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BRIEF REPORT

Breastfeeding Is Positively Associated With Child Intelligence Even Net of Parental IQ

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Some previous reviews conclude that breastfeeding is not significantly associated with increased intelligence in children once mother's IQ is statistically controlled. The conclusion may potentially have both theoretical and methodological problems. The National Child Development Study allows the examination of the effect of breastfeeding on intelligence in two consecutive generations of British children. The analysis of the first generation shows that the effect of breastfeeding on intelligence increases from Age 7 to 16. The analysis of the second generation shows that each month of breastfeeding, net of parental IQ and other potential confounds, is associated with an increase of .16 IQ points. Further analyses suggest that some previous studies may have failed to uncover the effect of breastfeeding on child intelligence because of their reliance on one IQ test.

Keywords: infant development, nutrition, health

The question of whether breastfeeding increases the child's intelligence has been a hotly and continuously debated topic, ever since Hoefer and Hardy initially documented the association in 1929. While a large number of studies over the past several decades have demonstrated that breastfed children on average have higher levels of intelligence than nonbreastfed children, some of the more recent reviews and meta-analyses conclude that maternal IQ might be a significant confound (Der, Batty, & Deary, 2006; Jain, Concato, & Leventhal, 2002; Walfisch, Sermer, Cressman, & Koren, 2013). Mothers who choose to breastfeed are on average more intelligent than those who choose not to, and it is mother's intelligence, rather than breastfeeding, that increases child's intelligence. Many of the studies that control for maternal IQ find that the effect of breastfeeding on child's intelligence is either statistically no longer significant or greatly diminished.

The conclusion from these reviews that breastfeeding, net of maternal IQ, has no independent causal effect on child's IQ may potentially have both theoretical and methodological problems. Theoretically, breastfeeding is well known to increase infant health and provide ideal nutrition. A public policy statement from the American Academy of Pediatrics, Work Group on Breastfeeding (1997) states, "Epidemiologic research shows that human milk and breastfeeding of infants provide advantages with regard to general health, growth, and development, while significantly decreasing risk for a large number of acute and chronic diseases" (p. 1035). This is why Der et al. (2006), whose original empirical study and meta-analysis conclude that breastfeeding does *not* increase children's intelligence, nonetheless conclude (citing the World Health Organization [WHO]), "Even if it does not enhance intelligence, breast feeding remains 'an unequalled way of providing ideal food for the healthy growth and development of infants'" (p. 6). Infant nutrition and health significantly affect childhood and adult intelligence (Lynn, 1990). In fact, it is one of the strongest nongenetic, environmental determinants of intelligence (Babson & Phillips, 1973; Churchill, 1965; Henrichsen, Skinhøj, & Andersen, 1986; Scarr, 1969). If breastfeeding significantly improves infant nutrition and health, and if infant nutrition and health significantly increase childhood and adult intelligence, then it logically follows that breastfeeding significantly increases childhood and adult intelligence. The conclusion that breastfeeding does not increase intelligence contradicts such logic.[1]

Methodologically, most of the studies of the effect of breastfeeding on intelligence measure intelligence with only one IQ test. For example, virtually all of the studies reviewed by Jain et al. (2002) and Walfisch et al. (2013) administer one, most age-appropriate cognitive test to assess a potential effect of breastfeeding on intelligence. Psychometricians universally concur that the best way to measure general intelligence is to administer a set of cognitive tests and perform a factor analysis with the individual test scores to eliminate random

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[1] One possibility is that cognitive development is sensitive to nutrition (and thus breastfeeding) only or primarily at the margin of nutritional sufficiency, and children who are not otherwise malnourished could derive health benefits from breastfeeding, but such benefits do not extend to intelligence during childhood. To the best of my knowledge, however, no one has formally proposed such nonlinear effect of breastfeeding and nutrition on health and intelligence.

measurement errors inherent in any one cognitive test and extract a latent factor for general intelligence (Jensen, 1998). Because most of the studies on the association between breastfeeding and intelligence only administer one cognitive test, they cannot perform a factor analysis to extract the general intelligence factor. It is possible that past studies failed to uncover the effect of breastfeeding on intelligence, net of maternal IQ, because intelligence was not measured precisely enough with multiple cognitive tests, although some recent high-quality studies have managed to detect an effect of breastfeeding on child intelligence, net of parental IQ, even without the use of multiple IQ tests and factor analysis (Belfort et al., 2013; Kramer et al., 2008; Victora et al., 2015).

