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King T, McKean C, Rush R, Westrupp E, Mensah FK, Reilly A, Gulsion D.  
of maternal education and its relation to single word reading in middle  
childhood: An analysis of the Millennium Cohort Study *Mercury  
Quarterly* 2017 **63**(2), 2.

**Link to published article:**

<http://digitalcommons.wayne.edu/mpq/vol63/iss2/2>

**ePrints link**

<http://eprint.ncl.ac.uk/3318>

**Date deposited**

05/04/2018

2017

# Acquisition of Maternal Education and Its Relation to Single-Word Reading in Middle Childhood: An Analysis of the Millennium Cohort Study

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## Recommended Citation

King, Thomas; McKean, Cristina; Rush, Robert; Westrupp, Elizabeth M.; Mensah, Fiona K.; Reilly, Sheena; and Law, James (2017) "Acquisition of Maternal Education and Its Relation to Single-Word Reading in Middle Childhood: An Analysis of the Millennium Cohort Study," *Merrill-Palmer Quarterly*: Vol. 63 : Iss. 2 , Article 2.

Available at: <http://digitalcommons.wayne.edu/mpq/vol63/iss2/2>

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# Acquisition of Maternal Education and Its Relation to Single-Word Reading in Middle Childhood: An Analysis of the Millennium Cohort Study

## **Cover Page Footnote**

We are pleased to acknowledge the contribution of the parents and children to the Millennium Cohort Study (doi:10.5255/UKDA-SN-6411-2). The work was conducted as part of the work of the Centre for Research Excellence in Child Language funded through the National Health and Medical Research Council (NHMRC) in Australia (APP1023493). This study was also supported by funding from a NHMRC-funded Early Career Fellowship (FKM 1037449), and a NHMRC-funded Practitioner Fellowship (SR 1041892). Research at the Murdoch Children's Research Institute is supported by the Victorian Government's Operational Infrastructure Support Program.

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## Acquisition of Maternal Education and Its Relation to Single-Word Reading in Middle Childhood: An Analysis of the Millennium Cohort Study

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Maternal education captured at a single time point is commonly employed as a predictor of a child's cognitive development. In this article, we ask what bearing the acquisition of additional qualifications has upon reading performance in middle childhood. This was a secondary analysis of the United Kingdom's Millennium Cohort Study, a cohort of 18,000 children born in 2000. Our outcome variable was Single-Word Reading from the British Abilities Scales at 7 years. Predictors included maternal age and education, relative poverty, and parity. Increasing maternal education over time was associated with improved child outcomes, with a 2-month developmental advantage for children whose

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*Merrill-Palmer Quarterly*, April 2017, Vol. 63, No. 2, pp. 181–209. doi: 10.13110/merrpalmquar 1982.63.2.0181 Copyright © 2017 by Wayne State University Press, Detroit, MI 48201.

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mothers had increased education over those whose mothers had not. Parity was important but conditional on this, and there was no evidence of child attainment reducing for the children of older mothers. A time-varying education-level model is consistent with an input-quality mechanism for language development.

Early child development in general, and oral language and literacy in particular, are associated with social advantage (Hoff, 2006; B. Hart & Risley, 1995; Maggi, Irwin, Siddiqi, & Hertzman, 2010) with implications for policy (Shonkoff 2007): There is a social gradient (Law, Reilly, & Snow, 2013; Marmot, 2010), as well as resilience, in more disadvantaged families (Schoon, 2006). A number of different mechanisms have been posited for this social gradient in terms of both proximal environment and behavioral genetics, which are likely to be interrelated (Harlaar, Dale, & Plomin, 2007; S. A. Hart et al., 2013; Trzaskowski et al., 2014). Numerous associations have been demonstrated between social disadvantage and language development (e.g., McCormack, Harrison, McLeod, & McAllister, 2011; Taylor, Christensen, Lawrence, Mitrou, & Zubrick, 2013) without establishing causes of observed disparities in populations. Control by randomization in small experimental studies, such as those evaluating Head Start interventions (Barnett, 1998; Heckman, 2013), makes understanding effects representing the full range of social difference very difficult. In general, studies of child-development outcomes account for socioeconomic by using a proxy variable in the analysis, or by matching control groups, understating the strength and breadth of the association with language outcomes observed in large empirical studies.

Socioeconomic status (SES) can be measured as income, housing (type and tenure), occupational status, and parental educational attainment at an individual or a household level, or by proxy of area deprivation. Although relative poverty (i.e., income below the poverty line) is established as a risk factor for negative child outcomes (Huston, McLoyd, & Garcia Col, 1994), poverty alone cannot explain gradients observed higher up the SES scale. For example, parents' economic and social context influences parental attitudes and aspirations, as well as the educational and cultural opportunities for children (Bennett et al., 2009), while resource limitations preclude certain activities beyond the home. The quality and nature of a child's early home learning environment is both strongly associated with their developmental outcomes and influenced by a range of SES factors and cultural practices (Froyen, Skibbe, Bowles, Blow, & Gerde, 2013; Johnson, Martin, Brooks-Gunn, & Petrill, 2008). The availability of books (whether or not for the child to read) is an example, and one that is often described as reflecting cultural capital because it reflects investment in cultural resources.

Behavioral genetics can ascribe a large amount of variation in language ability to heritability (Harlaar et al., 2007; S. A. Hart et al., 2013), implying that environmental intervention has constrained potential beyond the known toxicity of extreme privation. Earlier analyses rest on the zygosity of co-twins, who do not have typical language development (McEvoy & Dodd, 1992), and make further assumptions about the equal environments they experience (Shonkoff & Phillips, 2000; Trzaskowski et al., 2014). Detailed study of language outcomes shows that some aspects of language development are more related to environmental factors than others; specifically, language comprehension appears to be less heritable (Hoekstra, Bartels, van Leeuwen, & Boomsma, 2009). Although it has been proposed that gene–environment interactions could still play a role here, evidence from studies of candidate genes is very weak (Jerrim, Vignoles, Lingam, & Friend, 2015) and Genome Wide Association Study (GWAS) analyses have been unsuccessful in identifying the root of the large heritable component (Tran et al., 2013). There is some suggestion that genes may even influence SES (Trzaskowski et al., 2014), but careful attention to SES measurement and missing data has shown earlier effects to be overstated (Jerrim et al., 2015). Thus, Genetic Complex Trait Analysis (GCTA) is proposed by behavioral geneticists as combining the genetic and SES dimensions to predict cognitive outcomes (Trzaskowski et al., 2014).

