5 | 8.337 |
| Comparison Group* | | | | | | | |
| All White | | 104.16 | 16714 | 15.390 | 104.23 | 18201 | 14.787 |
| All Black | | 96.91 | 18732 | 13.806 | 96.32 | 19649 | 14.147 |
| All Asian | | 103.84 | 75 | 15.797 | 110.41 | 84 | 15.815 |
| All Hispanic | | 94.09 | 2022 | 13.341 | 95.27 | 1318 | 14.123 |

**Table 3:** IQ Scores For 4- and 7-years-old Children Among Interracial Families (Adjusted for gender).

| | | Age 4 | | | Age 7 | | |
|---|---|---|---|---|---|---|---|
| Interracial Mating | Race of Mother | Mean | N | SD | Mean | N | SD |
| White-Black | White | 105.07 | 72 | 14.579 | 104.42 | 74 | 12.319 |
| | Black | 98.70 | 22 | 10.901 | 101.17 | 22 | 9.088 |
| White-Asian | White | 105.67 | 9 | 13.551 | 114.24 | 11 | 9.990 |
| | Asian | 113.43 | 11 | 14.747 | 117.24 | 12 | 10.713 |
| White-Hispanic | White | 96.35 | 38 | 12.434 | 97.53 | 29 | 12.185 |
| | Hispanic | 102.46 | 27 | 10.692 | 102.18 | 6 | 6.459 |
| Comparison Group* | | | | | | | |
| All White | | 106.91 | 17126 | 14.954 | 107.08 | 18690 | 14.280 |
| All Black | | 94.61 | 19225 | 12.545 | 93.81 | 20209 | 12.636 |
| All Asian | | 110.06 | 76 | 15.751 | 116.89 | 84 | 15.546 |
| All Hispanic | | 92.53 | 2052 | 11.905 | 93.28 | 1356 | 12.803 |

*Groups are composed of both parents reporting being all White, or all Black, or all Hispanic, or all Asian.

interracial group. This is done by restricting the samples to intermarried couples (e.g., White mother and Black father couples as well as White father and Black mother couples being grouped into a single White-Black group variable), so as to produce accurate estimates. Holding constant the effect of sex and socio economic status, the effect of mother's race is evaluated. The mother's race variable was coded as 0 for the White majority group and 1 for the minority group.

Among the White-Black families, the Black mother variable shows a negative value at age 4 ($\beta$=-0.216, $p$=0.028) but a negative value that is not statistically significant anymore at age 7 ($\beta$=-0.154, $p$=0.122). Among the White-Hispanic families, the Hispanic mother variable shows a modest positive value at age 4 ($\beta$=0.223, $p$=0.060) and at age 7 ($\beta$=0.175, $p$=0.313). Among the White-Asian families, the Asian mother variable shows a sizable positive value at age 4 ($\beta$=0.268, $p$=0.277) but a small positive value at age 7 ($\beta$=0.106, $p$=0.612).

While the children were still young and the genotypic aspect of IQ not yet fully expressed, the result seems to suggest that the environmental advantage would decrease over time.

## 3.2 Add Health

We first disclose data on parent education by parent's race and look for patterns. In Table 4, we observe a pattern that is different from the CPP, as intermarried Black mothers (and fathers) have higher education levels than intermarried White mothers (and fathers). The explanation is simply that the Add Health sample is more representative than the CPP since the pattern is fully consistent with the research of Chiappori et al. (2016) who reported that White mothers who interracially marry are the less educated in their group whereas Black mothers who interracially marry are the more educated in their own group. Among White-Asian couples, the two parents in the White mother and Asian father couple achieved higher levels of education than the parents in the Asian mother and White father couple, although the difference is smaller among fathers. White-Hispanic couples display a similar pattern with intermarried Hispanic mothers achieving much lower education levels than intermarried White mothers. In general, the gap in education is greater among mothers.

**Table 4:** Parent Education Among Interracial Couples by Mother and Father's Race in the Add Health.

| Interracial Mating | Race of Mother | Mother's Education | | | Husband's Education | | |
|---|---|---|---|---|---|---|---|
| | | Mean | N | SD | Mean | N* | SD |
| White-Black | White | 5.227 | 27 | 2.473 | 5.268 | 27 | 2.009 |
| | Black | 6.503 | 10 | 1.638 | 6.510 | 10 | 2.585 |
| White-Asian | White | 6.610 | 11 | 1.443 | 6.846 | 11 | 1.333 |
| | Asian | 5.406 | 16 | 2.154 | 6.319 | 16 | 1.765 |
| White-Hispanic | White | 4.967 | 65 | 2.268 | 4.736 | 64 | 2.471 |
| | Hispanic | 3.956 | 199 | 2.666 | 4.382 | 198 | 2.861 |

*Smaller samples for Fathers education are due to missing data.