In this article, I examine the association between breastfeeding and intelligence with the National Child Development Study in the United Kingdom. Its prospectively longitudinal design allowed me to measure the effect of breastfeeding on intelligence in two consecutive generations of British respondents. For each generation, general intelligence was measured with multiple cognitive tests, and factor analyses were performed to extract the latent general intelligence factor. To the best of my knowledge, this was the first study that examined the effect of breastfeeding on general intelligence measured with multiple IQ tests and extracted with factor analysis. The results showed that, while controlling for parental IQ attenuated the effect of breastfeeding on intelligence, breastfeeding remained a statistically significant determinant of intelligence even net of parental IQ and other potential confounds. They also suggested that some past studies may have found null effects because they measured child intelligence with only one IQ test.

Study 1: First Generation

Data

The National Child Development Study (NCDS) is an ongoing large-scale prospectively longitudinal study that has followed a population of British respondents since birth for more than half a century. The study included *all* babies (n = 17,419) born in Great Britain (England, Wales, and Scotland) during one week (March 3–9, 1958). The respondents were subsequently reinterviewed in 1965 (Sweep 1 at Age 7; n = 15,496), in 1969 (Sweep 2 at Age 11; n = 18,285), in 1974 (Sweep 3 at Age 16; n = 14,469), in 1981 (Sweep 4 at Age 23; n = 12, 537), in 1991 (Sweep 5 at Age 33; n = 11,469), in 1999–2000 (Sweep 6 at Age 41–42; n = 11,419), in 2004–2005 (Sweep 7 at Age 46–47; n = 9,534), and in 2008–2009 (Sweep 8 at Age 50–51; n = 9,790). There were more respondents in Sweep 2 than in the original sample (Sweep 0) because Sweep 2 sample included eligible children who were in the country in 1969 but not in 1958. In each sweep, personal interviews and questionnaires were administered to the respondents; to their mothers, teachers, and doctors during childhood; and to their partners and children in adulthood. Virtually all (97.8%) of the NCDS respondents were Caucasian. The main NCDS respondents comprised my first-generation sample.

Dependent Variable: General Intelligence

The NCDS respondents took multiple intelligence tests at Ages 7, 11, and 16. At 7, the respondents took four cognitive tests: Copying Designs Test, Draw-a-Man Test, Southgate Group Reading Test, and Problem Arithmetic Test. At 11, they took five cognitive tests: Verbal General Ability Test, Nonverbal General Ability Test, Reading Comprehension Test, Mathematical Test, and Copying Designs Test. At 16, they took two cognitive tests: Reading Comprehension Test and Mathematics Comprehension Test. I performed a factor analysis at each age to compute their general intelligence score for each age. All cognitive test scores at each age loaded only on one latent factor, with reasonably high factor loadings (Age 7: Copying Designs = .671, Draw-a-Man = .696, Southgate Group Reading = .780, and Problem Arithmetic = .762; Age 11: Verbal General Ability = .920, Nonverbal General Ability = .885, Reading Comprehension = .864, Mathematical = .903, and Copying Designs = .486; Age 16: Reading Comprehension = .909 and Mathematics Comprehension = .909). The latent general intelligence scores at each age were then converted into the standard IQ metric, with a mean of 100 and a standard deviation of 15. I used the standard IQ scores at Ages 7, 11, and 16 as my main dependent variables in Study 1.

Independent Variable: Breastfeeding

At 7, the mother of the main NCDS respondent was asked whether she breastfed her child. The mother could indicate whether the child was not breastfed at all (= 0), breastfed for less than one month (= 1), or breastfed for more than one month (= 2). About a third (31.7%; n = 4,593) of the respondents in the first generation was not breastfed at all, a quarter (24.9%; n = 3,610) was breastfed for less than one month, and the remainder (43.3%; n = 6,295) was breastfed for more than one month.

Control Variables

Unfortunately, intelligence of the parents of the main NCDS respondents (Generation 0) was not measured, so I must use their education and social class as rough proxies. Mother's education and father's education were both measured at 16 as the age at which the mother or the father left full-time education on an 11-point ordinal scale (from 1 = under 13 years to 10 = 23 or more years). Social class at birth was measured as the father's occupational class (0 = unemployed, dead, retired, or no father present; 1 = unskilled; 2 = semiskilled; 3 = skilled; 4 = white-collar; 5 = professional). In my multiple regression analyses, I further controlled for mother's age at birth, father's age at birth, and birth weight in ounces, because all of these factors had been shown to be correlated with child intelligence in past studies.

