Infant Behavior and Development 57 (2019) 101326

Contents lists available at ScienceDirect

Infant Behavior and Development

journal homepage: www.elsevier.com/locate/inbede

Decomposing the social gradient in children's vocabulary skills at 3 years of age: A mediation analysis using data from a large representative cohort study

Sinéad McNally[a,*], Cathal McCrory[b], Jean Quigley[c], Aisling Murray[d]

[a] Institute of Education, Dublin City University, Ireland
[b] The Irish Longitudinal Study on Ageing, Department of Medical Gerontology, Trinity College Dublin, Ireland
[c] School of Psychology, Trinity College Dublin, Ireland
[d] Economic and Social Research Institute, Dublin, Ireland

ARTICLE INFO

Keywords:
Child vocabulary
Maternal education
Mediation analysis
Cohort study

ABSTRACT

Disparities in children's expressive language by socio-economic status are evident early in childhood and impact children's development and educational attainment. This study investigated the processes by which maternal education, as a powerful indicator for socio-economic status, affects early expressive language. A nationally representative cohort study of 8,062 children resident in the Republic of Ireland were assessed on the British Ability Scales (BAS) Naming Vocabulary Test at 36 months. A significant difference of almost six points was found between the mean vocabulary test scores of children whose mothers had completed the minimum level of educational attainment compared with children whose mothers had a degree-level qualification. Mediation analysis revealed that 78% of the difference was explained by mediating variables, with differences in household income, parental practice, and material resources accounting for most of the variation. The findings support interventions which redress gaps in maternal education, income, and caregiving.

1. Introduction

Expressive vocabulary in early childhood is an established predictor of children's later language development (Bates, Bretherton, & Snyder, 1988; Marchman & Fernald, 2008) and positively predicts children's literacy and academic skills (Ramey & Ramey, 1999; Snow et al., 1998). Social gradients in lexical development have been reported as early as 18 months (Hoff-Ginsberg, 1998) and gradients in children's vocabulary by socio-economic status (SES) are well established by the time children enter school and persist throughout the school years (Taylor, Christensen, Lawrence, Mitrou, & Zubrick, 2013) with differences in vocabulary knowledge exacerbated as children move through school (Cunningham & Stanovich, 1997 in Wright, 2012, p. 353).

SES is a compound variable that is most frequently indexed in the child development literature by maternal education (Ensminger & Fothergill, 2003 in Hoff, 2006, p.60). Maternal education is a distal factor in its influence on language development and is thought to affect children's expressive vocabulary through proximal processes, such as talking more with children (Bornstein, Haynes, & Painter, 1998) and providing more varied speech input (Hoff-Ginsberg, 1991). However, maternal education is also associated with a

* Corresponding author.
E-mail addresses: sinead.mcnally@dcu.ie (S. McNally), mccrorc@tcd.ie (C. McCrory), quigleyj@tcd.ie (J. Quigley), aisling.murray@esri.ie (A. Murray).

https://doi.org/10.1016/j.infbeh.2019.04.008
Received 24 October 2018; Received in revised form 18 April 2019; Accepted 22 April 2019
Available online 21 May 2019

broad range of health and caregiving practices that are in turn associated with children's cognitive development (Aizer & Currie, 2014). To the best of our knowledge, no study has yet examined whether maternal education affects children's vocabulary through factors in early development such as mothers' health behaviours during pregnancy (e.g. smoking) and after birth (e.g. breastfeeding), while also accounting for established predictors of vocabulary development such as book reading. This paper presents a mediation analysis of cohort data to examine (1) the relationship between maternal education, measured at baseline (9 months) and children's vocabulary at 36 months of age and the potential role in this relationship of early maternal characteristics and behaviours known to be structured by maternal education while (2) accounting for established predictors of vocabulary such as socio-demographic indicators and caregiving practices.

1.1. Maternal education, health behaviours and language development

Low levels of maternal education are associated with a host of health compromising behaviours that are deleterious to child development (Aizer & Currie, 2014) and may plausibly impact upon the child's language development through both direct and indirect pathways. For example, pregnancy planning is structured by maternal education and is a strong predictor of maternal investment in the child (McCrory & McNally, 2013): an intended pregnancy is associated with improved diet and supplementation during pregnancy (Fowles, 2002; McNally & Bourke, 2012), not smoking during pregnancy (Agrawal et al., 2010; Graham & Der, 1999), and not binge drinking during pregnancy (Sayal et al., 2014). Each of these health behaviours has been linked to children's academic achievement in later life: for example, smoking is known to be toxic to foetal development, and has been linked with reduced academic achievement in later life (Clifford, Lang, & Chen, 2012), and alcohol consumption at high concentrations is associated with Fetal Alcohol Syndrome (FAS) and impaired language skills (Church, Eldis, Blakley, & Bawle, 1997).

Lower maternal education is associated with higher risk of premature birth and low birth-weight, both of which have been associated with impaired cognitive development (Linsell, Malouf, Morris, Kurinczuk, & Marlow, 2015; Reidy, 2013). Further, there is evidence that socio-economic status may explain differences in expressive language between pre-term and full-term children at four years of age. Foster-Cohen, Friesen, Champion, and Woodward, (2010) demonstrated that SES variables explained a notable portion of the variance in receptive and expressive language scores between preterm ($\leq$ 33 weeks' gestational age [GA]) and full-term children at age four years (Foster-Cohen et al., 2010). Maternal education is also positively associated with the decision to breastfeed, and there is a large literature suggesting that breastfeeding promotes cognitive development independently of other covariates (e.g., Anderson, Johnstone, & Remley, 1999; McCrory & Layte, 2012; McCrory & Murray, 2013).

1.2. Maternal education, socio-economic status and language development

Maternal education is correlated with higher occupational position, and higher incomes, which may promote children's language development by providing access to resources (Hoff, 2003). Family income is an early source of inequality in relation to children's cognitive outcomes, with income making the strongest impact in infancy through to four years of age (Mollborn, Lawrence, & James-Hawkins, 2014). Income directly determines the quality of childhood nutritional exposures (Fowles, Hendricks, & Walker, 2005), the quality of housing, and access to learning supports and material resources in the home, all of which have been shown to have a beneficial effect on children's educational attainment (Dahl & Lochner, 2012).

Higher educated mothers are typically older giving birth, and older mothers are more likely to engage in the types of linguistic practices associated with enhanced language in early childhood (Hoff, 2003). Three and four-year-olds of older mothers have been found to score significantly higher on the British Ability Scales (II) Naming Vocabulary measure in a large cohort sample, even after controlling for a range of child and family characteristics (Sutcliffe, Barnes, Belsky, Gardiner, & Melhuish, 2012). However, even when mothers were matched on education, one study found that adolescent mothers with an average age of 15 years were more likely to engage in the types of linguistic practices associated with low maternal education (e.g. speaking less, and producing fewer utterances in joint attention) than young adult mothers with an average age of 23 years (Culp, Osofsky, & O'Brien, 1996, in Hoff, 2003 p.66). Finally, higher educated mothers are more likely to be in long-term stable relationships. The presence of a partner in the home predicts better cognitive outcomes for young children (Duursma, Pan, & Raikes, 2008) and may influence language development through educational capital (Amato, 1998), improved access to financial resources (Booth & Crouter, 1998) and quality father-child interactions (Gavin et al., 2002).

