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Heritability x SES interaction for IQ: Is it present in US adoption studies?

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Abstract

An interaction between socioeconomic status (SES) and the heritability of IQ, such that the heritability of IQ increases with higher SES, has been reported in some US twin studies, although not in others, and has generally been absent in studies outside the US (England, Europe, Australia). Is such an interaction present in US *adoption* studies? Data from two such studies, the Texas and the Colorado Adoption Projects, were examined, involving 238 to 469 adopted children given IQ tests at various ages. A mini multi-level analysis was made of the prediction of the IQs by the SES of the rearing home (a composite of parental education and occupation), by the birth mother's intelligence, and by the interaction of the two. Neither study showed any substantial heritability x SES interaction: the effect size estimates in units comparable to twin moderation models were negative (−.042 and −.004), and the meta-analytic estimate for the combined analysis was −.027 (*SE*=.042) with a 95% confidence interval of −0.109 to 0.054. Thus, while we cannot rule out positive moderation based on our two studies, the joint agreement across these studies, and with the non-US twin studies, warrants attention in further research. SES may not fully capture proximal familial-environmental aspects that moderate child IQ.

Keywords

Adoption studies; Heritability; Socioeconomic status; IQ; heritability x SES interaction

1. Introduction

1.1. Differential heritability across the SES range

Is the heritability of intelligence higher in families of high than of low socioeconomic status (SES)? In a review of this topic, Tucker-Drob and Bates (2016) concluded that (1) this occurred, on average, in US twin samples, although accounting for considerably less

Data sets from both the TAP and CAP are archived at Harvard's Dataverse: (https://dataverse.harvard.edu/dataverse/adoption: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BCDSEU) variance than found in some of the early studies, and (2) it was not evident in twin samples outside the US (in Europe, England and Australia).

Discussing the difference between US and non-US studies, Turkheimer and Horn (2014) speculated that it might reflect poorer conditions for intellectual development for individuals of low SES in the US than in the other countries, where educational systems might be more effective in reaching children of all economic levels. A difficulty with this explanation is that in the US the interaction was found in some twin samples in which few, if any, individuals were reared in poverty (e.g., the National Merit twin sample—Harden et al., 2007), and not found in some twin samples in which a substantial number of individuals presumably were (e.g., the Vietnam veterans twin sample— Grant et al., 2010). A large-scale Florida study based on twins' and siblings' school records found no evidence for SES moderation of the genetic influence on test scores (Figlio et al., 2017). Another large study based on polygenic scores from a genotyped Wisconsin sample did find a small but statistically significant interaction with childhood SES (Woodley of Menie et al., 2018).

Note that the present paper is concerned with the effect of the SES of the home in which the child was reared. Interaction studies have been conducted involving the attained SES of adult twins (e.g., Zavala et al., 2018). In such studies, an individual's intelligence may have a causal effect on his or her SES, making heritability-SES interactions more difficult to interpret. One study in the UK based on adult SES and genetic resemblances among unrelated individuals found an interaction in the opposite direction—additive genetic variation decreased with increasing SES (Tahmasbi et al., 2017).

With the exception of the two genotyping studies (Woodley of Menie et al., 2018; Tahmasbi et al., 2017), the heritability estimates in the above studies were based mostly on the comparison of identical (MZ) and fraternal (DZ) twins, a common method for estimating heritability. The study of adoptive families provides another, in the form of the correlation between birth mothers and their adopted-away children. Is there a heritability x SES interaction for intelligence in US adoption studies? We examine this interaction in two major US adoption studies.