### *SES as a Developmental Mechanism*

SES in the context of both child development and language/literacy is often conceptualized as maternal education (Dollaghan et al., 1999; Hoff, 2006; Shonkoff & Phillips, 2000). Although maternal education is likely to be associated with other aspects of SES such as occupational status, educational level specifically has been found to be associated with the observed variation in the nature of parent–child interaction (B. Hart & Risley, 1998), with ensuing advantages for children, including shared attention and well-developed attachment. Studies looking at the antecedents of early language/reading have shown that restricted maternal input has a bearing on later reading skills and that this is commonly associated with maternal education (Buckingham, Beaman, & Wheldall, 2014), and this holds when heredity is considered. In a large twin study from the United Kingdom, shared environmental factors explained most of the association with literacy at age 7 (Oliver, Dale, & Plomin, 2005), although a recent review of literacy interventions suggests demographic factors do not predict response

to interventions (Lam & McMaster, 2014). Parental phonological awareness, family history of reading difficulties, and school SES independently predicted whether a child was likely to experience difficulties (Heath et al., 2014): Maternal education dropped out as a predictor once the other variables were added into the models, suggesting they mediate its influence. Environmental factors shape developmental outcomes (Rutter, 2005), but longitudinal analysis of representative population studies is required to separate structures of influences and help us understand mechanisms (Hulme & Snowling, 2009, p. 347). Yet, as a mechanism, maternal education presents a challenge by being difficult to modify directly through intervention, confounded with other factors such as propensity to participate in research, and will require a long time to have an effect.

In their seminal study of the natural language development of a sample of children ( $N = 42$ ) to 30 months of age, B. Hart and Risley (1995, 1998) examined the development of three groups of children classified according to parental employment status (professional, blue collar, or welfare). Parent education was highly correlated with the occupational groups used, relating to expectations and behaviors of the parents (Shonkoff & Phillips, 2000), which are, in turn, closely associated with early reading skills (Scarborough, 2009; Silliman & Mody, 2008). B. Hart and Risley (1995) found that children of parents in professional occupations were exposed to a much larger functional vocabulary compared to children of parents in blue-collar occupations or parents receiving welfare payments. The occupations of parents or income of the families in B. Hart and Risley's (1995) study do not obviously drive parents' engagement and interactions with their child. Although the sample was small and their categories confounded with other factors, such as race, the detail of the parent-child interaction showed profound differences in the character of maternal responses to child utterances and resultant vocabulary among the three groups, a finding replicated by Hoff (2003).

SES, whether represented by parental occupation, education, income, or any other environmental measure, is one driver of the child's development, and other developmental factors are especially important in the early years (Christian, Morrison, & Bryant, 1998). Parity (or birth order) strongly influences child developmental outcomes: In larger families, parental resources are more thinly spread, so children receive less individual parental attention, such as child-directed speech (Berryman & Windridge, 2000; Cheng, Wang, Sung, Wang, Su, & Li, 2012; Coates & Messer, 1996; Dunn & Shatz, 1989; B. Hart & Risley, 1998; Hoff-Ginsberg, 1998; Hoff-Ginsberg & Krueger, 1991; Jaeger, 2008; Prime, Pauker, Plamondon, Perlman, & Jenkins, 2014; Tomasello & Mannle, 1985). A deleterious effect

is observed to increase as parity increases (Jaeger, 2008), and twins exhibit similar delays relative to singletons (McEvoy & Dodd, 1992; McMahon, Stassi, & Dodd, 1998), although most studies lack the power to test anything but the difference between large and small *sibships* (i.e., the group of siblings in the household) and are confounded by SES determinants of family size (Ghilagaber & Wänström, 2015). The observed sibling effect is moderated to some extent by maternal age and experience (Berryman & Windridge, 2000) and, to a degree, related to the *cognitive sensitivity* of the sibling (Prime et al., 2014). So family sociodemographic variables interact with one another (or combine as the child's social environment) at specific points in a child's development.

Social variables are commonly used as fixed predictors or risk factors for developmental outcomes of language and literacy in populations, but one might be able to study relations across time by using longitudinal prospective data (Shonkoff & Phillips, 2000). Most research is testing for divergent outcomes in children, so changes in the family are usually viewed from a perspective of specific disruptive events—for example, changes to the household membership or location (e.g., Melhuish et al., 2008). A number of family characteristics known to be cumulatively important to child development can change over time and affect different aspects of child development (Becker, 2011; Davis-Kean, 2005; Ermisch, Jantti, & Smeeding, 2012; Hoff, 2006). A parent's occupation may not be stabilized until their 30s (Sturgis & Sullivan, 2007), and earnings (or social class in general) can increase with age (Bennett et al., 2009, pp. 53–54). Inferences from any analysis of parental SES and child outcomes are likely to be a function of the point at which data are collected during the family's life course (Halfon, Larson, Lu, Tulli, & Russ, 2014).

Participation in postcompulsory and in higher (undergraduate and postgraduate) education has increased enormously in recent decades (Hordern, 2012) and often extends into the age in which childbearing commonly takes place. Further education for low-skilled adults is a step towards a professional career but is also posited to impact on both the parents and their children (K. Sullivan, Clark, Castrucci, Samsel, Fonseca, & Garcia, 2011). As parents obtain more education, their educational engagement and aspirations for their children improve, as does the home learning environment and educational experiences provided. Further education can also be a signal of disposable time or income, as well as more middle class child-rearing behaviors or parenting style such as providing more educational trips for their children, being more involved in school (parents' associations etc.), and having higher expectations for their children (A. Sullivan, Ketende, & Joshi, 2013), leading to improved outcomes. However, specific

job-relevant skills would link directly to income, and hobby courses of personal interest suggest recreational or cultural motivation. Improved outcomes for children associated only with an increase in maternal education is predicted by a sociocultural interpretation, although perhaps not something easily measured in the home environment (Magnuson, Sexton, Davis-Kean, & Huston, 2009). A mechanism corresponds to changes in how the mother behaves towards the child, as direct interaction and experiences in the family are more relevant in early childhood.