1.3. Maternal education, caregiving environment and language development

Maternal education is associated with better quality language input and more didactic behaviours such as talking (Hart & Risley, 1995; Hoff-Ginsberg, 1991) and reading (Augustine, Cavanagh, & Crosnoe, 2009; Dickinson, Griffith, Golinkoff, & Hirsh-Pasek, 2012) to the child. As such, maternal education may be conceptualised as 'an important determinant of the quality of the child's learning environment' (Magnuson, Sexton, Davis-Kean, & Huston, 2009, p. 321). Independently of other socio-demographic variables, maternal education potentially confers an advantage by allowing mothers to draw on various forms of capital including: (1) human capital which can be thought of as 'skills, knowledge and capabilities that contribute to productivity […] and is often equated to educational attainment' (Harding, Morris, & Hughes, 2015, p. 64); (2) cultural capital, defined as preferences and behaviours relevant for educational attainment; and (3) social capital, which is a mother's set of networks and resources that can be used to support educational endeavours and attainment (see Harding et al., 2015, for an in-depth discussion of the processes by which these forms of capital may be harnessed by higher educated mothers to children's advantage when accessing and navigating educational

institutions). Books and book reading may provide particularly powerful mechanisms for increasing vocabulary in early childhood through the provision of rich vocabularies and new content as well as opportunities to frequently repeat and talk about new words (DeTemple & Snow, 2003), and books in the household may reflect a 'scholarly culture' of intrinsically rewarding interactions with books that have a long-term impact on children's educational attainment (Evans, Kelley, Sikora, & Treiman, 2010, p. 172).

Higher maternal education is also associated with increased use of childcare, an outcome of being more likely to work in employment outside the home (McGinnity, Murray, & McNally, 2013). Experience of quality non-parental childcare in early childhood is associated with positive gains in language outcomes (NICHD Early Child Care Research Network, 2000; Vernon-Feagans, Bratsch-Hines, & The Family Life Project Key Investigators, 2013) and there is evidence that children of higher educated mothers experience higher quality childcare (DeMarco, Crouter, Vernon-Feagons, & Family life Project Key Investigators, 2009).

To investigate the potential role of each of these sets of variables, which as the literature suggests are highly structured by maternal education and which have been linked to children's cognitive development, in children's vocabulary development at 36 months, we conducted the following mediation analysis of the pathways linking education (our proxy marker of SES) and vocabulary development at 36 months of age using data from the infant cohort of the Growing Up in Ireland (GUI) study.

2. Method

2.1. Participants

This study used archived data from two waves of the Growing Up in Ireland (GUI) Infant Cohort, a nationally representative longitudinal study of children in Ireland. Data on the health and development of the children, and a wide range of socio-demographic information about their family circumstances, were collected through interviews with the children's primary caregivers at nine months (n = 11,134) and at three years (n = 9793) of age. Nearly all of the primary caregivers were the biological mother of the child. Interviews with primary caregivers were conducted by trained interviewers in the children's homes from 2008 to 2009 and from 2010 to 2011. Most questions were asked during a face-to-face interview but sensitive questions were self-completed by the primary caregiver.

The sample was randomly selected using the Child Benefit Register (CBR) as a sampling frame. Child benefit is a universal welfare entitlement in Ireland and has almost full coverage of all children resident in the Republic of Ireland at the time of the study. A total of 41,185 infants were registered as having been born between 1st December 2007 and 30th June 2008. Children eligible for inclusion in the study were sampled over this seven-month reference period. The sampling fraction for the study is approximately 1/4 of all infant births occurring in Ireland during this time period. The sample was selected on a payee systematic basis, pre-stratifying by marital status, county of residence, nationality and number of children in the claim. The samples for each of the seven months of fieldwork were selected independently from each relevant tranche of the CBR. A simple systematic selection procedure based on a random start and constant sampling fraction was used (Williams, Greene, McNally, Murray, & Quail, 2010). The data were re-weighted prior to analysis using inverse probability weights to compensate for any imbalances in the sample as compared with the overall population using two sources: the 2006 Census of Population and the total number of births (n = 73,662) recorded on the CBR during the 2008 calendar year. Further information concerning sample selection and statistical re-weighting of the sample is available elsewhere (Quail, Williams, McCrory, Murray, & Thornton, 2011). Written informed consent was obtained from the child's primary caregiver at each wave of the study. Materials and procedures for GUI were reviewed and approved by a Research Ethics Committee.

2.2. Materials and procedures

2.2.1. Language outcome variable

The Naming Vocabulary test from the British Abilities Scales II (Early Years) was used as the outcome measure in this study (Elliott, Smith, & McCulloch, 1997). The test represents a measure of expressive English language vocabulary. Children completed this measure in the home when they were three years of age. Trained survey interviewers administered the test having received formal instruction from a Level B qualified psychologist. In this test, the child was shown pictures of everyday objects and asked to name the object. The interviewer presented all items up to a decision point, beyond which children only proceeded if they had fewer than three failures on all items administered up to that point. The test also had an 'alternative stopping point' whereby the interviewer stopped the test if the child got five consecutive items incorrect. Raw scores from the test (i.e. the number of items correctly named) were transformed into an ability score which indicates both the raw score and the difficulty of the items being administered and subsequently into a t-score which are standardised scores based on the child's age and which were calculated using tables provided by the test publishers. The t-scores constitute the unit of analysis in this paper.

The test was administered in English so only answers given in English were acceptable. Children did not complete the vocabulary assessment if the Primary Caregiver felt that the child would be unable to reasonably attempt the test due to insufficient English or a specific learning disability. Interviewers were instructed not to penalise children for difficulty with pronunciation.

The BAS (II) Naming Vocabulary test has been used in similar circumstances by other cohort studies including the Millennium Cohort Study and Growing Up in Scotland, and was extensively piloted before its use in Growing Up in Ireland (GUI) (Murray, McCrory, & Williams, 2014). The test authors (Elliott et al., 1997) report internal reliability of .86 for the Naming Vocabulary scale at ages 3:0 – 3:5 years. They also report a correlation of .68 with the Verbal IQ score on the Wechsler Preschool and Primary Scale of Intelligence – Revised (Wechsler, 1989) based on a sample of children aged between 3:6 and 5:10 years (Elliott et al., 1997).

2.2.2. Primary explanatory variable

Maternal education: Mothers reported their highest level of educational attainment at the wave one sweep of data collection. An original list of 13 levels ranging from 'no formal education' to 'Doctorate' was reduced to four categories as follows: lower second-level or less (a maximum of 11 years of formal education), higher second-level (13 to 14 years of formal education), certificate/diploma (14 to 15 years of formal education), degree or postgraduate (a minimum of 16 years of formal education).

2.2.3. Mediating variables

A variable was considered a potential mediator if it was independently associated with the BAS vocabulary score and was structured by maternal educational status. Mediating variables were categorised as belonging to one of three possible pathways as evidenced by the literature.

(1) *Early maternal investment, health behaviours and perinatal outcomes.* This was a categorical question about whether the pregnancy was planned. Answer options included 'planned at that time', 'earlier or later than intended' (grouped together as 'mistimed'), 'ambivalent', and 'unwanted' (at that time). Number of biological children at the time of study child's birth (wave 1): Parity was recorded as the number of previous live births. Retrospectively recalled information on whether the primary caregiver smoked or drank alcohol at any time during her pregnancy were ascertained at nine months of age and are represented as dichotomous (yes/no) variables in the analysis.

Primary caregivers were asked to recall the number of weeks of pregnancy at which the study child was born. Responses were categorised as before 32 weeks of gestation, between 32 and 35 weeks of gestation, or after 36 or more weeks of gestation. The child's birth weight was reported by the primary caregiver at the 9-month interview. The weight in grammes was standardised with a mean of zero and a standard deviation of one before inclusion in the model. Several questions about duration and exclusivity of breast-feeding were asked in the main questionnaire. One categorical question, 'was the baby ever breastfed?' was selected for this analysis and is represented as a dichotomous yes/no variable. A binary variable was used in the analysis because the number of contrasts would potentially be very large if three categories of breastfeeding duration were included (never, complementary, exclusive) by four educational levels in the analysis.

(2) *Socio-demographic Characteristics*. The family's total household net income (i.e. income from all sources and all household members, net of the statutory deductions of income tax and social insurance contributions). Income was positively skewed so we transformed this variable to the natural log for use in the analysis. The mother's age in years at the time of the 9-month interview was used as a continuous variable. A dichotomous variable indicating whether the child's Primary Caregiver had a spouse or partner resident in the household.