1.2 Two US adoption studies

There are two large US adoption studies with the necessary IQ and SES data for testing an interaction: the Texas Adoption Project (TAP) and the Colorado Adoption Project (CAP). The TAP (Horn & Loehlin, 2010), studied 300 Texas families that had adopted one or more children from a San Antonio home for unwed mothers. IQ test scores were obtained for the birth mothers of the adopted children, and IQ tests were administered to the adoptive parents and all available children, biological and adopted, in the 300 families. At the initial testing, the adopted children ranged from 3 to 19 years of age (M = 7.7 years, SD = 2.93, N = 469). Information about the education of the adoptive mothers and fathers and the occupations of the adoptive fathers were obtained, and combined to create a measure of SES. At a follow-up, approximately 10 years later, a substantial proportion of the child generation was administered IQ tests again. At this wave, these adopted children ranged in age from 13 to 31 years (M = 17.0, SD = 3.316, N = 255). The TAP analysis sample for the current study included 358 individuals nested in 277 families with complete data on birth mother

IQ, adopted child IQ, and adoptive family SES. Of these, 345 individuals contributed data at baseline and 213 individuals at follow-up; 158 individuals contributed at one time point, and 200 contributed at two time-points (55.9%).

The CAP, with the cooperation of two Denver adoption agencies, tested birth mothers and a subset of birth fathers, as well as the adoptive parents and biological parents in a matched group of control families. Except for the small group of birth fathers (N = 50), the *Ns* fell in the range 238 to 245 at the beginning of the study: birth mothers, N = 245, adoptive mothers, N = 243, adoptive fathers, N = 238, control mothers, N = 243, control fathers, N = 244. Most of the 245 children in the adoptive families and the 245 children in the control families were tested repeatedly for cognitive abilities at ages 1, 2, 3, 4, 7, 9, 10, 12, 14, and 16 years. The Ns for adopted children at the ages 4, 7, 12, and 16, investigated in this study, ranged from 191 to 208. The analysis sample for CAP included 232 individuals, where 17 contributed data for one time-point only, 16 contributed data for only two time-points, 41 contributed data for three time-points, and 158 contributed at all four time-points (68.1%). For the origin and design of the study, see Plomin and DeFries (1985); for the results for cognitive development up to age 16, see Plomin et al. (1997).

The TAP and CAP studies are not identical in design. The TAP measured children of different ages in adoptive families twice, about ten years apart. The CAP measured adopted children repeatedly at a number of specified ages. Both studies supplied measures of general cognitive ability or IQ. However, they were different measures in the case of the birth mothers and only partially overlapping ones in the case of the adopted children. The SES measures for both studies combined father's and mother's education and prestige of father's occupation, although the components were obtained on slightly different scales, as shown in Tables 1 and 2. Descriptive statistics for the SES measures are described in Horn et al. (1982) for the TAP, and in Rhea et al. (2013) for the CAP. As with the typical adoptive family (Keyes et al., 2008), families in both the TAP & CAP are above average in SES, but still show considerable variation. Supplemental Methods Section SM1 provides additional information about the SES measures in both studies. Supplemental Figure SF1 compares the standardized distribution of SES scores in the two projects, and Supplemental Figures SF2a–c compare the parental SES indicators in CAP with those of its complimentary twin sample, Colorado's Longitudinal Twin Sample (Rhea et al., 2013).

Despite the differences, both studies supplied the essentials for a test of the interaction of SES and the heritability of intelligence (specifically additive genetic influences, or a^2 and hence a^2xSES[1]): measures of the intelligence of birth mothers and their adopted-away children, and measures of the socioeconomic status of the homes in which these children were reared.

[1]: Notation used for heritability in this MS differs by the estimation procedure. In the adoption studies using parent-offspring regression, a^2 indicates that it represents an estimate of narrow- sense heritability. In the twin studies, A is used to represent the estimate of heritability derived from standard ACE modeling in which dominance terms are excluded from the model.

2. Method

2.1. Testing for a heritability X SES interaction

In both the TAP and CAP, we first use multiple regression to examine how well the IQs of the adopted offspring are predicted by their age, by the standardized IQ/cognitive scores of their birth mothers (zIQBM or zgBM), by the standardized socioeconomic status of the homes in which they are reared (zSES), and by the interaction of SES and birth mothers' IQ. If the heritability of IQ is high, the birth mothers' intelligence should significantly predict the IQs of their adopted-away offspring. If this happens to a greater degree in the higher-SES adoptive homes, we should see the heritability x SES interaction that was observed in (some of) the US twin studies, although the narrow-sense heritability estimated in this way does not include some of the genetic variance estimated in classical twin studies.