Although many studies look at how SES and maternal education in particular affect early literacy outcomes (e.g., Christian et al., 1998), we only identified a single study that sought to test the specific effect of the accumulation of maternal education. Magnuson et al. (2009) investigated 3-year-olds' education increases and language in a targeted sample of just over 1,000 predominantly low-income parents in the United States (the National Institute of Child Health and Human Development). The mother's educational level was classified into five groups, each corresponding to a further 2 years of successful duration: none/unfinished, high school, some college (e.g., associate degree), college degree, and graduate school. A positive association between increased education and child-language gains was present and significant for those who were least well educated, but not overall, because the study was underpowered (only  $n = 53$  parents increased their education). Although increased education was associated with improved performance on the Home Observation for Measurement of Environment (HOME; Caldwell & Bradley, 1984), the effect of parental education gains on child language was not mediated by a change in the environment at age 2 on the HOME. Thus, the hypothesis of more enrichment in parental interaction and child stimulation was not supported.

Child-development measures are sensitive to timing of assessment: Language is a complex multicomponent skill involving interactions among subcomponents both in the act of language processing and over developmental time. Language interacts with the development of early literacy skills throughout childhood, so skills gained in one component cascade onto the learning of others with different developmental windows (Shonkoff & Phillips, 2000). This complexity is mirrored in the choices made to measure language in cohort studies: In the early years, the emphasis has tended to be on expressive vocabulary, although there are concerns about bias in some parental reports (Law & Roy, 2008), and later emphasis tends to shift to letter knowledge and early literacy. Early measures tend to be relatively unstable and unreliable; the profile of children's skills changes over time for a range of developmental and environmental reasons, so reading becomes a useful indicator of attainment once the child is

well established in primary school or kindergarten. Stability increases with age, and so assessing the impact on the child's abilities at 7 or 8 years of age should be especially relevant (Feinstein & Brynner, 2004). Examining these mechanisms in middle childhood enables focus on the developmental stage when most input has been from the mother as a primary carer, while allowing enough time and change for benefits to accrue from improving social circumstances.

### *Research Questions*

The aim of this study was to examine the impact of changes in maternal education on the literacy skills of children in middle childhood in a representative population. These were our research questions:

1. Does a mother's acquisition of new qualifications over the first seven years of life have a bearing on the child's reading skills in middle childhood?
2. To what extent is this relation affected by maternal age, parity, gender and income?

### **Method**

The data are from the Millennium Cohort Study (MCS) in the United Kingdom, comprising prospective longitudinal data on a cohort of children and others in their household. The MCS is a nationally representative cohort of around 19,000 children born in the United Kingdom in 2000–2001, spanning births in a full 1-year period. For themselves and their children, mothers and partners provided informed consent for participation in the study, and this was verified at each later sweep of data collection. Children's households were sampled randomly from a register of those receiving Child Benefit, which has estimated coverage of 97% of children resident in the United Kingdom. The MCS was designed to oversample areas of high deprivation in anticipation of greater attrition in those areas, and the devolved nations of the United Kingdom to increase the power of subgroup analyses (Plewis, 2007); thus, all population estimates require design weights, which are used throughout the analyses presented (subsample totals rounded to whole persons).

Families were first interviewed when their child was around 9 months old and were followed up when the child was 3, 5, and 7 years old. Over 13,800 families with over 14,000 cohort children took part in the age 7 survey; 90% of families who took part in all the previous

MCS sweeps (9 months and ages 3 and 5) also participated at age 7. The present analysis includes those children who were assessed by using the British Ability Scales (BAS II) Single-Word Reading (Elliott, Smith, & McCulloch, 1997) at 7 years of age— $N = 12,845$ : boys  $n = 6,574$  (51.2%) and girls  $n = 6,271$  (48.8%)—versus not completed by 427 children. This excludes further observations where information is lacking, the child or the mother had died, or the primary respondent was not the mother (in total,  $n = 296$  of original sample were not considered). Mothers holding overseas qualifications were excluded because of the heterogeneous and uncharacterized level of such qualifications ( $n = 527$ ). Twin pairs and triplets ( $n = 312$ ) were also excluded because of their known anomalous language outcomes (McMahon et al., 1998) and their problematic specification in terms of the birth order effect, but, as multiple births are random, their exclusion does not affect our analysis. The sample is statistically representative of singleton children born in the United Kingdom in 2000–2001 whose mothers were their primary carers and had British educational qualifications.

### *Variables*

Information about maternal education was recorded when the child was 9 months and followed up at 3, 5, and 7 years and is the qualification level (rather than the duration of schooling as is sometimes used) because this better reflects the hypothesized mechanism. At first interview, the mother was asked for her highest qualification, both academically and vocationally; in each subsequent interview, the mother was asked, “I’d now like to ask a few questions about your education and qualifications since [child name] was aged [last interview age]. Have you acquired any new qualifications?” Followed, separately for show cards listing academic and vocational qualifications, by “Please tell me which of these qualifications on this card you have gained since [child name] was [last interview age] old.” Vocational (as opposed to academic) qualifications are more difficult to classify and interpret, as well as less homogeneous and less predictive (A. Sullivan et al., 2013), so the study focuses on academic qualifications in line with the hypothesized level of the education mechanism. The data for maternal education at the child’s birth was coded into four levels:

1. Higher education
2. A level
3. O level/GCSE A\*-C
4. CSE/GCSE D-G and none

*Higher Education* (HE) covers qualifications from a foundation degree (i.e., less than a bachelor's degree) and higher diplomas and certificates, up to postgraduate qualifications in teaching, and higher and research degrees. Further subdivision of the Higher Education category was impractical for the range of qualification and a change to the coding scheme used in the data collection between Sweeps 2 and 3. In England, Wales, and Northern Ireland, the A (*Advanced*) level is required for university entrance and is typically completed by age 18, when children have usually leave school. The *General Certificate of Secondary Education* (GCSE) is completed during compulsory stages of education (usually by 16 years) where attainment is split into passing (A\*–C) and failing (D–G) grades. The lowest category indicates very limited attainment: Essentially no employer recognized qualifications. Scottish qualifications have been coded for equivalent levels. Comparing broadly to the work of Magnuson et al. (2009), in the U.S. system, we have HE = associate, bachelor, and graduate degrees; A level = graduated high school (age 18); GCSE A\*–C etc. = some high school but left before graduation (age 16); and GCSE D–G/none = failed high school/no high school. Variables were derived to record acquiring new education during the years between the child's birth and the outcome at age 7. We enumerate gains in terms of whether they raised the educational level of the mother on the 4-point scale described in her original report. We assume no further qualifications were achieved between the birth and the first interview, and we consider only whether a gain has been made at all and the type of gain, not the sweep at which it occurred.