(3) *Caregiving Environment*. At nine months, primary caregivers were asked how often they talked to the infant while busy doing other things such as housework. The original five categories ranged from 'never' to 'always' but 'never' and 'rarely' were combined for this analysis due to low cell numbers. At nine months, primary caregivers also reported on whether the child was in any regular non-parental care (including care by relatives, non-relatives such as childminders, or centre-based care). Use of childcare when the study child was nine months of age is represented as a dichotomous (yes/no) variable in the model. While detailed information with respect to childcare was collected as part of the GUI study (e.g. the age at which the child commenced childcare, the type of childcare provider, the number of days per week that the child spent in childcare, and the cost of childcare) there was no measure of the quality of childcare which is arguably the most important factor. As available variables are not a sufficient proxy for quality of childcare experiences, a binary variable was created to indicate simply whether the child was in childcare or not at nine months.

Primary caregivers reported the number of children's books available to the child in their home at 36 months using a five-point ordinal scale ranging from 'none' to 'more than 30′ books. The last two categories were collapsed to create a four level variable: none/less than 10, 10–20, 21–30, more than 30 books. Finally, primary caregivers were asked how many days per week (0–7) someone at home (not necessarily a parent) read to the child at 36 months.

2.3. Statistical analysis plan

All analyses were undertaken in STATA 14.0. Complete case analysis was used which reduced the effective sample size to 8062 cases. The basic characteristics of the sample are described using survey weighted means and standard deviations, medians and interquartile range, or proportions for each of the variables as appropriate.

The independent association of each of the covariates with performance on the BAS vocabulary test was estimated using ordinary least squares regression. Anova one-way tests for continuous variables, Kruskall-Wallis tests for median data, and an extension of the Wilcoxon rank sum test for binary/categorical variables (Cuzick, 1985) were used to determine whether the potential mediating variables were structured according to maternal educational status (i.e. test for linear trend across ordinal categories of education).

Mediation analysis was undertaken using the Karlson, Holm and Breen (KHB) module which was implemented using Stata Version 14.0. It is a powerful analytical tool that provides a decomposition of the effects of both continuous and discrete variables, and provides analytically derived statistical tests for determining the significance of putative mediating variables.

The outputs from the analyses are interpreted as follows. The reduced model describes the estimated effect of maternal education

Table 1
Baseline Characteristics of the Sample (n = 8062).

		Wgt % or mean (SD)	Unweighted n
BAS	Vocabulary score	*51.1 (12.57)*	*8062*
Sex	Girl	48.8%	3983/8062
Native Language	English	95.5%	7630/8062
PCG Education	Lower secondary or less	16.5%	839
	Leaving cert or equiv.	32.9%	2510
	Diploma/certificate	20.4%	1646
	Degree/Postgrad	30.2%	3067
Pregnancy Planning Status	Planned	59.7%	4885
	Mistimed	22.8%	1859
	Unwanted	10.2%	744
	Ambivalent	7.2%	574
Smoking	Smoked during pregnancy	18.6%	1326/8062
Drinking	Alcohol during pregnancy	21.1%	1779/8062
Gestational age	Born after 36 wks	95.9%	7738
	Born 32-35 wks	3.3%	258
	Born < 32 wks	0.9%	66
Parity	Number of previous live births	2.0 [1.0, 3.0]*	8062
Birth weight	Birth-weight (kgs)	3.48 (0.60)	8062
Breastfed	Mother ever breastfed	54.2%	4775/8062
PCG's age	Primary Caregiver's age (W1)	31.9 (5.40)	8062
Income (€)	Equivalised Median Household income	€ 19,622 [€12931, 28017]*	8062
Partner status	No resident partner	13.3%	817/8062
Talks to infant while doing other things	Never/Rarely	2.8%	215
	Sometimes	7.3%	582
	Often	23.5%	1922
	Always	66.4%	5343
Reads to Child	No. of days reads to child	7.0 [4.0, 7.0]*	8062
Books at home	Less than 10	7.1%	532
	20-30	19.2%	1418
	21-30	18.6%	1489
	30+	55.2%	4623
Childcare	In childcare (W1)	41.1%	3452/8062

* Median [Interquartile Range].

with no mediators in the model (i.e. total effect). The full model describes the estimated effect of maternal education with all mediators in the model (i.e. direct effect). The difference model is the estimated difference between these two models and represents the total indirect effect. A useful feature of the program is that it allows for the addition of variables to be controlled for in both the full and reduced models. In this analysis we include child sex and native language (a binary variable coded as English/non-English speaker) as control variables in all models.

The outputs include a table which describes the proportion of the difference explained by each constellation of mediating variables. The program also provides a decomposition analysis which indicates the proportion of the effect mediated by each of the variables and a statistical test for difference that is analogous to performing seemingly unrelated regression for each variable in the model and running a wald test to examine whether it leads to a significant change in the slope of the model relating maternal education to BAS vocabulary scores.

3. Results

Table 1 describes the baseline characteristics of the sample. The mean BAS vocabulary t-score at 3 years of age was 51.1 (SD = 12.57) and the mean raw score was 17.56 (SD = 5.11). There was a substantial number of mothers within each of the broad educational groups: 17 percent had a lower secondary education or equivalent (i.e. less than high school), 33 percent had a leaving certificate (i.e. equivalent to high school diploma), 20 percent had undertaken some additional training to sub-degree level following completion of secondary education, while almost a third of the sample (30%) had an undergraduate or post-graduate degree.

Table 2 summarises how BAS vocabulary scores vary by maternal education. A clear social gradient was evident in the data: scores on the BAS vocabulary measure were positively correlated with the educational attainment of the mother. The mean score on the BAS test was 47.5 [95% CI = 46.6, 48.5] for children whose mothers' had completed the minimum level of educational attainment compared with a mean score of 53.3 [95% CI = 52.8, 53.8] for children whose mothers' had a degree level qualification or higher. Table 2 also shows how the array of potential mediating variables are structured by maternal education. For example, 46 percent [95% CI = 41.7, 49.4] of those with a lower secondary education planned their pregnancy compared with 69 percent [95% CI = 67.3, 70.9] of those with a degree level qualification or higher. Similarly, 40 percent of those with a lower secondary education smoked during their pregnancy compared with 6 percent of those with a degree level qualification or equivalent.

Table 2
Variation in the Potential Mediating Variables across Levels of the Caregiver's Educational Attainment (n = 8062).