We then present results for the TAP and the CAP in combined analyses across the different ages and tests, to assess the evidence for an overall a^2 x SES interaction within the total data from each study, and to illustrate the consistency between the two studies. In these analyses we fitted a multi-level regression model using full maximum-likelihood estimation to simultaneously estimate the effect of birth mothers IQ (or *g*), rearing SES (zSES), and the interaction of these two variables, using PROC MIXED SAS version 9.4 (SAS 9.4; SAS Inc., Cary, NC).We accounted for dependencies of the repeated assessments (TAP and CAP), family structure (TAP), and age, where age was centered on 192 months (i.e., 16 years). Specifically, we estimated random effect components given repeated assessments of IQ for each adopted individual, decomposed into systematic between individual variance, and unsystematic residual variance. Hence, the between individual variance captures the systematic variance in IQ across assessment waves (two waves in TAP, four waves in CAP), while the residual variance reflects wave-specific residual variance that is not systematic across age. Moreover, as the TAP sample included siblings nested within the adoptive families we accounted for any systematic random effects variance between family that captures any sibling similarity in IQ across age.

2.2. Comparability of adoption to twin moderation models

We report the regression of standardized adopted offspring IQ (zIQ) on standardized birth mother IQ (or g; zIQ, z*g*) as an estimate of $1/2a^2(1+\mu)$ (DeFries et al., 1979), denoted β_1, where μ=0 if random mating is assumed. Moreover, in our design, shared environment is separable from $1/2a^2(1+\mu)$ if there is no selection bias (no selective placement). We adjust the model for child age (β_2) and standardized adoptive home SES (zSES;β_3). The addition of the interaction of zIQ (or *zg)* with zSES (β_4) provides an indication of how much the estimate varies over zSES. The regression models were fitted in SAS NLMIXED (SAS 9.4; SAS Inc., Cary, NC), accounting for nested observations across time within individuals (CAP and TAP) as well as within families (TAP only). In order to compare the size of the SES interaction in the twin model used by Tucker-Drob and Bates (2016) (denoted *a*') to ours (β_4), transformations are needed to take place because they are metricized in different ways. However, over the range of SES in TAP and CAP, we show that we can generate comparable effect sizes. Supplemental Method SM2 lays out the transformations. Supplemental Method SM3 contains the results of the regression models fitted with additional investigations of assortative mating, and a summary is presented below.

2.3. Meta-analysis and Power

Finally, we present a meta-analysis of the summary results from the two studies based on the regression models conducted in SAS Proc NLMIXED to present the overall conclusions from our analyses of these two adoption projects, with respect to an a^2 x SES interaction for IQ. Estimates of the effect of the interaction from the multi-level regression analyses, $\beta_4(zIQ_{BM} \times zSES)$, were subjected to a "mini meta-analysis", given that accumulating effect sizes are more powerful than the individual samples alone (Goh et al., 2016). The regression analyses were identical in form at different ages with equivalent predictors, two main effects and the interaction, as well as outcomes — adoptees' IQs, allowing for comparison of effect sizes based on the regression model. Two effect size estimates can be considered in this instance: transforming the accompanying *t*-statistic for the regression parameter to an r-equivalent (a partial *r*), or transforming the *r*-squared change attributed to the interaction by taking the square root (a semi-partial *r*). We performed a mini meta-analysis using the partial *r (cf* Goh et al., 2016; Goh, 2018), and we used the df as the associated N for each study based on the NLMIXED analyses which was deemed conservative (see Supplemental Methods SM3). Moreover, we note that the individual and mean estimates of these partial *r* effect sizes are approximately equal to solving for *a*'.