For the comparison of verbal IQ mean scores between groups, the regression equation included age, sex, and socioeconomic variables. The z-scores obtained from this regression are then converted into IQ metrics after standardizing the original PVT variables by the White mean and SD. Table 5 displays the scores of interracial children by mother's race. Among White-Black couples, there is no mother's effect at either Wave I or Wave III favoring the children of White mothers (only 1 IQ point at Wave III). Among White-Asian couples, the children of Asian mothers showed a lag of 9 IQ points at Wave I but they seem to catch up later as they show a lag of 3 IQ points at Wave III. Among White-Hispanic couples, the children of Hispanic mothers showed a lag of 7 IQ points at Wave I and 5.6 IQ points at Wave III. While the pattern among Hispanic groups seems to validate the mother's race effect, the pattern among Asian groups does not.

To find out if the socioeconomic variable acts as a moderator, the results are replicated without controlling for socioeconomic variable and are displayed in Table 6. We observe the same pattern generally holds even before controlling for the socioeconomic variable. The IQ gaps between subgroups are almost unaffected.

As a robustness check, we compare the interracial groups' scores to the mean score of the comparison groups. The scores of interracial children for each subgroups fall in between the mean of the majority group and their own minority group before and even after adjustment for the socioeconomic variable. This pattern seems odd for the children of White-Asian couples who have substantially higher scores than the children of Asian couples, but this is because a substantial portion of the Asian respondents were not East Asians.

To further investigate the relationship between parents' contribution to respondents' score, separate multiple regressions are also performed within each interracial group. Holding constant the effect of sex, age and parent education, the effect of mother's race is evaluated. The mother's race variable was once again coded as 0 for the White majority group and 1 for the minority group.

Among the White-Black families, the Black mother variable shows a modest negative value at Wave I ($\beta$=-0.192, $p$<0.001) which increased very little at Wave III ($\beta$=-0.212, $p$<0.001). Among the White-Hispanic families, the Hispanic mother variable shows a small negative value at Wave I ($\beta$=-0.168, $p$<0.001) which did not change at Wave III ($\beta$=-0.160, $p$<0.001). Among the White-Asian families, the Asian mother variable shows a stronger negative value at Wave I ($\beta$=-0.286, $p$<0.001) which decreased at Wave III ($\beta$=-0.220, $p$<0.001)[5].

[5] Because sampling weights are used, the inflated sample sizes significantly decreased the p-values. The same issue pertains to the regression analyses on the HSLS data. Therefore, p-values should be ignored for these analyses.

**Table 5:** Verbal IQ Scores For Children Among Interracial Families At Wave I and Wave III (Adjusted for SES, age and gender).

| | | Wave I | | | Wave III | | |
|---|---|---|---|---|---|---|---|
| Interracial Mating | Race of Mother | Mean | N | SD | Mean | N | SD |
| White-Black | White | 97.76 | 21 | 16.320 | 94.73 | 22 | 17.124 |
| | Black | 98.06 | 6 | 9.146 | 93.40 | 6 | 13.984 |
| White-Asian | White | 106.18 | 7 | 15.931 | 100.96 | 7 | 11.730 |
| | Asian | 97.31 | 10 | 22.246 | 97.76 | 10 | 13.585 |
| White-Hispanic | White | 101.10 | 52 | 14.304 | 104.74 | 52 | 15.501 |
| | Hispanic | 94.25 | 138 | 16.689 | 99.12 | 139 | 14.685 |
| Comparison Group* | | | | | | | |
| All White | | 103.06 | 1848 | 13.322 | 102.95 | 1859 | 12.984 |
| All Black | | 91.02 | 412 | 12.941 | 91.08 | 405 | 14.694 |
| All Asian | | 93.10 | 85 | 18.311 | 93.86 | 85 | 18.975 |
| All Hispanic | | 94.10 | 182 | 18.514 | 98.51 | 182 | 16.678 |

*Groups are composed of both parents reporting being all White, or all Black, or all Hispanic, or all Asian.