To complement the SES effect of maternal education, we use a binary threshold risk factor for material deprivation (Hoff, 2006; Huston et al., 1994). *Poverty* is derived from the Organisation for Economic Co-operation and Development (OECD) equivalized household income recorded at first interview, compared to the standard threshold (60% of median household income), after adjustment for household membership. Absolute values of the index are not meaningful, but it measures relative household income, and the 60% threshold is an indicator of material deprivation. Maternal age at child's birth is categorized in 5-year bands, with under 20s and 35+ as open-ended groups. Parity (birth order) was included for individual values up to 4 and then remaining values grouped together as 5+ (highest value was 9).

### *Sample Characteristics*

The first two columns from the left of factors in Table 1 list proportions having each attribute for mothers, respectively, of the sample completing the Single-Word Reading and the full MCS sample; the remaining

**Table 1.** Total and subpopulations for sociodemographic characteristics (%)

Factor	Population		Gaining qualifications		
	Responses	Sampled	LEL <sup>c</sup>	Higher level	
				Total	A level
Female child	48.8	48.7	52.9	50.2	46.2
Poverty <sup>a</sup>	31.4	28.3	25.5	38.5	41.1
Parity					
1	41.4	42.2	38.1	42.0	48.4
2	36.6	36.4	39.4	38.8	37.4
3	14.8	14.6	18.4	14.1	10.2
4	5.0	4.6	3.9	4.1	4.0
5+	2.1	2.1	0.2	1.1	0.0
Maternal age <sup>b</sup>					
<20	8.6	7.3	5.2	14.5	21.0
20–24	17.9	16.0	14.5	23.7	34.0
25–29	28.1	27.2	28.1	28.5	29.3
30–34	28.9	31.7	33.8	21.3	13.1
35+	16.4	17.8	18.4	11.9	2.5
Maternal education <sup>c, d</sup>					
University	26.2	29.1	60.4	— <sup>e</sup>	— <sup>e</sup>
A level	9.6	10.1	8.9	20.1	— <sup>e</sup>
O level/GCSE A*–C	36.0	35.5	28.1	48.5	72.6
GCSE D–G/none	28.2	25.5	2.6	31.4	27.4
Total (N)	12,385	18,055	446	641	115

<sup>a</sup> Poverty corresponds to household equivalized income below the 60% median.

<sup>b</sup> At childbirth.

<sup>c</sup> Qualifications gained at lower or equivalent level than those already held.

<sup>d</sup> Highest academic qualifications corresponding to stages: university = any higher education qualification; A level = academic school leaving at age 18; O level/GCSE (A\*–C) = academic school leaving at age 16 updated to general school leaving at a high level in 1986; GCSE (D–G)/none = nonacademic school-leaving qualifications at age 16 or no formal qualifications at an academic level. LEL = lower and equivalent-level qualification.

<sup>e</sup> These gain types are impossible by design.

columns list these proportions for various categories of educational gain. Mothers who are more advantaged, highly educated, and older, while having their first child, are more likely to have been excluded from the sample, but none of these differences are large enough to prejudice inference to the reference population. Overall there are roughly equal proportions

in the modal age groups of 25–29 (28%) and 30–34 (29%); similarly, the adjacent age groups of 20–24 and those over 35 are roughly equal in size. Most births (41.4%) are the mother's first, but nearly as many are their second (36.1%). Most mothers had only school-leaving qualifications (at age 16): More than one third had a good GCSE (36.0%) and 28.6% less than that or no formal academic qualifications, whereas 26.2% had university level qualifications.

In the fourth column of Table 1, we see more than 600 mothers making a gain in their educational level from when the child was nine months old to 7 years old. Although this group tended to be younger and more likely to be in poverty than the rest of the population, they were not substantially different in terms of their parity: These are women having their first child at a younger age, interrupting their education before gaining further qualifications. Conversely in column 3, those gaining qualifications, but not at a higher level, are more likely to be older, not in poverty, and having had their second or third child, although they are also likely to have had university qualification at the time of the child's birth: They are at a more established stage of life. Finally, in column 5, we also consider a variable for a specific gain in educational level (A level), a subgroup of the general gain group and not dissimilar in the proportions of mothers with each of the sociodemographic characteristics.

### *Outcome Variable*

The outcome was the Single-Word Reading test of the British Abilities Scales (Elliott, Smith, & McCulloch, 1997), an age-standardized direct assessment requiring the child to read a series of increasingly difficult single words. This is a personal face-to-face assessment, in this case performed by the same interviewer who completed all of the other questionnaires, with the parent present. The standardization covers 65–145 ( $100 \pm 3$  SDs), but in a large, representative population we expect to observe floor and ceiling effects: The slightly offset population mean resulted in a larger proportion of children being at ceiling. The ability score (before age standardization) was used to extrapolate those at ceiling. Intentions to interview all families when the child was aged 7 years, realized a range in the months of age at assessment ( $M = 86.6$ ,  $SD = 2.97$ ). Thence, using age, ability score, and standard score (originally constructed as a linear relation), we derived the differences above or below the average for the whole sample and used this transformed value as the dependent variable in our models to facilitate interpretation of the effect size as months of developmental difference.

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*The Analytical Approach*

We estimate the most parsimonious model based on mechanisms for the variation in population language development, specifically in relation to SES (Hoff, 2006). This includes variables for gender and parity together with two complementary measures of social risk (household poverty and maternal education), with maternal age giving some demographic context. Many proximal activities may influence the outcome during the child's development, but our analysis estimates some of the more distal SES effects are already established when the child is born. Furthermore, Magnuson et al. (2009) were unable to establish a mechanism for the observed effect by influence on the HOME score (Caldwell & Bradley, 1984) while finding a significant direct effect. Thus, we are estimating the relative population difference of variables fixed at (but recorded soon after) the birth of the child to enable a robust estimate of the effect on the outcome associated with an increase in maternal education, controlling for gender, maternal age, and baseline SES.

All of the analyses were performed in Stata Version 13.0: The models used ordinary least squares regression to predict the outcome, weighted to make a representative inference about the native U.K. population, by using the population mean as the baseline for the model estimates. Categorical predictors enable more parameters to be used than for continuous variables and facilitates estimates of possible relations that are not linear, but rests on an assumption of homogeneity within categories. Inference is relative to a reference category chosen as the largest group: the child being male, mothers aged 30–34 at the birth of the child, the child being their firstborn, and mothers having an educational level of a good GCSE (similar to having graduated from high school, but at the normal age of 16), not being in income poverty, and not gaining further qualifications in the period. Separate models, conditional on the same covariates, are estimated to test the three distinct specified gains in maternal education:

1. Further education that increases the mother's educational level
2. Any other further education (termed lower- or equivalent-level qualification)
3. A gain of A level representing an increase in highest qualification

Specification 3 is chosen to be the most homogeneous type of change and therefore the most powerful estimate of an effect, corresponding to the subgroup finding reported by Magnuson et al. (2009) of completing high school, but it is a subset of the first specification.