We conducted power analyses in SAS PROC IML (Shieh, 2010) to evaluate the N needed to achieve a confidence interval for the interaction effect based on our observed meta-analytic value. For this power analysis we made use of the observed associations between the predictor and moderator (Shieh, 2010), of zIQBM (or zgBM) and zSES, in TAP and CAP, respectively.

3. Results

3.1. Single wave analyses for both sites, all waves

Table 3 presents the single wave analyses from all six waves of data (two from the TAP, and four from the CAP). The table lists the standardized regression coefficient, the *t*-value of the coefficient, and its probability. Except for one anomalous result for age in CAP, the six waves present a very consistent picture of the lack of predictive power of all predictors in these models except the birth mothers' cognitive scores. The one age exception, at age 12 in CAP, reflects within-age variation that may be at least partially related to the fact that some CAP age 12 subjects (tested after sixth grade), had been held back a year in school. The sign of the interaction term varies across waves between negative and positive, and is not significant in any of the individual wave analyses.

3.2. The Texas Adoption Project

Multi-level regression results for the baseline and follow-up assessments are presented in Table 4 for the TAP. This and a subsequent similar table (Table 5) for the CAP provide for each predictor the regression coefficient, its standard error, and the *t*-test and probability value for the departure of the estimate from zero. zIQBM, zSES and zIQBM×zSES represent standard scores for birth mother's IQ, rearing family's SES, and the product of these, after controlling for age (in months from 192). Adopted child's IQ is the dependent variable. Note that birth mother's IQ has a significant and substantial predictive value, and that SES and its interaction (and age) do not.

Also shown is an estimate of the systematic variance among an individual's IQ scores across assessments. Because the TAP may have more than one adopted child per family, this is broken down into two components, individual within-family and between-family—the former accounting for a much larger share than the latter (89.8% vs. 10.2%). Controlling for family SES, there is little between-family contribution to systematic variance in IQ across age.

3.3. The Colorado Adoption Project.

Table 5 represents the CAP analysis analogous to that of the TAP shown in Table 4. Note there are differences in the detail of the design. ZgBM is the birth mother's score on a general cognitive ability factor, rather than IQ as such. Also, there is only one child per family, so the issue of within- family covariance of IQs does not arise.

It will be observed that Tables 4 and 5 are generally similar. Birth mother's intelligence significantly predicts differences in the IQs of their offspring, a difference reflecting the genes (or possibly correlated prenatal environmental effects). The SES of the adoptive home predicts only small and statistically nonsignificant differences—positive in one study, negative in the other. However, of primary relevance to the interaction hypothesis being examined, the interaction *t*-values of −.80 and −.06 indicate that the differences predicted by birth mother's intelligence are about the same across increasing levels of SES; i.e., there is no evidence of a positive interaction. Indeed, there are small (nonsignificant) negative ones in both studies. We also explored the possibility of nonlinear interactions, described in Supplemental Methods SM4. Briefly, no evidence for nonlinear interactions was found for the TAP, while evidence was equivocal for the CAP.

The overall conclusion from the Texas and Colorado adoption projects is that birth mother's measured cognitive ability positively predicts the measured IQs of her adopted-away child, i.e., there is heritability; that the SES of the adoptive home has small and somewhat inconsistent effects; and—regarding the interaction—that there is no indication of greater heritability of IQ for adoptees placed in higher SES adoptive homes.

Models fitted to standardized child IQ result in parameters $\beta_1(zIQ_{BM})$ and $\beta_4(zIQ_{BM} \times zSES)$ that are in units of $1/2a^2(1+\mu)$ and highlight this point. Supplemental Figure SF3 plots the resulting heritability estimates of a^2 by zSES (c.f. Model 2, $\mu = 0$, in Supplemental Tables ST1 and ST2) indeed showing a non-significant declining heritability across higher SES adoptive homes.