	Primary Caregiver's Highest Level of Educational Attainment (Wave 1)				
	Lower secondary or less (11 years)	Upper secondary (13/14 years)	Diploma / Certificate (15/16 years)	Degree / Postgrad (17 years +)	Test for linear trend
Dependent Variable					
Vocabulary score	47.5 [46.6, 48.5]	50.2 [49.6, 50.7]	52.2 [51.6, 52.8]	53.3 [52.8, 53.8]	(+) $p < 0.001$
Mediating Variables					
Planned pregnancy	45.5% [41.7, 49.4]	56.2% [53.9, 58.5]	63.0% [60.4, 65.6]	69.1% [67.3, 70.9]	(+) $p < 0.001$
Smoked during pregnancy	40.0% [36.3, 43.9]	22.7% [20.8, 24.7]	13.0% [11.2, 15.0]	6.1% [5.2, 7.2]	(-) $p < 0.001$
Alcohol during pregnancy	14.9% [12.4, 17.9]	16.8% [15.2, 18.7]	22.8% [20.7, 25.1]	27.9% [26.2, 29.7]	(+) $p < 0.001$
Born after 36 wks gestation	94.8% [92.3, 96.3]	95.3% [94.2, 96.1]	96.4% [95.3, 97.2]	96.7% [95.8, 97.2]	(+) $p < 0.001$
Number of previous live births*	2.0 [1.0, 3.0]	2.0 [1.0, 3.0]	2.0 [1.0, 2.0]	2.0 [1.0, 2.0]	(-) $p < 0.001$
Birth-weight (kgs)	3.39 [3.34, 3.44]	3.47 [3.44, 3.50]	3.50 [3.47, 3.53]	3.54 [3.51, 3.56]	(+) $p < 0.001$
Breastfed	26.8% [23.5, 30.4]	43.8% [41.5, 46.1]	59.1% [56.5, 61.7]	77.1% [75.3, 78.7]	(+) $p < 0.001$
Mother's age*	30.2 [29.7, 30.7]	30.7 [30.5, 31.0]	32.5 [32.2, 32.7]	33.6 [33.4,33.8]	(+) $p < 0.001$
Income (€)*	12,214 [9648, 16810]	16,426 [11593, 23517]	21,654 [15948, 28448]	27,181 [20100, 36180]	(+) $p < 0.001$
No resident partner	30.8% [27.3, 34.7]	17.4% [15.5, 19.4]	8.1% [6.4, 10.1]	2.9% [2.1, 3.9]	(-) $p < 0.001$
Talks to infant = rarely/never	3.4% [2.2, 5.1]	3.7% [2.9, 4.7]	1.9% [1.3, 2.7]	2.2% [1.7, 2.9]	(-) $p < 0.05$
No. of days reads to child*	5.0 [3.0, 7.0]	7.0 [4.0, 7.0]	7.0 [5.0, 7.0]	7.0 [6.0, 7.0]	(+) $p < 0.001$
More than 30 children's books in the home	30.9% [27.4, 34.6]	47.8% [45.5, 50.1]	61.3% [58.7, 63.8]	72.2% [70.4, 74.0]	(+) $p < 0.001$
Regular childcare as infant	25.0% [21.8, 28.6]	35.6% [33.4, 37.8]	47.1% [44.5, 49.7]	52.2% [50.2, 54.2]	(+) $p < 0.001$

(+) (-) – indicates whether the test for linear trend was positive or negative.
Figures in brackets represent the 95% confidence intervals.
* Median [Interquartile Range].

Table 3 describes the results of the decomposition analysis using the highest educational group as the reference category. In this section, only the difference in vocabulary scores between children at polarised ends of the maternal educational distribution are discussed, but results for all educational groups are presented in Table 3. Children of mothers with a lower secondary education score 6.25 points lower on average (95% CI = -7.29, -5.21; $p < 0.001$) compared with children whose mothers had a degree-level education. The initial difference was reduced by 1.32 points (i.e. 21% of the total effect) when adjusted for pregnancy intention, prenatal smoking, prenatal alcohol consumption, and maternal parity in model one.

Table 4 shows the proportion of the total effect that is explained by each of the mediators. In model one, maternal parity and unwanted pregnancy were significant mediators of the educational association with child vocabulary, reducing the total effect by 10.8 percent and 6.2 percent respectively. The educational differential was reduced by a further 0.45 points (cumulative proportion mediated = 28%) when adjusted additionally for gestational age, birth weight and breastfeeding in model two. Maternal parity (11%) and unwanted pregnancy (6%) continued to be significant mediators of the educational association in model 2 as was breastfeeding, which accounted for 7 percent of the total effect.

When socio-demographic factors were added in model three, the educational differential was reduced by a further 1.62 points (cumulative proportion mediated = 54%). Log Income was by far the biggest contributor, accounting for 24 percent of the total effect. Single parent status, maternal age and parity were also significant mediators of the educational association in model three. Pregnancy intention and breastfeeding by contrast were no longer significant mediators of the educational association. Further adjustment for caregiving environment variables in model four reduced the difference in BAS vocabulary scores between the highest and lowest educational groups to 1.38 points. That is, the set of mediating variables reduced the total effect of maternal education by a cumulative 78 percent across all four models. In this final model, 66 percent of the total effect of maternal education on BAS scores for the lowest compared with the highest educational grouping was accounted for by four variables: maternal parity (9%), income (17%), reading to children (16%) and number of children's books in the home (25%).

The reduction in the magnitude of the educational association at each stage of the analysis for each educational group relative to the reference category is shown in Fig. 1. It shows that there is no longer any significant difference in children's BAS scores when we

Table 3
Discrete Difference in Children's Vocabulary Scores by Maternal Educational Level in the Crude and Multivariable Adjusted Models and the Proportion of the Total Effect Mediated (n = 8062).

	Model 1 (Prenatal)	Model 2 (Postnatal)	Model 3 (Socio-demographic)	Model 4 (Caregiving Environment)
	Coef.	*Coef.*	*Coef.*	*Coef.*
Lower Secondary				
Total effect	−6.25***	−6.25***	−6.25***	−6.25***
Direct Effect	−4.93***	−4.48***	−2.85***	−1.38*
Indirect Effect	−1.32***	−1.77***	−3.39***	−4.87***
% Mediated	21.2%	28.3%	54.4%	77.9%
Upper Secondary				
Total effect	−3.44***	−3.44***	−3.44***	−3.44***
Direct Effect	−2.80***	−2.52***	−1.41***	−0.71
Indirect Effect	−0.65***	−0.92***	−2.02***	−2.73***
% Mediated	18.7%	26.7%	58.9%	79.4%
Diploma/Certificate				
Total effect	−1.57***	−1.57***	−1.57***	−1.57***
Direct Effect	−1.31***	−1.14**	−0.62	−0.33
Indirect Effect	−0.26**	−0.43***	−0.95***	−1.24***
% Mediated	16.5%	27.1%	60.5%	78.9%

*** Significant at the 0.001 level; ** significant at the 0.01 level; * significant at the 0.05 level.
Reference category = degree educated.
Total effect = Effect of Education adjusted for child sex, child's native language (i.e. crude model).
M1: Crude model + (smoked during pregnancy, drank alcohol during pregnancy, pregnancy intention, maternal parity).
M2: M1 + (gestational age, birth weight, breastfed).
M3: M2 +(log income, maternal age, single parent status).
M4: M3 + (in childcare, talks to child, reads to child, number of books in the home).

compared children of parents with upper secondary or non-degree level education with those who had a degree level education in model four. That is, our mediating variables are sufficient to account for the significant differences that existed in vocabulary scores between these educational groups. However, in the fully adjusted models, children from a lower secondary educational background still score significantly lower on the BAS compared with children of the tertiary educated [B = . -1.38, CI=-2.60, -0.16; $p < 0.05$], although the magnitude of the association is much attenuated.

4. Discussion

This study reports a substantial gap in children's vocabulary at 36 months by levels of maternal education: a difference of almost six points was found in vocabulary scores between children of the least and most highly educated mothers which amounts to a difference of approximately 2.5 words in the raw score metric. This early gap in vocabulary means that children whose mothers had low levels of education were significantly lagging behind children of higher educated mothers in their language ability even before the majority of children had entered pre-school.

This is in keeping with findings from the Millennium Cohort Study (MCS) in the United Kingdom which also used the BAS Naming Vocabulary test at 36 months and again at five years to measure expressive language. In a study to examine if preschool education can close socially structured gaps in early child vocabulary, Becker (2011) found a significant gap in vocabulary at age three by parents' education, a gap which remained stable or even increased slightly by age five. While participation in early childhood education had a positive impact on the vocabulary development of children of lower educated parents, it did not narrow the gap and without early childhood education the gap widened further. In a study of 10,366 children in the Children of the National Longitudinal Survey of Youth 1979 (CNLSY) in the United States, socially structured gaps in receptive vocabulary persisted from age 3 years throughout formal schooling (Farkas & Beron, 2004).

However, unlike other cohort studies which examine socio-economic effects on children's language development, this study included important early maternal characteristics which are known to be socially structured and are associated with cognitive development in a robust mediation analysis of the relationship between maternal education and children's vocabulary at 36 months. In total, 78 percent of the difference in vocabulary scores between children of mothers with a degree-level qualification and those with a lower second-level education could be explained by differences in family structure and resources, and the caregiving environment. In the final model, just four variables – family size, household income, reading to the child, and number of children's books in the household - remained significant mediators of the educational association, accounting for 66 percent of the total effect of maternal education on children's vocabulary scores.