The specified aforementioned covariates (maternal age, child's gender, initial maternal education, poverty indicator, and maternal education gains) are not complete in all cases. Where items such as maternal age, gender, or birth order are missing at the initial sweep, they can be retrieved in later sweeps of the study, as can poverty, whereas unit nonresponse at age 7 is accounted for by weights. As the design of the MCS used a third-party sampling frame that is updated periodically, initial recruitment missed some children ( $n = 692$ ) who were then contacted for the first time at age 3. Three variables retain item-level missingness: the poverty indicator ( $n = 477$ ), initial maternal education ( $n = 460$ ), and consequent gain of education in the first 3 years of the child's life. Multiple Imputation by Chained Equations was used, and all model estimates are based on 20 imputations (Royston, 2004; Rubin, 1987).

## Results

Independent predictions of the Single-Word Reading outcome are listed in Table 2 and show the anticipated differences, with girls above the population average by more than 1 month and boys below by a similar amount. Poverty has a substantial negative association (6 months below average) with the outcome (Single-Word Reading) and so does every increase in parity, and, because of the large sample size, these differences all have statistical significance. Educational level showed the expected pattern: High maternal education is associated with above-average outcomes and vice versa; maternal age saw an increase in predicted outcomes up to age 30, followed by a slight decline for the oldest mothers. There is an effect of education as a manifestation of SES, but education level is dependent on maternal age, such that attainment characterizes a different range of life courses at different ages. In Table 3 we can see by considering a cross-tabulation of maternal age and maternal education that the association between the two is pronounced; this interaction between the two variables is included in the multivariate analyses. The principal interest here is in the main effects of the maternal education levels and the poverty indicator, but these effects are associated with (and therefore confound the estimates in Table 2) the levels of the maternal age variable. Hence, we initially abstract the effect of the interaction from the remainder of the variables.

Figure 1 shows the combined estimated effects of the variables for maternal age and initial maternal education, fitted as an interaction in the models. As zero corresponds to the reference category for other variables—that is, being male, firstborn, and not in poverty, almost all estimates appear to be above average. Maternal education levels are strongly predictive of

**Table 2.** Uncontrolled predictions<sup>a</sup> of outcome for sociodemographic groups

Predictor	<i>M</i>	<i>SE</i>	<i>n</i>	% <i>N</i>
Boy	-1.3	0.21	6,644	54
Girl	1.4	0.18	6,338	51
No poverty	2.8	0.16	8,517	69
Poverty <sup>b</sup>	-6.0	0.27	3,898	31
Parity				
1	1.6	0.21	5,374	43
2	0.4	0.24	4,573	37
3	-2.7	0.38	1,926	16
4	-5.2	0.69	652	5
5+	-7.5	1.03	277	2
Maternal age				
<20	-6.1	0.49	1,115	9
20-24	-3.4	0.34	2,330	19
25-29	-0.2	0.27	3,652	29
30-34	2.7	0.25	3,756	30
35+	2.4	0.35	2,129	17
Maternal education				
University	6.4	0.25	3,251	26
A level	3.3	0.42	1,193	10
O level/GCSE A*-C	-0.5	0.23	4,466	36
GCSE D-G/none	-6.2	0.28	3,506	28

<sup>a</sup> Values are uncontrolled number of developmental months of difference from sample average on the British Ability Scales Single-Word Reading outcome at age 7. Academic qualifications are explained in Table 1.

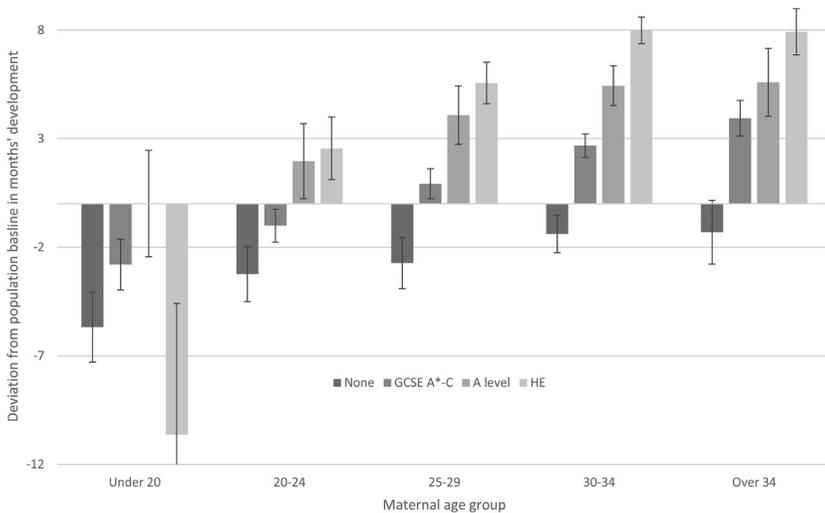
<sup>b</sup> Poverty corresponds to household equivalized income below the 60% median.

the child's reading skills at 7 years while being complicated by the effect of the maternal age at birth, and the large sample allows us to consider the patterns as robust. The scale of the differences seen is substantial, being an estimated mean developmental difference of nearly 6 months at age 7 for mothers aged 20-24 when comparing mothers who have higher education and those who have no qualifications. This rises to above 9 months for the same difference in mothers who are over 30. The trend between age groups identifies those with higher levels of education as seeing higher child outcomes at age 7 by roughly 2 months development being in an older age

**Table 3.** Cross tabulation of predicted<sup>a</sup> outcome (mean [SE] *n*) by age and education

Education	Age group				
	<20	20–24	25–29	30–34	35+
University	-7.48 (4.24) 17	2.00 (1.14) 176	5.54 (0.47) 907	7.58 (0.38) 1,321	6.76 (0.50) 831
A level	-0.64 (1.82) 56	1.16 (1.19) 185	3.28 (0.74) 367	4.52 (0.73) 375	3.95 (1.01) 210
GCSEs	-4.29 (0.80) 402	-2.45 (0.50) 893	-0.54 (0.45) 1,273	0.99 (0.40) 1,270	1.76 (0.62) 628
None	-7.98 (0.70) 565	-6.09 (0.55) 959	-5.97 (0.54) 962	-5.17 (0.64) 664	-5.90 (0.89) 356

<sup>a</sup> Predictions for each maternal age/initial education combination are the uncontrolled average number of developmental months of difference from the sample average on the British Ability Scales Single Word Reading outcome at age 7. Academic qualifications are explained in Table 1.