Results

Appendix Table A1 presents the results of the OLS regression analysis of the first generation of NCDS respondents. When entered alone, breastfeeding was significantly associated with intelligence at all ages (Age 7: $b = 2.002$; Age 11: $b = 2.323$; Age 16: $b = 2.803$; all $p < .001$). It is interesting to note that the association steadily increased from Age 7 to 16. The association was somewhat attenuated but remained statistically significant when mother's education, father's education, and social class at birth (as proxies for parental intelligence) were statistically controlled (Age 7: $b = 1.211$; Age 11: $b = 1.377$; Age 16: $b = 1.679$; all $p < .001$) and slightly increased when mother's age at birth and father's age at birth were further controlled (Age 7: $b = 1.304$; Age 11: $b = .1553$; Age 16: $b = 1.861$; all $p < .001$). The association remained statistically significant even when birth weight was further controlled in the full regression model (Age 7: $b = 1.196$; Age 11: $b = 1.420$; Age 16: $b = 1.741$; all $p < .001$). In all models, the association monotonically increased from Age 7 to 16.

Figure 1 presents the association between breastfeeding and intelligence at Ages 7, 11, and 16 graphically. It shows that increased breastfeeding is significantly associated with intelligence at each age. It is interesting to note that first-generation respondents who were either not breastfed at all or breastfed for less than one month appeared to decline in intelligence as they became older, but those who were breastfed for more than one month did not suffer a similar decline in intelligence throughout childhood.

When examined individually, three of four IQ tests administered at 7 were not significantly associated with breastfeeding, net of all the control variables (Copying Designs: $b = .020$, $SE = .005$, $p < .001$; Draw-a-Man: $b = .024$, $SE = .013$, $p = .075$; Southgate Group Reading: $b = .015$, $SE = .013$, $p = .251$; Problem Arithmetic: $b = .024$, $SE = .014$, $p = .083$), even though four of five IQ tests administered at 11 and both administered at 16 were still significantly associated with breastfeeding. Because intelligence was typically measured in early childhood in previous studies of the effect of breastfeeding on child intelligence (Der et al., 2006; Jain et al., 2002; Walfisch et al., 2013), the use of a single IQ test might potentially have accounted for the null finding in such previous studies.

Discussion

Results of Study 1 suggested that, even net of proxies of parental intelligence (parental education and social class) and other potential confounds, breastfeeding was significantly positively associated with child intelligence. The association remained nontrivial and substantive, and it monotonically increased from 7 to 16. Teenagers who were breastfed after birth appeared to have much higher levels of intelligence than their classmates who were not breastfed 16 years later.

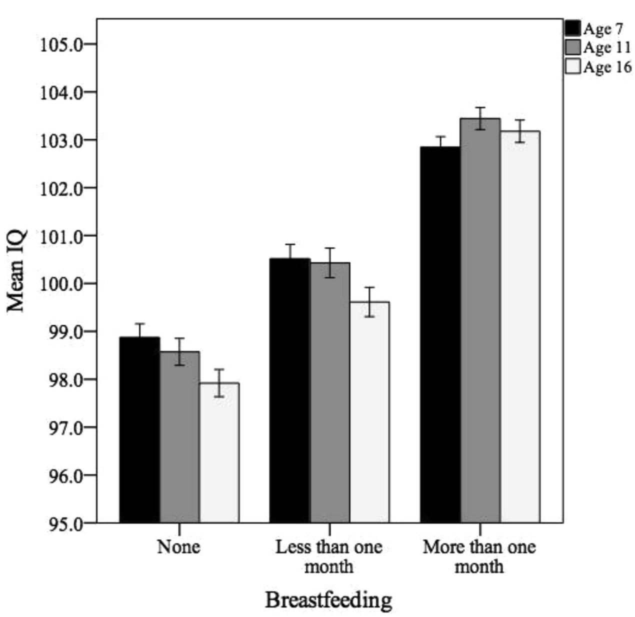

Figure 1. The association between breastfeeding and IQ at Ages 7, 11, and 16 (Generation 1).