**Table 6:** Verbal IQ Scores For Children Among Interracial Families At Wave I and Wave III (Adjusted for age and gender).

| | | Wave I | | | Wave III | | |
|---|---|---|---|---|---|---|---|
| Interracial Mating | Race of Mother | Mean | N | SD | Mean | N | SD |
| White-Black | White | 98.63 | 21 | 15.202 | 96.00 | 22 | 16.881 |
| | Black | 99.95 | 6 | 8.592 | 96.02 | 6 | 8.340 |
| White-Asian | White | 109.19 | 7 | 18.080 | 104.24 | 7 | 13.763 |
| | Asian | 98.92 | 10 | 17.135 | 99.13 | 10 | 13.062 |
| White-Hispanic | White | 99.98 | 52 | 15.050 | 103.64 | 52 | 14.570 |
| | Hispanic | 91.45 | 139 | 16.249 | 96.05 | 140 | 14.506 |
| Comparison Group* | | | | | | | |
| All White | | 104.28 | 1848 | 13.124 | 104.17 | 1859 | 12.930 |
| All Black | | 91.11 | 412 | 12.917 | 91.28 | 405 | 14.464 |
| All Asian | | 95.84 | 85 | 18.348 | 96.60 | 85 | 17.640 |
| All Hispanic | | 88.47 | 183 | 16.934 | 92.49 | 184 | 16.116 |

*Groups are composed of both parents reporting being all White, or all Black, or all Hispanic, or all Asian.

## 3.3 *HSLS*

We first display the data on parent education and look for patterns. In Table 7, we observe a pattern that is different from the CPP as well. Both parents in the Black mother and White father couple have higher education than the White mother with Black father. But similar to the CPP, the Hispanic mother with White father both average a slightly higher education than the White mother with Hispanic father. With respect to the White-Asian couples, we observe a similar pattern to the previous data. White mothers with Asian fathers both achieved higher education levels than Asian mothers with White fathers.

We then obtain the math scores controlling for the effect of parent education and gender using multiple regression, and we convert the z-scores from this regression into IQ metrics after standardizing the original math variable by the White mean and SD. Table 8 displays the math scores of interracial children by mother's race. We observe that the mother's effect is absent among White-Asian and White-Hispanic couples, whereas

**Table 7:** Parent Education Among Interracial Couples by Mother and Father's Race in the HSLS.

| Interracial Mating | Race of Mother | Mother's Education | | | Husband's Education | | |
|---|---|---|---|---|---|---|---|
| | | Mean | N | SD | Mean | N* | SD |
| White-Black | White | 2.796 | 61 | 1.113 | 2.788 | 59 | 1.167 |
| | Black | 2.943 | 17 | 1.209 | 3.911 | 17 | 1.651 |
| White-Asian | White | 3.550 | 35 | 1.519 | 4.013 | 35 | 1.555 |
| | Asian | 3.241 | 96 | 1.191 | 3.574 | 95 | 1.414 |
| White-Hispanic | White | 2.908 | 192 | 1.033 | 2.827 | 189 | 1.254 |
| | Hispanic | 2.985 | 212 | 1.216 | 3.047 | 212 | 1.320 |

*Smaller samples for Fathers education are due to missing data.

the mother's effect shows a negative impact on the children's score among White-Black couples, as the Black mother variable is associated with a much higher children's score, an advantage of 9.3 points. To find out if the socioeconomic variable acts as a moderator, the results are replicated without controlling for the socioeconomic variable and are displayed in Table 9. We observe the same pattern generally holds even before controlling for the socioeconomic variable.

As a robustness check, we compare the interracial groups' scores to the mean score of the comparison groups. First, the interracial children of Black mothers shows a score advantage of 4.3 points compared to the mean of the White group when the socioeconomic variable is accounted for but shows an advantage of only 1.5 points when the socioeconomic variable is not controlled, which suggests that socioeconomic related factors moderate their advantage. Furthermore, the interracial children of White-Asian couples shows a mean score which falls in between the White and Asian groups after accounting for socioeconomic variable but a score very close to the mean score of the Asian group before controlling for socioeconomic variable. Finally, the interracial children of White-Hispanic couples shows a score similar to the mean score of both the White and Hispanic groups after accounting for socioeconomic variable but a score which falls in between the White and Hispanic groups before accounting for socioeconomic variable. The mere fact that the White and Hispanic means are almost perfectly matched after adjustment (a difference of 2 points in favor of the White group) indicates that socioeconomic related factors account for the difference, and whatever factor remains must be non-significant.