**Figure 1.** Seven-year outcome by educational attainment and maternal age. Highest academic qualifications corresponding to stages: A level = academic school leaving at age 18; GCSE (A\*–C) = academic school leaving at age 16 updated to general school leaving at a high level in 1986; HE = higher education.

group from 20–24 years to 25–29 years and again from 25–29 years to 30–34 years but perhaps only half that for those without good qualifications. There is an anomaly in the estimate for the youngest mothers with the highest level of qualification ( $n = 17$ ) who have by far the worst child outcomes: This is a very small group that is not old enough to have completed a bachelor degree, perhaps corresponding to community college or associate degrees.

1. *Does a mother's acquisition of new qualifications over the first 7 years of life have a bearing on the child's reading skills in middle childhood?* Table 4 lists the estimates for gains in education, given all covariates and [maternal age  $\times$  initial education] interaction described above (equivalent models for the three proposed educational gain variables show similar covariate effects) in the first research question. Gain in educational level has three types, its effect on the cognitive outcome is shown in Table 4: an educational gain to a higher level has a positive association which is marginal in terms of statistical significance (95% CI [0.3, 3.4]). The lower and equivalent level (LEL) qualifications show an insubstantial and slightly negative effect that is associated with exclusion of those gaining both lower and higher qualifications in the period. A-level gains are associated with a higher child outcome, and we can compare the estimated effect (a gain of 4 months, 95% CI [0.9, 7.8]) to the estimated difference between the two levels of education. The estimated association of benefit for later gain generally exceeds the penalty of not having that level of

**Table 4.** Effect estimates<sup>a</sup> for different specification of acquired maternal education

Gain indicator	<i>B</i> (SE)	95% CI
A level <sup>c</sup>	4.32 (1.76)	[0.88, 7.77]
LEL qualification <sup>b</sup>	-0.30 (0.83)	[-1.92, 1.32]
New highest level	1.85 (0.77)	[0.33, 3.36]

*Note.* All values represent predicted number of developmental months of difference on the British Ability Scales Single-Word Reading outcome at age 7; each estimate is independently estimated in a model with all other covariates (gender, poverty, age, initial education, and parity).

<sup>a</sup> *B* corresponds to the parameter estimate conditional on covariates in the full regression model.

<sup>b</sup> LEL qualification = lower-level or equivalent-level qualification gain, in contrast to higher-level qualification gain.

<sup>c</sup> A level corresponds to those mothers gaining the A level who had only lower-level qualifications at the child's birth. Academic qualifications are explained in Table 1.

education at the child's birth. This would likely relate to either further subsequent gains or starting from a lower level than the good school-leaving qualifications; it may also exaggerate the effect due to a selection bias. We replicate and extend the results observed by Magnuson et al. (2009): with generally positive, significant effects of gain to educational level and specifically of advanced school-leaving qualification.

2. *To what extent is this relation affected by maternal age, parity, gender, and income?* In this question, we see further in Table 5 all of the model-effect estimates for the variables, the covariates included (gender, parity, and poverty) in the model for A level gain. Parity has an effect of around a 2-month delay to the cohort child for every preceding child the mother has had (the estimates use dummy variables; for each, we see a simple additive effect, petering out for the largest families), notably with the difference between first and second born at around a very high level of significance (CI [1.4, 2.8]). Reading this with the effect of maternal age, as a mother is necessarily older when having subsequent children, parity still has a negative effect. As is typical in language development, we observe that girls have an advantage at age 7 of nearly 3 months (CI [2.1, 3.3]) on the Single-Word Reading measure. Finally, we see that the effect of poverty also corresponds to a developmental delay of around 4 months (CI [3.0, 4.7]) in terms of Word Reading, controlling for the other effects in the model, showing that maternal education does not capture the whole of the SES association with the outcome, but the effect is considerably reduced from the 6 months shown in Table 2.

From the whole model, we predict substantial difference in the language development of children at age 7 based only on information available at their birth. While some of these are more biological circumstances such as gender and birth order, substantial effects are associated with social factors. The pattern shown in Figure 1 is one of improving prospects for child language outcomes associated with both the age and the education of the mother. Although both maternal age and maternal education have an effect, these interact so education sees a greater benefit at older ages, or conversely there is a greater negative association of a mother having no qualifications at an older age. Contrasting extremes, there is a difference of more than 1 year in test performance between the children of mothers with the lowest qualifications whose children are born before the mothers are 20 years of age and the children of mothers with higher education whose children were born after the mothers were 30 years of age. There is a social gradient across levels of education, particularly noticeable in the modal group of mothers, which lends itself to more precise estimates, and this social gradient is more pronounced among children with older mothers. Finally, very

**Table 5.** Final model predicting reading vocabulary at 7 years

Predictor	<i>B</i> ( <i>SE</i> )	95% CI	<i>n</i>	% <i>N</i>
A-level gain	4.32 (1.76)	[0.86, 7.77]	109	0.7
Parity				
2	-2.09 (0.37)	[-2.81, -1.37]	4,703	36.5
3	-4.67 (0.53)	[-5.70, -3.64]	1,906	14.8
4	-5.83 (0.89)	[-7.56, -4.09]	645	5.0
5+	-6.49 (1.23)	[-8.89, -4.09]	274	2.1
Poverty	-3.89 (0.43)	[-4.74, -3.04]	3,884	30.1
Female	2.73 (0.32)	[2.11, 3.35]	6,271	48.9
Age group				
<20	-5.47 (1.17)	[-7.77, -3.18]	1,104	8.4
20-24	-3.69 (0.76)	[-5.17, -2.20]	2,305	17.7
25-29	-1.76 (0.69)	[-3.11, -0.41]	3,610	28.0
35+	1.26 (0.82)	[-0.34, 2.87]	2,107	16.7
Education <sup>a</sup>				
HE	5.30 (0.61)	[4.11, 6.50]	3,243	26.6
A level	2.76 (0.89)	[0.98, 4.54]	1,190	9.6
None	-4.07 (0.87)	[-5.77, -2.37]	3,497	27.8
Age × Education <sup>a</sup>				
<20 × HE	-13.13 (6.04)	[-24.98, -1.29]	17	0.1
<20 × A level	-0.05 (2.45)	[-4.75, 4.85]	56	0.4
<20 × None	1.19 (1.61)	[-1.97, 4.34]	564	4.5
20-24 × HE	-1.74 (1.44)	[-4.57, 1.09]	176	1.5
20-24 × A level	0.21 (1.73)	[-3.18, 3.61]	185	1.5
20-24 × None	1.84 (1.26)	[-0.62, 4.31]	956	7.6
25-29 × HE	-0.66 (0.96)	[-2.53, 1.21]	904	7.3
25-29 × A level	0.40 (1.34)	[-2.24, 3.03]	366	3.0
25-29 × None	0.42 (1.18)	[-1.90, 2.73]	960	7.6
35+ × HE	-1.31 (1.06)	[-3.40, 0.76]	829	6.9
35+ × A level	-1.11 (1.56)	[-4.17, 1.94]	210	1.7
35+ × None	-1.18 (1.47)	[-4.07, 1.71]	355	2.8