There were two significant weaknesses in Study 1. First, the breastfeeding status was measured very crudely (as not at all, less than one month, and more than one month); second, parental IQ was not measured and only its proxies were used to control for it. Both of these weaknesses were rectified in Study 2.

Study 2: Second Generation

Data

At 33, one third of NCDS respondents were randomly selected, and, if they had children, they were included in the "mother" and "child" interviews. If the respondent was female, she was automatically the mother; if the respondent was male, his spouse or partner was interviewed; if a male respondent with children was living without a spouse or partner, he completed the mother interview. Then all children (up to four) of all mothers completed the "child" interview, which included several cognitive tests, depending on their age. In total, 2,588 mothers and 4,287 children were included in the sample I used for Study 2.

Because the children were nested under the mothers, the proper statistical procedure for analyzing such data was either mixed-level (hierarchical) linear regression or the generalized estimating equation. However, preliminary analyses revealed that the results from both mixed-level regression and generalized estimating equation were substantively identical to those from OLS. This was likely due to the minimal clustering in the sample; there was a limit of four children per mother, and virtually all mothers (96.7%) had three or fewer children. I therefore decided to present the results from OLS regression below (in Appendix Table A2) in order to facilitate comparisons with the results from Study 1 and to provide estimates of effect sizes. The results of the mixed-level regression and generalized estimating equation are presented in Appendix Table A3.

Dependent Variable: General Intelligence

All children who were four years old or older took a set of cognitive tests. Four-year-olds took the Peabody Picture Vocabulary Test (PPVT) and the verbal memory test. Five- and six-year-olds took the PPVT, the verbal memory test, the Peabody Individual Achievement Test (PIAT) math test, and the PIAT reading test. Children who were seven years old or older took the PPVT, the PIAT math test, the PIAT reading test, and forward and backward digit span test.

I performed a factor analysis within each age group to compute the general intelligence score. All cognitive test scores loaded only on one latent factor, with reasonably high factor loadings (Age 4: PPVT = .806, verbal memory = .806; Age 5–6: PPVT = .506, verbal memory = .656, PIAT math = .842, PIAT reading = .821; Age 7+: PPVT = .391, PIAT math = .880, PIAT reading = .892, digit span = .802). The latent intelligence scores were converted into the standard IQ metric, with a mean of 100 and a standard deviation of 15.

The test scores were normed only within the age categories (4, 5–6, 7+), not for each age; there were not enough children at any given age to allow reliable normalizations. It was therefore important to control for the child's age in examining the association between breastfeeding and intelligence, because older children were on average expected to do better than younger children on the same set of cognitive tests.

Independent Variable: Breastfeeding

The mother indicated whether the child was breastfed and, if so, for how many months. The length of breastfeeding ranged from 0 (never breastfed) to 78 months ($M = 3.35$, $SD = 5.20$). The distribution of breastfeeding length in months was highly positively skewed (skewness = 4.289; kurtosis = 34.393). However, dividing the breastfeeding length in months into three ordinal categories comparable to Study 1 (0 = none; 1 = one month or less; 2 = more than one month) in multiple regression analyses below did not alter the substantive conclusions.

Control Variable: Parental Intelligence

As a measure of parental intelligence, I performed a second-order factor analysis with the NCDS respondent's IQ score at Ages 7, 11, and 16 that I used as dependent variables in Study 1 above. The IQ scores at three ages loaded only on one latest factor with very high factor loadings (Age 7 = .867; Age 11 = .947; Age 16 = .919). The latent general intelligence score was then converted into the standard IQ metric, with a mean of 100 and a standard deviation of 15. I used the standard IQ score as a measure of parental intelligence.

Other Control Variables

In addition to child's age and parental IQ, I further controlled for parent's education (0 = no qualification; 1 = CSE 2–5/NVQ 1; 2 = O levels/NVQ 2; 3 = A levels/NVQ 3; 4 = higher qualification/NVQ 4; 5 = degree/NVQ 5–6), parent's earnings (in 1K GBP), how frequently the mother consumed alcohol during pregnancy (1 = never; 2 = less than monthly; 3 = 1–2 days a month; 4 = 3–4 days a month; 5 = 1–2 days a week; 6 = 3–4 days a week; 7 = nearly every day; 8 = every day), how many cigarettes the mother smoked per day during pregnancy after the third month, and child's height (in cm) and child's weight (in kg), both measured by the interviewer. Parental age was not controlled in Study 2 because it was a constant (= 33) for all respondents, and parent's age at birth was not included because it would be perfectly collinear with child's age.