**Table 8:** Mathematics Assessment Scores For Children Among Interracial Families (Adjusted for SES and gender).

| Interracial Mating | Race of Mother | Mean | N | SD |
|---|---|---|---|---|
| White-Black* | White | 97.911 | 56 | 11.312 |
| | Black | 107.221 | 15 | 12.924 |
| White-Asian | White | 110.763 | 33 | 9.428 |
| | Asian | 108.867 | 90 | 12.558 |
| White-Hispanic | White | 100.842 | 173 | 16.419 |
| | Hispanic | 101.560 | 200 | 17.459 |
| Comparison Group** | | | | |
| All White | | 102.953 | 5696 | 14.115 |
| All Black | | 94.543 | 500 | 13.900 |
| All Asian | | 113.293 | 854 | 14.735 |
| All Hispanic | | 100.925 | 988 | 13.773 |

*The small sample for the Black children living with both biological parents is due to the fact that in the U.S., many Blacks live with the mother alone, and this pattern is also reflected in the present data.
**Groups are composed of both parents reporting being all White, or all Black, or all Hispanic, or all Asian.

To further investigate the relationship between parents' contribution to respondents' score, a multiple regression

**Table 9:** Mathematics Assessment Scores For Children Among Interracial Families (Adjusted for gender).

| Interracial Mating | Race of Mother | Mean | N | SD |
|---|---|---|---|---|
| White- Black* | White | 100.742 | 58 | 10.634 |
| | Black | 107.965 | 16 | 14.904 |
| White- Asian | White | 116.919 | 34 | 12.303 |
| | Asian | 113.802 | 93 | 13.122 |
| White- Hispanic | White | 103.597 | 179 | 15.652 |
| | Hispanic | 104.303 | 212 | 14.355 |
| Comparison Group** | | | | |
| All White | | 106.433 | 5966 | 14.452 |
| All Black | | 97.372 | 528 | 13.675 |
| All Asian | | 116.702 | 911 | 14.915 |
| All Hispanic | | 97.693 | 1054 | 13.411 |

*The small sample for the Black children living with both biological parents is due to the fact that in the U.S., many Blacks live with the mother alone, and this pattern is also reflected in the present data.
**Groups are composed of both parents reporting being all White, or all Black, or all Hispanic, or all Asian.

is also performed within each interracial group. Holding constant the effect of sex and parent education, the effect of mother's race is evaluated. The mother's race variable was once again coded as 0 for the White majority group and 1 for the minority group.

Among the White-Black families, the Black mother variable shows a strong positive value ($\beta$=0.309, $p$<0.001). Among the White-Hispanic families, the Hispanic mother variable shows a very small positive value ($\beta$=0.042, $p$<0.001). Among the White-Asian families, the Asian mother variable shows a very small negative value ($\beta$=-0.056, $p$<0.001).

## 3.4 Meta-analysis

To obtain more precise results, as these samples are small, a meta analytic method is conducted. Since there are multiple waves in the Add Health data, we decide to combine and average the Wave-I and Wave-III verbal scores so as to eventually reduce sampling errors. But for the CPP, we decide to only use IQ data measured at age 7 since, as proposed by the hereditarian hypothesis, environmental gains should decrease among older children.

The inverse variance method is carried out for the present meta-analysis. This method calculates the weighted mean of the effect sizes using the inverse variance of the individual studies as weights. In our current situation, it requires both the regression coefficients and standard errors from our previous regression analyses. However, here, the standard errors will be computed using the Bootstrap approach, which has the advantage of disregarding assumptions about the data distribution. But because we used sampling weights in several datasets, it would seem that the inflated sample size would produce biased standard errors. In the case of resampling with replacement, as with the usual Bootstrap method, it is possible to ignore sampling weights and assume instead equal probabilities for the selected samples (Antal & Tillé, 2011). Therefore, regression coefficients are taken from the weighted results whereas standard errors are taken from the unweighted results of the Bootstrap regression based on 1000 resamples.

The inverse variance analysis is finally performed in R software using Metafor package (Viechtbauer & Viechtbauer, 2015) and assuming random effects modeling. The result is presented in Table 10.