*Note.* The reference category is male child, firstborn, above poverty threshold, maternal age of 30-34, and maternal education of GCSE (A\*-C) at childbirth; all estimated are for the number of developmental months of difference on the British Ability Scales Single-Word Reading outcome at age 7.

<sup>a</sup> HE = higher education; None = no academic qualification or only D-G grades at GCSE. Academic qualifications are explained in Table 1.

little difference is observed between ages 30–34 and 35+, remembering that the model is conditional on parity, which obviously increases with age, thus explaining the divergence from univariate estimates in Table 3. These estimates allow for a negative effect of household poverty on child outcomes, suggesting the underlying maternal education has substantial explanatory power, replicating a pronounced social gradient (cf. Marmot, 2010).

## Discussion

The developmental staging of early literacy and oral language is a complex function of exposure and experience in the sense that synthetic skills are likely to reflect what the parent and others (e.g., teachers) do to engage with the child. We found that on average, in the United Kingdom, the more education that the mother has, the higher the child's reading scores are at age 7, and specifically increasing her educational level during this time is associated with a better outcome. More subtly, there is a greater difference for older mothers, on top of better outcomes for the children of older mothers more generally; we describe this combination as an association of *maternal maturity* with better early literacy outcomes for children. This age benefit is offset by a negative effect of birth order, with second and later children having poorer outcomes, consistent with disruption of beneficial exposure and shared parental resources more generally. So although maternal maturity definitely matters for the child outcome, opportunities for adult education do not require postponing childbearing until after further education as the eponymous Rita perceived:

I've been realisin' for ages that I was y'know, slightly out of step. I'm twenty-six. I should have had a baby by now; everyone expects it. I'm sure me husband thinks I'm sterile. He was moaning all the time, y'know, "Come off the pill, let's have a baby." I told him I'd come off it just to shut him up. But I'm still on it. See, I don't wanna baby yet. See I wanna discover meself first. Do you understand that? (Russell, 1996, p. 271)

All educational levels show greater benefit to the child with increasing maternal age. We do not see any reduction in prospects for children of older mothers, but the effects for the mothers aged over 30 are consistent. (An initial analysis based on 6-year age groups from 20 to 25 etc. showed the same pattern despite yielding 38+ as the oldest category.) Poorer prospects (seen in Table 2) for children of older mothers are related to the increase in parity, which is not, at that age, offset by benefits from increasing age. Indeed, the consistent effect of parity, even of the child being a second child,

is striking, but household financial resources may constitute a selection effect that prejudices interpretation as a natural experiment (Ghilgaber & Wänström, 2015), yet the observed effect exceeds potential selection bias.

The combined socioeconomic effects (poverty discriminates within the lowest level of qualifications) are associated with more than 1 year of development (or more than 1 *SD* of difference on the standard score scale) of the Single-Word Reading task, representing large differences between broad population groups rather than a determination of prospects for all children. Maternal education is additive, implying differences being due to a change in the mother, in terms of higher social status, or a shift in the character of direct language input. We observe an improved outcome for children when their mother has increased her education level since they were born, particularly proceeding to university entrance level, but no difference for other further education. A selection effect for households with capacity for time in education should not be limited to increases in the mother's highest attainment. Studying reduces the time the mother can spend with her children, so higher qualifications perhaps entailing larger commitments may not see a benefit or one that takes a longer time to be seen in outcomes. Thus, the SES relation to language outcomes is not completely determined by maternal education when the child is born, but the mechanism can be quality of maternal language input (cf. B. Hart & Risley, 1998), latent social status (Sturgis & Sullivan, 2007), or other cultural aspects of later attained SES (Bennett et al., 2009).

### *Study Limitations*

The MCS data focus on the children in the cohort and are directly comparable as a sample of births in the United Kingdom within 1 year, so mothers are parenting at the same period of time but maternal age-effect estimates may relate to diverse formative experiences. The range of more than 25 years that covers the mothers in the cohort corresponds to the mothers themselves leaving school between roughly 1975 and 2000, a period in which both the prospects for women in society and the norms of the school educational system have changed. The school-leaving outcome expectation changed: All children are entered for the higher level of school-leaving qualification, so some say the GCSE qualification does not represent the same standard as the O level it replaced. In our model, we see better outcomes for that group, compared to adjacent educational levels, for the children of 35+ mothers, in evolving prospects for young people entering the labor market straight from school.

The relation, shown in Figure 1, between the level of maternal education with the outcome, coupled with the positive effect of gains, suggests that it

is the experience of exposure to education, and associated maturity, that is affecting literacy in middle childhood. An observed association may represent unfinished education attained by parents who were too young, meaning gains were returned to only younger mothers. However, there can be something inherently different about the mothers who achieve further and higher education prior to their further engagement in the education that is driving the differences at 7 years. They can be more oriented towards educational activities and more cognitively sensitive than other parents. Then maternal educational level becomes an indicator of an underlying predisposition rather than the mediator of the process, and it is those mothers who go back to education, rather than the education, creating the association. Although the direct effect of exposure to higher levels of education has face validity in terms of increased language skills and intellectual curiosity and a more critical approach to questioning and knowledge, a cohort study does not provide causal evidence. Specifically, possible restrictions on maternal opportunities for further study could be associated with lower cognitive outcomes for their child (e.g., the child having a disability).