3.4. Meta-analysis of TAP and CAP heritability x SES effects.

We transformed the $\beta_4\ (zIQ_{BM} \times zSES)$ parameter *t*-statistics from the NLMIXED analyses (*t*'s = −.79 for TAP and −.06 for CAP, respectively) to an *r*-equivalent (a partial *r*). The effect size for the interaction in the TAP was −.042 while in the CAP it was −.004. The mean effect size r was −.027 (SE = .042, Z = −.654, p = .513; 95% CI [−.109, .054]) suggesting a small negative contribution of the interaction to childhood IQ, but with a confidence interval that extends into the positive range.

We note that these individual and mean estimates of effect size r's are approximately equal to solving for a'. For the individual effect size estimates, we observed a'_{TAP} = −.046, and a'_{CAP} = −.004. Moreover, based on the average heritabilities across TAP and CAP regression-based results, we likewise estimated $a'_{TAP+CAP}$ = −.027, equal to our meta-analytic effect size r-equivalent.

3.5. Power

With the present *Ns,* we would expect limited power for detecting specific details of the individual studies, such as the small negative interactions. In the mini multi-level analysis, taking into account multiple measures of intelligence for most of the adoptees, the lower and upper limit of the 95% confidence interval for the mean effect size r of −0.027 was −.109 and .054, respectively. At an increase of over 13 times the effective joint sample size (i.e., N ≥ 7939 mother-offspring pairs), we would achieve a 95% confidence interval that excludes positive moderation assuming our effect size of a' = −0.027 (equivalent to β_4 = −0.021). Notably, the effect size of a' in Tucker-Drob & Bates (2016) is positive at 0.074, but outside our confidence interval. To observe a significant moderation effect based on Tucker-Drob & Bates' value of a' = 0.074 (equivalent to β_4 = 0.046) it would take sample sizes of 1695 – 1977 mother-offspring pairs to achieve a 95% confidence interval excluding negative values. Thus, we can rule out Tucker-Drob & Bates' positive 0.074 value but not all positive values. Yet, the agreement across our two studies, and with the non-US twin studies, warrants further attention in SES moderation research.

3.6. Means and Correlations among Variables

Although the tables above suggest general similarity of results in the two studies, they do not completely account for all possible relations among the variables. For example, birth mother's IQ and the SES of the adoptive home may show some degree of correlation (i.e., there might be selective placement of adoptees, particularly in the TAP). For the benefit of readers who wish to pursue these issues further, Tables 6 and 7 provide means, SDs, and correlations across variables within the two studies.

Of particular note in these tables: (1) There is some evidence of selective placement in the TAP—correlations of SES with BMIQ and with IQ in the original testing—but little or none in the CAP. These correlations in the TAP drop to nonsignificance at later ages, and those in the CAP go slightly (but nonsignificantly) negative. (2) IQ correlations across time, at least after age 4, are substantial, typically in the .60s, but not so close to 1.00 as to render the various regressions completely redundant. (3) The correlation of birth mother's cognitive skill with the IQ of her adopted-away child suggests that her genes are contributing, but less so than the .50 that would be if only her genes were involved (father's genes, measurement error, and within-family environmental variation have yet to be accounted for, and possibly between-family variation not captured by SES).

4. Discussion

Thus, based on the results of the analyses presented here, the US adoption studies join the non-US twin studies and some of the US twin studies in failing to show a substantial interaction of heritability and SES (i.e., of heritability being higher in high-SES homes). There was consistency of this result over different ages Where there are small age-to-age inconsistencies in the directions of the weak interactions, the simplest interpretation is random deviations from zero.

How, in general, are these results to be interpreted?

It may be that the handicap of being reared in low SES homes accounts for the heritability x SES interaction in US twin studies. This would be consistent with the absence of such an interaction in adoptive families, where low-SES homes would most likely be selected for other favorable characteristics. However, this would predict that the interaction would be absent in US samples that include few if any low-SES families, such as the National Merit twin sample, and that the absence of an interaction in the Vietnam veterans or Florida samples implies few low-SES homes in these samples. It would also require that individuals from low-SES homes in Europe, England, and Australia either are not included in twin studies in these countries, or are not handicapped by their low SES.