Financial circumstances were a strong mediator of the effect of maternal education on children's vocabulary with income accounting for 16.7 percent of this relationship. A range of evidence from large-scale randomised intervention studies and studies of child outcomes associated with periods of national welfare reforms or changes to tax benefits indicates that increasing income for very poor families is causally related to improvements in children's outcomes, and that additional income in early childhood makes

Table 4
The Percentage of the Total Effect of Maternal Education on Children's Vocabulary Scores Explained by each of the Mediators in Models One to Four (n = 8062).

		Model 1			Model 2			Model 3			Model 4		
		Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect
Lower secondary													
Pregnancy Intent	Mistimed	0.01	0.01	−0.1	0.01	0.01	−0.1	0.00	0.01	0.0	0.00	0.01	0.0
(reference = wanted)	Unwanted	−0.38	0.11	6.2	−0.37	0.11	5.9	−0.12	0.11	1.9	−0.09	0.11	1.5
	Ambivalent	−0.05	0.05	0.8	−0.05	0.05	0.7	0.00	0.05	0.1	−0.01	0.05	0.2
	Smoked during pregnancy	−0.19	0.15	3.0	−0.08	0.15	1.3	0.13	0.15	−2.1	0.17	0.15	−2.8
	Alcohol during pregnancy	−0.03	0.05	0.5	−0.02	0.05	0.3	0.02	0.05	−0.3	0.01	0.05	−0.1
	No. of biological children	−0.68	0.10	10.8	−0.68	0.10	10.9	−0.72	0.12	11.5	−0.57	0.11	9.2
Gestational age	Born 32 < 36 weeks				0.00	0.01	0.0	0.00	0.01	0.0	0.00	0.01	0.0
(Reference = born > = 36 weeks)	Born prior to 32 weeks				0.01	0.01	−0.1	0.01	0.01	−0.1	0.01	0.01	−0.1
	Birth weight (kgs) z-score				−0.15	0.05	2.4	−0.15	0.05	2.5	−0.13	0.05	2.1
	Breastfed				−0.43	0.17	6.9	−0.34	0.17	5.4	−0.15	0.16	2.4
	Mother's age (years)							−0.32	0.14	5.2	−0.19	0.13	3.0
	Log income							−1.51	0.25	24.1	−1.04	0.26	16.7
	Single parent							−0.39	0.18	6.3	−0.27	0.18	4.3
Childcare	In childcare (W1)										−0.13	0.09	2.1
(reference = home care)													
Talks to infant	Sometimes										0.00	0.01	0.0
(reference = Rarely/Never)	Often										−0.03	0.06	0.5
	Always										0.05	0.05	−0.9
	No. of days reads to child										−0.98	0.14	15.7
No. of children's books	10-20 books										0.55	0.18	−8.8
(reference = < 10 books)	21 to 30 books										0.06	0.06	−1.0
	30+ books										−2.14	0.30	34.3

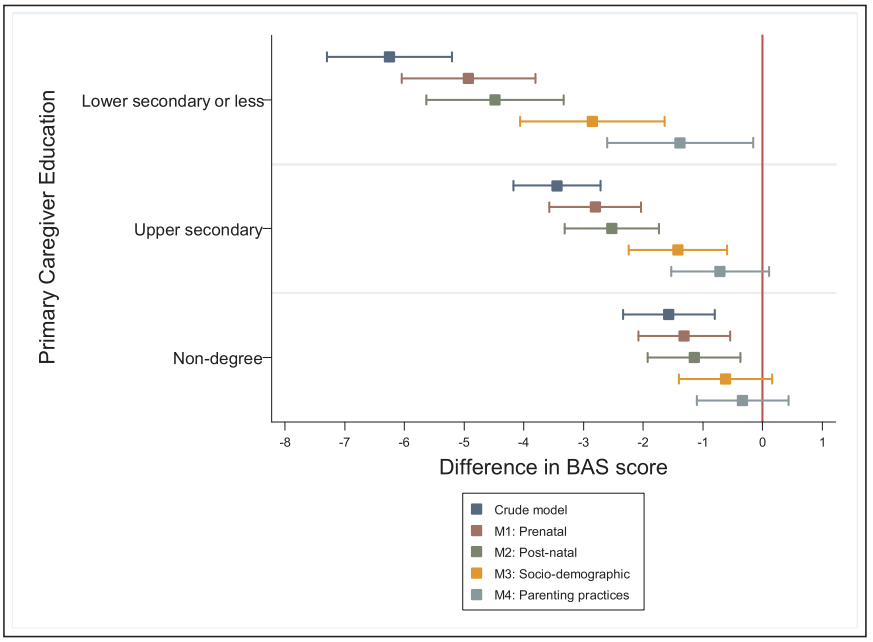
		Model 1			Model 2			Model 3			Model 4		
Upper secondary		Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect
Pregnancy Intent	Mistimed	0.00	0.01	−0.1	0.00	0.01	−0.1	0.00	0.00	0.0	0.00	0.00	0.0
(reference = wanted)	Unwanted	−0.22	0.06	6.4	−0.21	0.06	6.1	−0.07	0.06	2.0	−0.05	0.06	1.5
	Ambivalent	−0.02	0.02	0.7	−0.02	0.02	0.7	0.00	0.02	0.1	−0.01	0.02	0.2
	Smoked during pregnancy	−0.09	0.07	2.7	−0.04	0.07	1.2	0.06	0.07	−1.8	0.08	0.07	−2.5
	Alcohol during pregnancy	−0.02	0.04	0.7	−0.01	0.04	0.4	0.02	0.04	−0.5	0.01	0.04	−0.2
	No. of biological children	−0.29	0.05	8.3	−0.29	0.05	8.4	−0.31	0.06	8.9	−0.24	0.05	7.1
Gestational age	Born 32 < 36 weeks				0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0
(Reference = born > = 36 weeks)	Born prior to 32 weeks				0.01	0.01	−0.2	0.01	0.01	−0.2	0.01	0.01	−0.3
	Birth weight (kgs) z-score				−0.07	0.03	2.0	−0.07	0.03	2.0	−0.06	0.03	1.7
	Breastfed				−0.29	0.11	8.3	−0.22	0.11	6.5	−0.10	0.11	2.9
	Mother's age (years)							−0.27	0.11	7.8	−0.15	0.11	4.5
	Log income							−0.98	0.16	28.4	−0.68	0.17	19.6
	Single parent							−0.20	0.09	5.9	−0.14	0.09	4.1
	In childcare (W1)										−0.08	0.05	2.3
Talks to infant	Sometimes										0.01	0.02	−0.3
(reference = Rarely/Never)	Often										−0.05	0.08	1.4
	Always										0.10	0.09	−2.8
	No. of days reads to child										−0.60	0.09	17.3

(*continued on next page*)

Table 4 (*continued*)