Large demographic cohorts like the MCS have their strength in the random-sampling-based recruitment of participants in the surveys, but this is only true for the entire original sample: Participants are missed at each stage of sampling, recruitment, follow-up, and agreement to provide data to the study (Plewis, 2007). Sampling weights adjust for the design of the survey, but they have also been used in our analyses to make the sample more representative of the original sampled population. This allows us to say that our inferences apply to the U.K.-born population of 2000–2001, but it requires the mechanism for attrition and refusal to participate being unrelated to our conditional inferences about the outcome. The life-course-event nature of returning to education makes it likely to be associated with changes of circumstances—for example, relocating for purposes of study or new employment that cause attrition, and a transition possibly indicates a more successful progression for the parent—that is, a greater increase in her social status. More generally, this may explain the low estimate of outcomes of the youngest but most educated group in that more resilient mothers may have moved on. A large cohort study of this kind is focused on the entire population, and the parents as much as the children, so uncooperative or impaired children may not have completed the assessment and have been excluded from our analysis. However, the poverty measure included may be capturing some of these more pathological problems, as well as representing the effect of material deprivation and poor nutrition, which are also most significant at the youngest ages (Huston et al., 1994). Thus, conclusions about the clinically impaired tail of the developmental

scale, which would in any case be less responsive to changes in maternal SES, require another approach and different predictors.

### *Recommendations for Policy and Practice*

Although many policy initiatives characterize the socioeconomic of the household as a fixed factor to control for, that approach is challenged by our analysis, which suggests the potential for poorer prospects to be affected by SES changes at the family level. Parents too young to have established themselves in socioeconomic terms, and the range of their ages, mean that they are also at very different stages in their lives. For many mothers, their SES evolves over time, and our analysis saw concomitant benefits to their children in middle childhood. Yet the categorical nature of our educational data may mask a continuous trend in maternal cognitive ability being passed to the child (whether genetic or otherwise), with higher ability mothers in each category more likely to succeed at further education. For social policy, further maternal education or indeed poverty per se are certainly relevant but identifying barriers faced by mothers in taking up further education after the birth of a child is salient, even though we are controlling already for a number of likely factors.

In the United Kingdom, there is a program for the surveillance of the development of young children. Health Visitors—known as community health nurses in other health systems—visit children in the family home from birth through to 2 or 3 years and sometimes beyond. They advise on breast feeding and early child care at first and, later, child development and behavior: Language development and preliteracy-skills advice in such interventions are delivered via various media, including verbally. Initial contacts focus on the parent, but this shifts to the child's performance; our analyses present opportunities for such services, which are not in current programs. Although there may be an informal narrative about ensuring that all children get their say, relative to their siblings, specific guidance is lacking, given the sizable relation seen between outcome and birth order. And policy makers could encourage mothers to return to education not only to benefit their own economic prospects (the current focus of government policy) but also for a beneficial effect on the well-being of the child.

### *Recommendations for Future Research*

Before implementing social policies, experimental studies are preferred for inferences about changes in outcomes, but a policy randomizing returns to education, and maintaining this allocation is unrealistic as a study

design. As social factors influence this decision and the outcome overall, a representative sample like a birth cohort is the ideal observational study, especially because it is large enough to observe returns to education. Qualitative work exploring the dynamic attitudes of parents to their education and their aspiration for their children (cf. Domina & Roska, 2012) would complement this. Whether some parents link their own achievement with their children's and others do not, and if such attitudes in themselves make a difference to the child, would aid the development of policy.

The exposure model of language stimulated by input quality and quantity during a child's development is one that requires wider interrogation and is a very high level (in that it may be mediated by a number of processes) characterization of a mechanism for SES, as realized in educational level, affecting middle-childhood language outcomes. It needs to be shown to have specificity to language/literacy as opposed to other cognitive outcomes and so elucidate whether the mechanism by which parental education has an effect is via language exposure of the child. That input quality is determined by academic educational level, and potentially disrupted by older siblings, is consistent with the empirical evidence presented here but needs consideration of paternal inputs and the actual time spent with the child. Selection effects for returns to education and earlier and later siblings are likely to be present in terms of the concept of SES, as well as measures like education level, and should be accounted for in more complex analyses. As children grow older, peer effects, subject to peer selection in relation to parental SES, should be seen to be more important so that the effects of parental SES *are* still seen but more indirectly.

To present the exposure model of maternal education, we restricted the covariates included in our models, but other factors go broader and deeper—for example, paternal factors and co-parenting behaviors (Lamb, 2010). In another analysis of the same outcome, we compared the relations of maternal and paternal reading to the child and noted the increasing importance of paternal reading as the child moves into middle childhood (Law, King, & Rush, 2014). Our model also showed older siblings restricting these beneficial outcomes, and detailed consequences of the observed relations can be explored. If the effect of siblings is that they ameliorate the input quality associated with the education of parents, parenting practices with these children should make a difference, and we should be able to see a similar result for twins as seen by McMahon et al. (1998). Unfortunately, cohort studies do not include enough twins to test this, and a study like the Twins' Early Development Study (TEDS) does not include siblings for us to compare to, but, as twin studies are significant sources of evidence (Harlaar et al., 2007), large cohorts could oversample them as they

do other population groups. The suggestion that genetics could influence SES (Trzaskowski et al., 2014), and particularly changes to it, makes good data on domains of cognitive development coupled with genetic material in large representative samples with good measurement of SES factors a priority for funders.

Overall, Word Reading has substantial associations with factors of environmental origin, but, in the United Kingdom, early-years education focuses on the development of literacy skills so that the educational process lessens the overall relation of external environmental factors on literacy specifically. This may be especially relevant in more disadvantaged groups of children, who may have had less exposure to educational opportunities prior to starting school (Becker, 2011), so not accounting for early education can be attenuating the observed effects. The measure available to this study was word reading, but oral language skills or indeed other cognitive skills that are less a focus of educational provision should demonstrate a more pronounced direct effect of maternal education. Similarly, if the work of Coates and Messer (1996) is replicable, our finding that parity has a negative association with Word Reading might not be replicated for other aspects of oral language (e.g., pragmatics or narrative). Then the trade-off between parity and increasing maternal education might be less pronounced, and the effects of parental education increase might be even more marked than it is for Single-Word Reading. Similarly, one might include issues associated with locus of control (which is possible in the MCS) or family history of learning difficulties (which is not).

## Conclusion

Any large study of child development over time should consider the changing status of the family and the relative age of adults whose children's outcomes are being compared. The data show a consistently positive message about the relation of the mother's further study to the child's early literacy, taking into account other interrelated aspects of family environment, replicating the findings of Magnuson et al. (2009).

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