Alternatively, it might mean that being reared in low-SES homes is not critical, but other factors account for the varying role of the heritability x SES interaction in US twin studies, and that these factors, are not present in Europe, England, or Australia—or among US adoptees. We note, however, that while our meta-analytic estimate of a^2 x SES was negative and non-significant, the confidence interval did not allow us to rule out positive moderation as observed in Tucker-Drob & Bates (2015) among US twins. This further underscores the need for clarification of how effects attributed to SES might manifest in children's lives at both familial and extra-familial levels.

To distinguish between these and other possible interpretations of the data, it would be desirable to have more specific assessment of particular environmental conditions than just broad SES, and cognitive abilities more differentiated than general intelligence—and to have these both in the US and elsewhere, and perhaps for different ethnicities. Of course, large, unselected samples remain desirable for any compelling conclusion. Theoretically, a heritability x SES interaction is interesting and important in understanding the roles of heredity and environment in intelligence, and deserves a detailed and convincing empirical analysis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Educational level as coded in the Texas and Colorado Adoption Projects

Texas Adoption Project	**Colorado Adoption Project**
1. 4–5 grade	4 or 5
2. 6–8 grade	6, 7 or 8
3. 9–11 grade	9, 10 or 11
4. high school graduate	12. high school graduate
5. some post high school educ.	14. Associate of Arts degree
6. 4-year college graduate	16. 4-year college graduate
7. some postgraduate education	18. Master’s degree
8. graduate or professional degree	21. MD, PhD

Note: TAP education coded as shown. CAP education coded as years of education completed; comparable levels shown in table.

Table 2

Occupational prestige as coded in the Texas and Colorado Adoption Projects

Texas Adoption Project	Colorado Adoption Project
1. Professionals and proprietors of large businesses	e.g., Physician (81.2)
2. Semi-professionals and smaller officials of large businesses	e.g., Secondary School Teacher (60.1)
3. Clerks and kindred workers	e.g., Bookkeeper (47.4)
4. Skilled workers	e.g., Carpenter (39.6)
5. Proprietors of small businesses	e.g., Bar Owner (38.9)
6. Semi-skilled workers	e.g., House Painter (29.8)
7. Unskilled workers	e.g., Freight & Material Handler (19.0)

Note: Occupational prestige scores for TAP based on Warner (1967). Order is reversed to form the TAP SES composite, i.e., high values for Professionals and low for Unskilled workers. For CAP, typical corresponding occupations are shown, with 1970 census codes from Hauser & Featherman (1977), Appendix B.

Table 3

Comparing standardized coefficients for the prediction of adopted child's IQ from birthmother's intelligence, the SES of child's home of rearing, and their interaction, for sites and wave

		Texas Adoption Project		Colorado Adoption Project			
Predictors	**Statistics**	**Initial (N=345)**	**Follow-up (N=213)**	**Age 4 (N=193)**	**Age 7 (N=191)**	**Age 12 (N=192)**	**Age 16 (N=205)**
Age	Beta	0.09	−0.08	−0.10	−0.06	−0.20	0.13
(In months)	*t*	1.70	−1.20	−1.32	−0.88	−2.83	1.87
	P	0.090	0.230	0.190	0.378	0.005	0.063
Birth Mother	Beta	0.25	0.34	0.18	0.27	0.21	0.27
(zIQBM or zgBM)	*t*	4.39	5.01	2.49	3.76	3.03	3.93
	P	< .001	< .001	0.014	< .001	0.003	< .001
zSES	Beta	0.09	0.06	0.06	0.04	−0.04	−0.04
	t	1.72	0.91	0.75	0.50	−0.61	−0.62
	P	0.087	0.362	0.453	0.617	0.545	0.534
Interaction	Beta	−0.07	−0.01	0.06	0.00	0.01	−0.04
	t	−1.20	−0.11	0.83	0.00	0.17	−0.51
	P	0.231	0.915	0.408	0.998	0.869	0.608

Note. Analyses conducted in SPSS 24.