Results

Appendix Table A2 presents the results of the OLS regression analyses. When entered alone with age, each month of breastfeeding was associated with an increase of .3 IQ points ($b = .306$, $p < .001$). When parental IQ was controlled, the association was slightly attenuated ($b = .137$, $p = .007$) but increased slightly when parental education and earnings ($b = .164$, $p = .003$), drinking and smoking during pregnancy ($b = .158$, $p = .008$), and child's height and weight ($b = .161$, $p = .007$) were incrementally controlled. Even in the full model, the association remained statistically significant.

Figure 2 presents the association between breastfeeding and intelligence graphically, for the second-generation respondents at Age 4, comparable to Figure 1. Breastfeeding length was significantly positively and monotonically associated with intelligence at Age 4. Unadjusted for confounds, those who were breastfed for more than one month had IQ scores at Age 4 that was nearly 12 points higher than those who were never breastfed (101.8 vs. 90.0).

When examined individually, none of the IQ tests were significantly associated with breastfeeding, net of all the control variables (digit span: $b = .001$, $SE = .009$, $p = .945$; PIAT math: $b = .002$, $SE = .009$; $p = .833$; PIAT reading: $b = .002$, $SE = .009$, $p = .858$; PPVT: $b = .003$, $SE = .009$, $p = .743$; verbal memory: $b = .096$, $SE = 1.27$, $p = .940$). Once again, this suggested that the use of a single IQ test in previous studies of the effect of breastfeeding on child intelligence might potentially have accounted for their null findings.

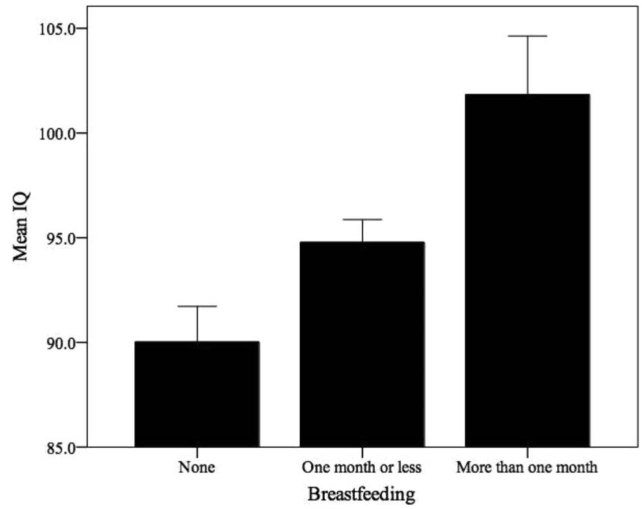

Figure 2. The association between breastfeeding and IQ at Age 4 (Generation 2).

Discussion

Results presented in Appendix Table A2 suggested that breastfeeding was significantly positively associated with child intelligence, even net of parental IQ. Even when parental IQ and all the other potential confounds were statistically controlled, each month of breastfeeding was associated with an increase of .16 IQ points. Although one must be extremely cautious in extrapolating the results, especially since only 1% of the respondents were breastfed for 24 months or longer, the results above seemed to suggest that, for example, two years of breastfeeding, as recommended by the WHO (2000, pp. 8–9), may potentially translate to an increase of 3.86 IQ points.

General Discussion

Extensive reviews (Der et al., 2006; Jain et al., 2002; Walfisch et al., 2013) have concluded that the seemingly significant effect of breastfeeding on intelligence may be confounded by mother's IQ. More intelligent mothers are more likely to breastfeed, and children of more intelligent mothers are more likely to be intelligent. Such conclusion, however, potentially has both theoretical and methodological problems. Theoretically, if breastfeeding improves child nutrition and health (American Academy of Pediatrics, Work Group on Breastfeeding, 1997; WHO, 2003), and if early childhood nutrition and health increase intelligence (Babson & Phillips, 1973; Henrichsen et al., 1986; Lynn, 1990; Scarr, 1969), then breastfeeding should be theoretically expected to increase intelligence. Methodologically, most studies use only one cognitive test to measure child intelligence, which precludes a factor analysis of multiple cognitive test scores to extract a latent factor for general intelligence and eliminate random measurement errors.