As can be seen, the mean estimate for either subgroup is close to zero and largely non-significant. Moreover, the large confidence intervals for each estimate suggest these estimates are not precise (e.g., we are 95 % confident that the mean effect of Black mothers among the Black-White interracials is between -.5519 and .5344). Finally, it may be useful to see how the different studies compare in the estimates. The forest plot displayed in Figure 1 shows the estimates of all subgroups within each study. It appears that the CIs for the Add Health estimates are

**Table 10:** Meta-Analysis Using Inverse Variance Method.

| Subgroup Race | Weighted Mean $\beta$ | Standard Errors | $p$-values | 95% CI (lower) | 95% CI (upper) |
|---|---|---|---|---|---|
| Black-White | -.0088 | .2771 | .9747 | -.5519 | .5344 |
| Hispanic-White | .0000 | .2187 | .9998 | -.4286 | .4287 |
| Asian-White | -.0306 | .3134 | .9223 | -.6449 | .5838 |

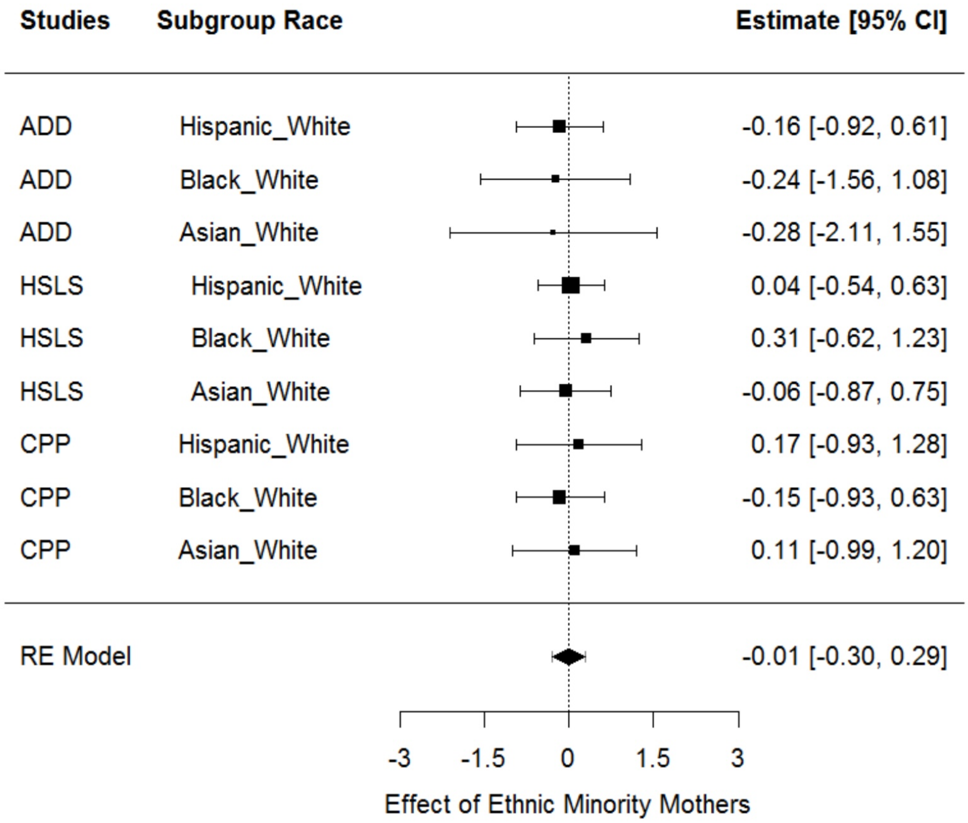


**Figure 1:** Forest Plot of Beta Coefficients.

extremely large, compared to the CPP and HSLS, indicating huge uncertainty with respect to the estimates (especially of the Black-White and Asian-White interracials, likely owing to their very small sample sizes) from the Add Health. But even if we disregard the Add Health outcomes, the CIs are still large for both the CPP and HSLS.

## 4 Discussion

Our findings do not exhibit a substantial mother effect among interracial families. Our meta-analytic Beta coefficients show values that are close to zero for all groups, although it should be noted that one data administered an achievement test instead of a cognitive test. Looking at those data individually leads to a similar conclusion. In the CPP, the significant decrease in the mother's effect between age 4 and age 7 among Black-White families follows the same downward trend observed in education programs and adoption studies (te Nijenhuis et al., 2014, 2015). In both the Add Health and HSLS data, the mother's effect was null or inconsistent. Generally, these results contradict the mother's involvement effect. Considering the assumption that Black/Hispanic mothers and Asian mothers provide, respectively, inferior and superior home environments in a way which explain their score differences, this wasn't evidenced in this data.