		Model 1			Model 2			Model 3			Model 4		
Upper secondary		Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect
No. of children's books	10-20 books										0.25	0.08	−7.3
(reference = < 10 books)	21 to 30 books										0.21	0.06	−6.1
	30+ books										−1.26	0.18	36.6
		Model 1			Model 2			Model 3			Model 4		
Diploma/Certificate		Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect	Coef.	SE	% of total effect
Pregnancy Intent	Mistimed	0.00	0.01	0.2	0.00	0.01	0.2	0.00	0.00	0.0	0.00	0.00	0.0
(reference = wanted)	Unwanted	−0.07	0.03	4.3	−0.06	0.02	4.1	−0.02	0.02	1.3	−0.02	0.02	1.0
	Ambivalent	−0.02	0.02	1.0	−0.01	0.02	0.9	0.00	0.01	0.1	0.00	0.01	0.2
	Smoked during pregnancy	−0.04	0.03	2.4	−0.02	0.03	1.1	0.03	0.03	−1.6	0.03	0.03	−2.2
	Alcohol during pregnancy	−0.01	0.02	0.7	−0.01	0.02	0.4	0.01	0.02	−0.5	0.00	0.02	−0.2
	No. of biological children	−0.13	0.04	8.0	−0.13	0.04	8.1	−0.13	0.04	8.5	−0.11	0.04	6.8
Gestational age	Born 32 < 36 weeks				0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0
(Reference = born > = 36 weeks)	Born prior to 32 weeks				0.00	0.00	0.1	0.00	0.00	0.1	0.00	0.00	0.1
	Birth weight (kgs) z-score				−0.04	0.02	2.7	−0.04	0.02	2.7	−0.04	0.02	2.3
	Breastfed				−0.15	0.06	9.6	−0.12	0.06	7.5	−0.05	0.06	3.3
	Mother's age (years)							−0.11	0.05	7.0	−0.06	0.04	4.0
	Log income							−0.48	0.09	30.9	−0.33	0.08	21.3
	Single parent							−0.07	0.04	4.6	−0.05	0.03	3.2
	In childcare (W1)										−0.03	0.02	1.7
Talks to infant	Sometimes										0.00	0.01	−0.3
(reference = Rarely/Never)	Often										−0.01	0.03	0.9
	Always										0.04	0.04	−2.7
	No. of days reads to child										−0.31	0.06	19.7
No. of children's books	10-20 books										0.14	0.05	−8.9
(reference = < 10 books)	21 to 30 books										0.13	0.06	−8.1
	30+ books										−0.58	0.11	36.7

Reference category = degree educated.



Legend:

Crude model: adjusted for child sex, child's native language

M1: Crude model + -smoked during pregnancy, drank alcohol during pregnancy, pregnancy intention, maternal parity

M2: M1 + gestational age, birth weight, breastfed

M3: M2 + log income, maternal age, single parent status

M4: M3 + in childcare, talks to child, reads to child, number of books in the home

The red line represents the reference category (i.e. mothers with a degree level education).

Fig. 1. Marginal Effects at the Means in Children's Vocabulary Scores by Maternal Education in the Crude and Multivariable Adjustment Models (reference = Degree educated).
Legend:
Crude model: adjusted for child sex, child's native language
M1: Crude model + -smoked during pregnancy, drank alcohol during pregnancy, pregnancy intention, maternal parity
M2: M1 + gestational age, birth weight, breastfed
M3: M2 + log income, maternal age, single parent status
M4: M3 + in childcare, talks to child, reads to child, number of books in the home
The red line represents the reference category (i.e. mothers with a degree level education).

the biggest impact on children's development when compared to increases in income in later childhood (Duncan & Magnuson, 2012). The negative impact of family size on language outcomes at three years of age, which persisted across all four models, may be related to income also and reflect a dilution of parental financial and non-material resources as the number of children increased (2001, Downey, 1995). The finding that pregnancy planning and breastfeeding were no longer significant mediators when we adjusted for socio-demographic factors suggests that while pregnancy planning and breastfeeding have positive associations with language development, this is primarily because they serve as proxy measures for socio-economic advantage.

Availability of books in the home was an important mediator of the educational differential in children's vocabulary scores at three years explaining 24.5% of the total effect, with 71.9 percent of mothers with a third level education reporting having 30 or more children's books in the home compared with 30.6 percent of mothers with lower secondary education. This finding adds to the growing literature (DeTemple, 2001; Raikes, 2006) on the impact of availability of children's books on vocabulary development and echoes similar findings from the ALSPAC cohort study (Roulstone, Law, Rush, Clegg, & Peters, 2011) which indicated that the number of books at six months positively predicts school entry results, even after controlling for other aspects of the communication environment and socio-demographic characteristics. Pooling data from 27 countries, Evans and her colleagues (2010) found that having many books in the home predicted three years more schooling for children compared to growing up with few books in the home. This finding was independent of a range of socio-demographic variables and cultural background, and gains were greatest for the least

educated families (Evans et al., 2010).

Evans and colleagues have proposed that the availability of books, as representative of parents' 'scholarly culture' (described as 'a way of life' where books are esteemed, read and enjoyed (Evans et al., 2010, p. 171), gives children specific skills and knowledge such as vocabulary as well as a value of learning that together are particularly important for educational success, and that scholarly culture as evidenced through books in the home may therefore be as, or more important than, parental education (Evans et al., 2010) This echoes the human and cultural capital processes which Harding and colleagues have proposed may explain maternal education effects on academic outcomes (Harding et al., 2015). The finding that differences in book reading to children also partially explained the impact of maternal education on vocabulary skills at 36 months, supports longitudinal research which found that daily book reading to children in low income families positively predicted language outcomes at 36 months (Raikes, 2006). Book reading may be particularly protective for low education families because experience of language in these tasks is likely to be more standardised across educational groups particularly by providing a rich vocabulary and content that might be missing from daily conversations and by enabling consolidation of new words through opportunities for rereading (DeTemple & Snow, 2003). Of note in this study is the finding that mothers' self-reported talkativeness at nine months was not associated with children's vocabulary ability at 36 months, providing further evidence that simply talking more to young children is insufficient for vocabulary growth (Pan, Rowe, Singer, & Snow, 2005).

Finally, although the association between maternal education and children's vocabulary at 36 months was completely attenuated by family resources and practices, children of mothers with very low levels of education still scored significantly worse in terms of vocabulary scores than children of mothers with the highest levels of education in the fully adjusted model. There is growing evidence that increasing education for mothers with initially low levels of education can have a dramatic impact on children's language outcomes whereas increasing education for mothers with higher levels of education may not impact children's language in the same way (Magnuson et al., 2009; Moore & Schmidt, 2004). This study supports this finding in that maternal education remains an independent risk for poorer vocabulary development only for mothers with very low levels of education. It is likely that increasing educational opportunities for this particular group of mothers will have positive impacts for children's language development through changes to the quality of the home environment (Magnuson et al., 2009).

There are some limitations to the study. Maternal IQ was not assessed as part of the Growing Up in Ireland (GUI) study and was therefore not included in the analysis. This is perhaps the greatest limitation to the study as it is possible that income and book reading explain so much of the social gradient in vocabulary because they are correlated with a mother's cognitive ability. However, while maternal IQ is an important predictor of child ability, recent research suggests that it may play a less important role than environment in children's early neurocognitive development, particularly with regard to the quality of the family context, shared experiences and language input (Ronfani et al., 2015). A direct measure of the quality of maternal linguistic input is also unavailable and this is a common problem in large-scale cohort studies where direct observations of parent-child interaction are not always feasible. Only one measure of language development was used. Nevertheless, it is comparatively rare to have nationally representative data for a standardised measure of language development at three years such as the BAS Vocabulary Subscale. Experience of non-parental care in infancy was analysed in this study as a binary variable and the model did not differentiate non-parental care by type or length of time in non-parental care due to modelling constraints. Perhaps of greater significance is the absence of a measure of the quality of non-parental care in the GUI survey given that quality of care has been linked to gains in vocabulary in early childhood (Melhuish, Belsky, MacPherson, & Cullis, 2010) and may also be structured by maternal education (DeMarco et al., 2009). The validity of the variable, 'talks to infant while doing other things', is difficult to ascertain but this variable was included as a limited proxy for the quantity of maternal language input in infancy which is a strong predictor of vocabulary development and linked to socio-economic status (Hart & Risley, 1995). Finally, much of the data is from parental self-reports of adult and child behaviours such as book-reading, number of books available and prenatal health choices. While some caution is warranted due to social desirability, each of the variables included in the analysis have been used in other longitudinal studies (McCrory, Williams, Murray, Quail, & Thornton, 2013; Thornton, Williams, McCrory, Murray, & Quail, 2013) and have been piloted by the GUI study team (Murray, McCrory, & Williams, 2013, 2014). Questions which may be particularly vulnerable to social desirability were conducted on a sensitive, self-complete questionnaire in order to minimise bias. The validity of using retrospective reports of variables such as birth-weight and pregnancy intention has also been queried. There is strong support, however, from a number of studies that parental recall of birth-weight is a good proxy for measured birth-weight (O'Sullivan, Pearce, & Parker, 2000; Walton et al., 2000), and negligible differences between prospective and retrospective accounts of pregnancy intention have been reported (Gipson, Koenig, & Hindin, 2008).

