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The relationship between child behaviour problems at school entrance and teenage vocabulary acquisition: A comparison of two generations of British children born 30 years apart

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Behaviour problems in early childhood have a lasting impact on cognitive development and education attainment in later adolescence and into adulthood. Here we address the relationship conduct and hyperactivity problems at school entrance, and vocabulary acquisition in adolescence. We compare performance in identical assessments across two generations of British children born 30 years apart in 1970 (n = 15,676) and 2000/2 (n = 16,628) and find that both conduct and hyperactivity problems have a negative association with later vocabulary in both generations. We take advantage of rich longitudinal birth cohort data and establish that these relationships hold once family socioeconomic status and a child's personal characteristics and earlier vocabulary acquisition are taken into account. We also find that teenagers today achieved substantively lower scores in the vocabulary assessment compared to their counterparts born 30 years earlier, and that this holds across all categories within each of the family and individual characteristics considered in this article. As vocabulary and language skills are key prerequisites for wider learning, we discuss implications the findings have for education policies.

Keywords: behaviour problems; childhood; socioeconomic inequality; vocabulary

Introduction

Both behavioural disturbance and poor language skills are linked to adverse educational and life outcomes. This article examines the role of behaviour problems at school entrance on teenagers' vocabulary. We examine this relationship for two cohorts born 30 years apart, in 1970 and 2000, and also compare the total level of vocabulary attainment in these two generations.

Whilst all infants and young children display some degree of behavioural disturbance over the course of their development (Earle, 2013), poor childhood behavioural adjustment has been shown to be associated with reduced language skills at

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school entrance (Cohen, 2001; Whiteside *et al.*, 2017), and cognitive and academic progress through the school years (Barbaresi *et al.*, 2007; Washbrook *et al.*, 2013; Whiteside *et al.*, 2017). In addition, language difficulties in childhood have been linked to a range of adverse outcomes later on in life, including relatively poor educational attainment and labour market outcomes (Law *et al.*, 2009; Schoon *et al.*, 2010a, b; Parsons *et al.*, 2011).

From later childhood through adolescence, individuals learn a substantial number of words, with evidence from Landauer and Dumais (1997) suggesting that the meaning recognition of between 3,000 and 5,400 words per year is acquired during the late primary and secondary school years. Vocabulary is acquired via indirect or incidental exposure to language materials, including school activities, books, the internet, cinema, TV and radio, and interaction with parents and peers (Messer *et al.*, 2004; Gobet, 2015). Vocabulary also becomes more sophisticated (Berman, 2007) as young people start to use longer, more complex and less common words and become more sensitive to linguistic registers that allow them to alternate between casual conversation and more formal language. This development continues well into adulthood, as demonstrated by Sullivan and Brown (2015), who show that average scores in identical vocabulary assessments were higher at age 42 than at age 16. Language development increases at an expeditious pace in the first 4 years of life and then gradually stabilises with age. Bornstein *et al.* (2014, 2016) have shown this stability to be extremely high during the adolescent years, with similar stability found for latent word-reading accuracy measures (Hulslander *et al.*, 2010) and observed reading fluency measures (Landerl & Wimmer, 2008) from late childhood (9–10 years) to adolescence (14–16 years).

In this article we first review the literature on the socioeconomic and individual characteristics that are inter-related with both behaviour and vocabulary, before outlining our research questions, the two longitudinal data sources and key comparable measures. We then present our findings, and conclude with a discussion including implications for policy, and the strengths and limitations of our study.

Socioeconomic characteristics, behaviour problems and vocabulary acquisition

Socioeconomic, behavioural and language characteristics are inter-related, so it is important to consider them in combination. Socioeconomic inequality is evident in a child's life from the time of their birth, for example in birthweight (Karlson *et al.*, 2010; Weightman *et al.*, 2012) and breastfeeding practices (Kelly & Watt, 2005), and persists in behavioural problems during the early years (Dex & Joshi, 2004; Hansen & Joshi, 2007; 2008; Reiss, 2013; Deighton *et al.*, 2019) and in cognitive development throughout childhood (Feinstein, 2003; Parsons *et al.*, 2011; Sullivan *et al.*, 2013). The social gradient in cognitive and academic achievements over the lifecourse is well established (Halsey *et al.*, 1980; Sullivan *et al.*, 2014), and socioeconomic differentials in both verbal and general cognitive attainment emerge early in life, and widen during the pre-school and school years (Feinstein, 2004; Becker, 2011; Byford *et al.*, 2011; Sullivan *et al.*, 2013; Sullivan & Brown, 2015). In both the United States and the United Kingdom, a social gradient in vocabulary size and processing speed has been found as early as 18 months (Fernald *et al.*, 2013; McGillion *et al.*, 2017), and there

is evidence that it persists throughout the lifespan (Sullivan & Brown, 2015; Sullivan *et al.*, 2017).