Table 4

TAP Multi-level Model: Baseline & Follow-up of adopted child's IQ

Fixed Effects Parameters	***B***	***se***	***df***	***t***	***P***	**LL_{95}**	**UL_{95}**
Intercept	110.03	0.74	380	148.52	< 0.001	108.57	111.49
zIQBM	3.87	0.63	365	6.11	< 0.001	2.62	5.12
zSES	0.85	0.63	219	1.34	0.180	−0.39	2.09
zIQBM * zSES	−0.48	0.60	385	−0.80	0.423	−1.67	0.70
Age	−0.02	0.01	271	−3.23	0.001	−0.03	−0.01
Random Effects Variance	**σ^2**	***se***	--	--	--	--	--
Between Family	8.61	15.03	--	--	--	--	--
Individual Within Family	75.64	16.68	--	--	--	--	--
Residual	50.21	4.87	--	--	--	--	--

Note. Analyses conducted in PROC MIXED, SAS 9.4. LL and UL = Lower and Upper level of the 95% Confidence Interval. zIQBM =standardized birth mother IQ, zSES=standardized family socioeconomic status. Age in months centered at 192 months.

Table 5

CAP Multi-level Model: Age 4 to Age 16 adopted child's IQ scores

Fixed Effects Parameters	***B***	***se***	***df***	***t***	***P***	**LL_{95}**	**UL_{95}**
Intercept	106.80	0.69	378	154.83	< 0.001	105.45	108.16
ZgBM	2.83	0.59	225	4.78	< 0.001	1.66	3.99
zSES	−0.16	0.60	222	−0.27	0.790	−1.35	1.03
ZgBM x zSES	−0.03	0.56	217	−0.06	0.954	−1.14	1.08
Age	−0.02	0.01	583	−3.91	< 0.001	−0.03	−0.01
Random Effects Variance	**σ^2**	***se***	--	--	--	--	--
Individual	57.99	7.51	--	--	--	--	--
Residual	63.75	3.84	--	--	--	--	--

Note. Analyses conducted in PROC MIXED, SAS 9.4. LL and UL = Lower and Upper level of the 95% Confidence Interval. Z*g*BM=standardized birth mother general cognitive factor, zSES=standardized family socioeconomic status; Age in months centered at 192.

Table 6

Intercorrelations of TAP variables

	IQBM	zSES	BIQ16	WIQ 16	WIQ7	Mean	SD
IQBM	1.00	.30	.34	.35	.30	108.62	8.86
SES		1.00	.11	.10	.23	166.34	24.98
BIQ16			1.00	.60	.56	110.49	8.22
WIQ16				1.00	.66	109.58	13.13
WIQ7					1.00	111.51	11.64

Note: IQBM = birth mother's (Beta) IQ; BIQ16 = Beta IQ at average age 16; WIQ = Wechsler IQ at average ages 16 and 7. SES coded 10*(med/SD + fed/SD – focc/SD)+100. Correlations of .11 or less nonsignificant, p > .05, all others p < .001.

Table 7

Intercorrelations of CAP variable

	gBM	zSES	SBIQ4	WIQ7	WIQ12	WIQ16	Mean	SD
*g*BM	1.00	.11	.18	.28	.24	.27	.01	1.04
SES		1.00	.07	.06	−.05	−.05	.00	.81
SBIQ4			1.00	.37	.32	.31	106.85	11.51
WIQ7				1.00	.69	.64	111.63	10.67
WIQ12					1.00	.79	110.74	10.84
WIQ16						1.00	104.48	10.88

*Note: g*BM = Birth mother principal component; SBIQ4 = Stanford-Binet IQ at age 4; WIQ = Wechsler IQ, at ages 7, 12 and 16. *g*BM and SES are on scales standardized for total sample. Correlations of .13 or less nonsignificant ($p > .05$), correlations of .25 or more $p < .001$.