Among the major strengths of the study are that the mediators that explained much of the association between maternal education and children's vocabulary at 36 months are amenable to intervention which has significant implications for policy. Additionally, improving maternal education for mothers with initially very low levels of education is likely to improve outcomes for children and their families through improved financial circumstances and caregiving practices at home. However, where increases in maternal education are not practicable, this study also provides support for parenting interventions which raise awareness of book reading and which aim to improve material wellbeing through income supports for very low income families.

Declarations of interest

None.

Acknowledgements

The Growing Up in Ireland data have been funded by the Government of Ireland through the Department of Children and Youth Affairs and have been collected under the Statistics Act, 1993, of the Central Statistics Office. The project has been designed and implemented by the joint ESRI-TCD Growing Up in Ireland study team.

References

Agrawal, A., Scherrer, J., Grant, J. D., Sartor, C., Pergadia, M. L., Duncan, A. E., et al. (2010). The Effects of Maternal Smoking During Pregnancy on Offspring Outcomes. *Preventive Medicine, 50*(1-2), 13. https://doi.org/10.1016/j.ypmed.2009.12.009.

Aizer, A., & Currie, J. (2014). The intergenerational transmission of inequality: Maternal disadvantage and health at birth. *Science (New York, NY), 344*(6186), 856–861. https://doi.org/10.1126/science.1251872.

Amato, P. R. (1998). More than money? Men's contributions to their children's lives. In A. Booth, & A. C. Crouter (Eds.). *Men in families: When do they get involved? What difference does it make?* (pp. 241–278). Mahwah, NJ: Erlbaum.

Anderson, J. W., Johnstone, B. M., & Remley, D. T. (1999). Breast-feeding and cognitive development: A meta-analysis. *The American Journal of Clinical Nutrition, 70*, 525–535.

Augustine, J. M., Cavanagh, S. E., & Crosnoe, R. (2009). Maternal education, early child care and the reproduction of advantage. *Social Forces, 88*(1), 1–29.

Bates, E., Bretherton, I., & Snyder, L. (1988). *From first words to grammar: Individual differences and dissociable mechanisms.* New York: Cambridge University Press.

Becker, B. (2011). Social disparities in children's vocabulary in early childhood. Does pre-school education help to close the gap? *The British Journal of Sociology, 62*, 69–88. https://doi.org/10.1111/j.1468-4446.2010.01345.x.

Booth, A., & Crouter, A. C. (Eds.). (1998). *Men in families: When do they get involved? What differences does it make?*. Mahwah, NJ: Erlbaum.

Bornstein, M. H., Haynes, M. O., & Painter, K. M. (1998). Sources of child vocabulary competence: A multivariate model. *Journal of Child Language, 25*, 367–393.

Church, M. W., Eldis, F., Blakley, B. W., & Bawle, E. V. (1997). Hearing, language, speech, vestibular, and dentofacial disorders in fetal alcohol syndrome. *Alcohol Clinical Exposure Research, 21*(2), 227–237.

Clifford, A., Lang, L., & Chen, R. (2012). Effects of maternal cigarette smoking during pregnancy on cognitive parameters of children and young adults: A literature review. *Neurotoxicology and Teratology, 34*(6), 560–570.

Culp, A. M., Osofsky, J. D., & O'Brien, M. (1996). Language patterns of adolescent and older mothers and their one-year-old children: A comparison study. *First Language, 16*, 61–76.

Cunningham, A. E., & Stanovich, K. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. *Developmental Psychology, 33*(6), 934–945. https://doi.org/10.1037/0012-1649.33.6.934.

Cuzick, J. (1985). A wilcoxon-type test for trend. *Statistics in Medicine, 4*, 543–547. https://doi.org/10.1002/sim.4780040416.

Dahl, G. B., & Lochner, L. (2012). The impact of family income on child achievement: Evidence from the earned income tax credit. *The American Economic Review, 102*(5), 1927–1956.

DeMarco, A., Crouter, A., Vernon-Feagons, L., & Family life Project Key Investigators (2009). The relationship of maternal work characteristics to child care type and quality in rural communities. *Community, Work & Family, 12*(4), 369–387.

DeTemple, J. (2001). Parents and children reading books together. In D. Dickinson, & P. Tabors (Eds.). *Beginning literacy with language* (pp. 31–52). Baltimore, MD: Brookes Publishing.

DeTemple, J., & Snow, C. E. (2003). Learning words from books. In S. Stahl, A. van Kleeck, & E. B. Bauer (Eds.). *On reading books to children: Parents and teachers* (pp. 16–36). Mahwah, NJ: Erlbaum.

Dickinson, D., Griffith, J., Golinkoff, R. M., & Hirsh-Pasek, K. (2012). How reading books fosters language development around the world. *Child Development Research, 2012*. https://doi.org/10.1155/2012/602807.

Downey, D. B. (1995). When bigger is not better: Family size, parental resources, and children's educational performance. *American Sociological Review,* 746–761.

Downey, D. B. (2001). Number of siblings and intellectual development: The resource dilution explanation. *The American Psychologist, 56*(6-7), 497.

Duncan, G. J., & Magnuson, K. (2012). Socioeconomic status and cognitive functioning: Moving from correlation to causation. *Wiley Interdisciplinary Reviews Cognitive Science, 3*(3), 377–386.

Duursma, E., Pan, B. A., & Raikes, H. (2008). Predictors and outcomes of low-income fathers reading with their toddlers. *Early Childhood Research Quarterly, 23*, 351–365.

Elliott, C. D., Smith, P., & McCulloch, K. (1997). *British ability scales(BAS II): Technical manual* (second edition). London: NFER-Nelson.

Ensminger, M. E., & Fothergill, K. (2003). A decade of measuring SES: What it tells us and where to go from here. In M. H. Bornstein, & R. H. Bradley (Eds.). *Socioeconomic status, parenting, and child development*. Mahwah, NJ: Lawrence Erlbaum.

Evans, M., Kelley, J., Sikora, J., & Treiman, D. (2010). Family scholarly culture and educational success: Books and schooling in 27 nations. *Research in Social Stratification and Mobility, 28*(2), 171–197.

Farkas, G., & Beron, K. (2004). The detailed age trajectory of oral vocabulary knowledge: Differences by class and race. *Social Science Research, 33*, 464–497.

Foster-Cohen, S. H., Friesen, M. D., Champion, P. R., & Woodward, L. J. (2010). High prevalence/low severity language delay in preschool children born very preterm. *Journal of Developmental & Behavioral Pediatrics, 31*(8), 658–667.

Fowles, E. R. (2002). Comparison of pregnant women's nutritional knowledge to actual dietary intake. *The American Journal of Maternal Child Nursing, 27*, 171–177.

Fowles, E. R., Hendricks, J. A., & Walker, L. O. (2005). Identifying healthy eating strategies in low income pregnant women: Applying a positive deviance model. *Health Care for Women International, 26*, 807–820.

Gavin, L. E., Black, M. M., Minor, S., Abel, Y., Papas, M. A., & Bentley, M. E. (2002). Young disadvantaged fathers' involvement with their infants: An ecological perspective. *Journal of Adolescent Health, 31*, 266–276.

Gipson, J. D., Koenig, M. A., & Hindin, M. J. (2008). The effects of unintended pregnancy on infant, child, and parental health: A review of the literature. *Studies in Family Planning, 39*, 18–38.