In this article, I used the NCDS, which allowed me to examine the association between breastfeeding and intelligence in two consecutive generations of a large population sample. My analyses of both generations showed that breastfeeding was significantly associated with child intelligence even net of parental IQ and other potential confounds such as parental education, earnings, and social class. They showed that breastfeeding was significantly associated with child intelligence, even when parental IQ was very precisely measured (by 11 different cognitive tests administered at three different ages) and controlled. My results contrasted sharply with the findings of many previous studies, which found a null effect of breastfeeding on child intelligence once maternal IQ was statistically controlled. I suggest that the earlier null findings may be due to the imprecise measure of child intelligence from one cognitive test.

The analysis of the first generation suggested that the association between breastfeeding and intelligence remained statistically significant and substantive, and it monotonically increased from Age 7 to 16. The analysis of the second generation showed that each month of breastfeeding was associated with an increase of .16 IQ points, which translated to 3.86 IQ points for two years of breastfeeding (recommended by the WHO). It appears that breastfeeding increases child intelligence *net and regardless* of parental IQ.

There were some weaknesses in the current studies. First, my sample was not genetically informative. There is some evidence that whether breastfeeding increases child intelligence depends on the child's genotype, in particular, which allele of the *FADS2* gene, which metabolizes fatty acids in the breast milk, the child has (Caspi et al., 2007). Fortunately, most individuals (over 90% of Caucasians) have the C allele, which allows them to metabolize fatty acids and take advantage of the breast milk to increase their intelligence (Caspi et al., 2007, Table 1). Second, it is possible that mothers who choose to breastfeed their children may be different from those who choose not to in ways other than intelligence, education, earnings, social class, and other variables statistically controlled in my analyses. For example, mothers who choose to breastfeed may be more attached or committed to their children, and it is their attachment or commitment that increases their children's intelligence. Third, the association between breastfeeding and intelligence that I uncovered, although theoretically important and substantively meaningful, was nevertheless small by effect size, especially in Study 2. Future research is clearly necessary to investigate the independent effect of breastfeeding on child intelligence net of parental IQ, hopefully with genetically informative samples, which include measures of attachment, commitment, and other personality and individual difference variables.

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(*Appendix follows*)

Appendix

Table A1
The Effects of Breastfeeding on Intelligence: Generation 1

		Age 7	Age 11	Age 16
(1)	Unadjusted	2.002***	2.323***	2.803***
		(.148)	(.153)	(.168)
		.116	*.135*	*.163*
(2)	(1) + mother's education, father's education, social class at birth	1.211***	1.377***	1.679***
		(.177)	(.174)	(.179)
		.071	*.081*	*.099*
(3)	(2) + mother's age at birth, father's age at birth	1.304***	1.553***	1.861***
		(.179)	(.175)	(.180)
		.077	*.091*	*.109*
(4)	(3) + birth weight	1.196***	1.420***	1.741***
		(.181)	(.178)	(.182)
		.070	*.083*	*.102*

Note. Main entries are unstandardized coefficients.
(Entries in parentheses are standard errors.)
Entries in italics are standardized coefficients.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table A2
The Effects of Breastfeeding on Intelligence: Generation 2

(1)	Age adjusted	.306***
		(.040)
		.122
(2)	(1) + parental IQ	.137**
		(.050)
		.054
(3)	(2) + parental education, parental earnings	.164**
		(.056)
		.065
(4)	(3) + drinking during pregnancy, smoking during pregnancy	.158**
		(.059)
		.063
(5)	(4) + child height, child weight	.161**
		(.060)
		.064

Note. Main entries are unstandardized coefficients.
(Entries in parentheses are standard errors.)
Entries in italics are standardized coefficients.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

(*Appendix continues*)

Table A3
The Effects of Breastfeeding on Intelligence: Generation 2

		MLM	GEE
(1)	Age adjusted	.306***	.306***
		(.040)	(.051)
(2)	(1) + parental IQ	.137**	.137*
		(.050)	(.062)
(3)	(2) + parental education, parental earnings	.164**	.164*
		(.056)	(.075)
(4)	(3) + drinking during pregnancy, smoking during pregnancy	.158**	.158†
		(.059)	(.082)
(5)	(4) + child height, child weight	.161**	.161*
		(.060)	(.081)

Note. Main entries are unstandardized coefficients.
(Entries in parentheses are standard errors.)
MLM = mixed-level model; GEE = generalized estimating equations.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

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