Nonetheless, the finding that the Black mother is still associated with depressed scores of interracial children at age 7 among unmarried couples in the CPP is worth interpreting. It could be that the worst environment associated with having a single parent in the household prevented these children from catching up. But this doesn't explain why Hispanic mothers have children with higher scores compared to White mothers or why Asian mothers do not have children with significantly higher scores. Perhaps more importantly, it was found in both data that the children's cognitive score seems to closely resemble the education level of their parents. In the CPP, interracial families with White mothers show higher education levels and children with higher cognitive score whereas, in the HSLS, interracial families with Black mothers show higher education levels and children with higher cognitive score regardless of socioeconomic adjustment, and although this was not found to be the case in the Add Health, the samples were very small. This pattern is further confirmed among White-Hispanic and White-Asian families. It is possible that the children's score is more determined by the parents' characteristics related to their higher education level (e.g., cognitive ability), which cannot be accounted for solely by controlling for education or SES, rather than characteristics (e.g., cultural) related to mother's race.[6]

The result of the present study generally failed to replicate the findings of Willerman et al. (1974) and Arcidiacono et al. (2015). The latter study found that having a Black (or a Hispanic) mother is associated with lower verbal IQ in the Add Health. However, upon closer inspection, their regressions analyses evaluated the mother's race effect in the combined sample of the majority and minority groups. In other words, they didn't restrict the sample to interracial families in the same way as was done in the present study. This may have caused biased estimates of the mother's race effect.[7]

On the other hand, the finding that the mother's involvement effect did not determine the children score was rather unexpected considering that most studies found a positive relationship between the mother's involvement and the children's achievement (McBride et al., 2009) even though these analyses did not look into interracial families. However, with respect to the HSLS data, Sheng (2021) reported a stronger positive effect of the father's involvement. Not only did fathers show a higher level of involvement in school-based activities compared to mothers but it was found that the positive relationship between parent involvement and adolescents' GPA was stronger for the fathers. It is therefore unclear that mothers should always be expected to determine the children's score more significantly than the fathers.

While the positive effect of mother's involvement is a well documented finding, Beaver et al. (2014) noted that often these studies fail to account for genetic confounding. Indeed, not only it is known that family and home environments are substantially heritable (Kendler & Baker, 2007) but GCTA studies showed there is a strong evidence that genes which account for variances in intelligence and achievement are the same genes which account for variances in family SES (Trzaskowski et al., 2014; Marioni et al., 2014; Krapohl & Plomin, 2016; Hill et al., 2019; Rask-Andersen et al., 2021). Using adoption-based design to isolate any possible genetic overlap between family variables and intelligence scores, Beaver et al. (2014) reported in the Add Health data that while both the father and mother's involvement positively affected children's verbal IQ at early age, such a positive effect disappeared when these children were examined seven years later. It is yet possible that, unlike postnatal environments, prenatal environments could be more conducive to sustained cognitive gains. As a recent review (Murray et al., 2017) reported, longer gestation period is moderately correlated with higher cognitive abilities among children tested at young ages (e.g., 1-, 4- and 6-years old).

In general, data on racially mixed individuals are restricted to children tested at a very young age, well before the genotypic aspect of IQ fully manifests. Since cognitive differences exhibit lower heritability at a younger age (Briley & Tucker-Drob, 2013), an examination of the longitudinal trajectory of their IQ would better help understanding cognitive development across different levels of cognitive environments. Indeed, a direct test of the environmental hypothesis is to measure the g-loadedness of educational gains in a longitudinal perspective over a long period of time. A longitudinal study conducted by Ritchie et al. (2015), using SEM method, was able to address this issue. Going from a bifactor model, their best fit data, they compared three model pathways, all controlling for prior IQ measured at age 11: The first model considers education affecting subtest scores only through g, the second model considers education affecting subtest scores through g but also independently of g, and finally the third model considers education affecting subtest scores only independent of *g*. Their best fit was the third model. Although this is a first step to understanding the nature of educational gains, extending this line of research to minority groups would help clarify this issue.

[6] Since Black mothers who intermarry are more educated (Chiappori et al., 2016), it could be argued that the negative effect of the Black mother variable would have been reduced. Controlling for SES should attenuate this bias.

[7] Another possible explanation is that Arcidiacono et al. (2015) have access to a larger sample. Furthermore, in the present study, it was found that the results were sensitive to the use of sampling weight variables and the choice of the PPVT variable at Wave I (the new version of the PPVT being unbiased). On the other hand, Arcidiacono et al. (2015) did not report which PPVT variables they used for Wave I in their study.

## 5 Supplemental materials

Supplemental materials available on OSF: http://osf.io/jfuhv/

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