Graham, H., & Der, G. (1999). Patterns and Predictors of Smoking Cessation Among British Women. *Health Promotion International, 14*, 231–239.

Harding, J. F., Morris, P. A., & Hughes, D. (2015). The Relationship Between Maternal Education and Children's Academic Outcomes: A Theoretical Framework. *Journal of Marriage and the Family, 77*, 60–76. https://doi.org/10.1111/jomf.12156.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experience of young american children.* Baltimore, MD: Paul H. Brookes.

Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development, 74*(5), 1368–1378.

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review, 26*(1), 55–88.

Hoff-Ginsberg, E. (1998). The relation of birth order and socioeconomic status to children's language experience and language development. *Applied Psycholinguistics, 19*(4), 603–629. https://doi.org/10.1017/S0142716400010389.

Hoff-Ginsberg, E. (1991). Mother-child conversation in different social classes and communicative settings. *Child Development, 62*(4), 782–796.

Linsell, L., Malouf, R., Morris, J., Kurinczuk, J. J., & Marlow, N. (2015). Prognostic factors for poor cognitive development in children born very preterm or with very low birth weight: A systematic review. *JAMA Pediatrics, 169*(12), 1162–1172.

Magnuson, K. A., Sexton, H. R., Davis-Kean, P. E., & Huston, A. C. (2009). Increases in maternal education and young children's language skills. *Merrill-Palmer Quarterly, 55*(3), 319–350.

Marchman, V. A., & Fernald, A. (2008). Speed of word recognition and vocabulary knowledge in infancy predict cognitive and language outcomes in later childhood.

Developmental Science, 11, F9–F16. https://doi.org/10.1111/j.1467-7687.2008.00671.x.
McCrory, C., & Layte, R. (2012). Breastfeeding and risk of overweight and obesity at nine years of age. *Social Science & Medicine, 75*(2), 323–330.
McCrory, C., & McNally, S. (2013). The effect of pregnancy intention on maternal prenatal behaviors and parent and child health: Results of an Irish cohort study. *Paediatric and Perinatal Epidemiology, 27*(2), 208–215.
McCrory, C., & Murray, A. (2013). The effect of breastfeeding on neuro-development. *Infancy, Maternal and Child Health Journal, 17*(9), 1680–1688.
McCrory, C., Williams, J., Murray, A., Quail, A., & Thornton, M. (2013). *Growing up in Ireland: Design, instrumentation and procedures for the infant cohort at wave two (3 years).* Dublin: Office of the Minister for Children and Youth Affairs.
McGinnity, F., Murray, A., & McNally, S. (2013). *Growing up in Ireland: National Longitudinal Study of Children: Mothers' return to work and childcare choices for infants in Ireland.* Dublin: Department of Children and Youth Affairs ISBN 9781406427752.
McNally, S., & Bourke, A. (2012). Periconceptional folic acid supplementation in a nationally representative sample of Irish mothers. *Irish Medical Journal, 7*(105), 236–238.
Melhuish, E. C., Belsky, J., MacPherson, K., & Cullis, A. (2010). *The quality of group childcare settings used by 3-4 year old children in Sure Start local programme areas and the relationship with child outcomes.* London: Department for Education.
Mollborn, S., Lawrence, E., & James-Hawkins, L. (2014). When do socioeconomic resources matter most in early childhood? *Advances in Life Course Research, 20*, 56–69.
Moore, Q., & Schmidt, L. (2004). *). Do maternal investments in human capital affect childrens' academic achievement? Department of economics working papers 13.* Department of Economics, Williams College.
Murray, A., McCrory, C., & Williams, J. (2013). *Report on pre-piloting, piloting and dress rehearsal phases of the infant cohort at wave one (9 months)*Dublin: Office of the Minister for Children and Youth Affairs.
Murray, A., McCrory, C., & Williams, J. (2014). *Report on pre-pilot, pilot and dress rehearsal exercises for phase 2 of the infant cohort at age three years*Dublin: Office of the Minister for Children and Youth Affairs.
NICHD Early Child Care Research Network (2000). The relation of child care to cognitive and language development. *Child Development, 71*, 960–980.
O'Sullivan, J. J., Pearce, M. S., & Parker, L. (2000). Parental recall of birth weight: how accurate is it? *Archives of Disease in Childhood, 82*, 202–203.
Pan, B. A., Rowe, L. M., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development, 76*, 763–782.
Quail, A., Williams, J., McCrory, C., Murray, A., & Thornton, M. (2011). *Sample design and response in wave 1 of the infant cohort (at 9 months) of growing up in Ireland.* Dublin: Department of Children and Youth Affairs.
Raikes, H. T. (2006). Mother–child bookreading in low-income families: correlates and outcomes during the first three years of life. *Child Development, 77*(4), 924–953.
Ramey, S. L., & Ramey, C. T. (1999). *Going to school: How to help your child succeed.* New York: Goddard Press.
Reidy, N. (2013). Impaired language abilities and white matter abnormalities in children born very preterm and/or very low birth weight. *The Journal of Pediatrics, 162*(4), 719–724.
Ronfani, L., Vecchi Brumatti, L., Mariuz, M., Tognin, V., Bin, M., Ferluga, V., et al. (2015). The complex interaction between home environment, socioeconomic status, maternal IQ and early child neurocognitive development: A multivariate analysis of data collected in a newborn cohort study. *PloS One, 10*(5), https://doi.org/10.1371/journal.pone.0127052 e0127052.
Roulstone, S., Law, J., Rush, R., Clegg, J., & Peters, T. (2011). *Investigating the role of language in children's early educational outcomes: An analysis of data from the Avon Longitudinal Study of Parents and Children (ALSPAC).* Nottingham: Department for Education.
Sayal, K., Heron, J., Draper, E., Alati, R., Lewis, S. J., Fraser, R., et al. (2014). Prenatal exposure to binge pattern of alcohol consumption: Mental health and learning outcomes at age 11. *European Child & Adolescent Psychiatry, 23*(10), 891–899.
Snow, C. E., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing Reading difficulties in Young children.*. Washington, DC: National Academy Press.
Sutcliffe, A. G., Barnes, J., Belsky, J., Gardiner, J., & Melhuish, E. (2012). The health and development of children born to older mothers in the United Kingdom: Observational study using longitudinal cohort data. *British Medical Journal, 345*, e5116.
Taylor, C. L., Christensen, D., Lawrence, D., Mitrou, F., & Zubrick, S. R. (2013). Risk factors for children's receptive vocabulary development from four to eight years in the Longitudinal Study of Australian Children. *PloS One, 8*.
Thornton, M., Williams, J., McCrory, C., Murray, A., & Quail, A. (2013). *Design, instrumentation and procedures for the infant cohort at wave one (9 months).* Dublin: Office of the Minister for Children and Youth Affairs.
Vernon-Feagans, L., Bratsch-Hines, M. E., & The Family Life Project Key Investigators (2013). Caregiver–Child verbal interactions in child care: A buffer against poor language outcomes when maternal language input is less. *Early Childhood Research Quarterly, 28*(4), 858–873.
Walton, K., Murray, L., Gallagher, A., Cran, G., Savage, M., & Borham, C. (2000). Parental Recall of Birth Weight: A Good Proxy for Recorded Birth Weight? *European Journal of Epidemiology, 16*, 793–796.
Wechsler, D. (1989). *Wechsler preschool and primary scale of intelligence—Revised manual.* San Francisco: Psychological Corporation.
Williams, J., Greene, S., McNally, S., Murray, A., & Quail, A. (2010). *Growing up in Ireland: The infants and their families.* Dublin: Office of the Minister for Children and Youth Affairs.
Wright, T. S. (2012). What classroom observations reveal about oral vocabulary instruction in kindergarten. *Reading Research Quarterly, 47*, 353–355. https://doi.org/10.1002/RRQ.026.