Income, education and occupation class are among the key indicators of socioeconomic status (SES), with lower levels of education (Sullivan *et al.*, 2010; McLaughlin *et al.*, 2011), social class (Sabates & Dex, 2012; Sullivan *et al.*, 2014) and income (Ayre, 2016; Green *et al.*, 2017) each being associated with poorer cognitive skills, academic attainment and behaviour problems in children and adolescents. Looking specifically at the intergenerational transmission of vocabulary in the UK Millennium Cohort Study (MCS), Sullivan *et al.* (2017) found that teenagers whose parents had studied to degree level or higher achieved vocabulary scores 1.5 times greater than peers whose parents had no formal educational qualifications. In a small observational study of 42 families in one town in the United States, Hart and Risley (2003) found that 'upper class' children had been exposed to 30 million more words than 'welfare children' had by age 3.

Socioeconomic status measures are associated with a range of other family structure and environment measures (e.g. housing conditions, family status [lone parenthood] and family size) that influence child behaviour and cognitive outcomes. For example, single-parent families experience more economic deprivation (Kiernan & Huerta, 2008), are more likely to exhibit depressive symptoms (Osborn *et al.*, 1984; Kiernan & Huerta, 2008) and their children have three times as many behaviour problems as children in stable married families by age 5 (Hansen & Joshi, 2010). Children from larger families are twice as likely to develop conduct disorder problems than children from smaller families (Meltzer *et al.*, 2000), and parity is a well-established predictor of educational chances, with an advantage for children higher up the birth order (Nisbet, 1953). Home ownership is an important indicator of wealth (Furley, 1989; Tunstall *et al.*, 2013), and poor housing and overcrowding in the home are related to behaviour problems (Office of the Deputy Prime Minister, 2004; Evans, 2006; Coley *et al.*, 2015; Mind, 2017) and lower academic attainment (Goux & Maurin, 2003), together with increased arguments and fighting among children (Reynolds & Robinson, 2005).

Individual characteristics, behaviour problems and vocabulary acquisition

Sex, age, ethnicity, birth order, birthweight and breastfeeding have all been shown to relate to early behaviour problems, which in turn influence cognitive development and later academic performance. For example, in the 1970 cohort when age 5, being non-White, part of a larger family and having low birthweight were all associated with increased temper tantrums (Golding & Rush, 1986) and more antisocial behaviour (Osborn *et al.*, 1984). At school entry, very low birthweight (<1,500 g) children were more likely to have behaviour problems after adjusting for family background characteristics (Reijneveld *et al.*, 2006) and low birthweight children also go on to experience more cognitive deficits on average (Currie & Hyson, 1999), including poorer vocabulary (Taylor *et al.*, 2013), and to pass fewer public examinations at age 16 (Case *et al.*, 2006). Conversely, breastfeeding a child for at least 3–4 months was found to be associated with fewer behaviour problems in early childhood in the majority of papers in a review of evidence (Poton *et al.*, 2018), although

other evidence does not find this to be the case (Fitzsimons & Vera-Hernandez, 2013). However, breastfeeding is associated with improved cognitive development (Quigley *et al.*, 2012). In terms of age, younger children display more behaviour problems than older children (Fauth *et al.*, 2017), and children born later in the academic year do less well in school-based assessments (Parsons & Hallam, 2014). Research has shown that boys score significantly higher (reflecting worse behaviour) in the overall SDQ scale (Straatmann *et al.*, 2018), in four of the five individual scales (the exception is the emotional scale) at younger ages (Davis *et al.*, 2010), and they continue to show more externalising behaviour problems as they age (Cullis & Hansen, 2008). Boys (Reilly *et al.*, 2010) and BAME children (Farkas & Beron, 2004) have also been found to have a poorer grasp of vocabulary in the early years, and children with poorer English language skills at school entrance—whether English was the first or additional language—had more concurrent behaviour problems and were less likely to meet curriculum targets 2 years later on (Whiteside *et al.*, 2017). However, girls with poor early language skills at age 5 are more likely than boys with poor early language skills to go on to become competent readers at age 10 (Parsons *et al.*, 2011) and to achieve higher levels of educational attainment at 16+, with more girls than boys at school in England consistently achieving the threshold five-plus A–C grade examination passes since 1988 (Department for Education), even when behaviour problems have been taken into account (Washbrook *et al.*, 2013).

Aims and research questions

In this article we use uniquely rich longitudinal data collected across two generations of British children born 30 years apart in 1970 and 2000/2, to address the question of how child behaviour problems at school entrance are associated with vocabulary acquisition in adolescence. Although past studies show that behaviour problems in early childhood are associated with cognitive and educational progress, a great strength of using these two British birth cohorts is that we can operationalise identical measures of vocabulary performance and (near identical) measures of behaviour problems, together with a wide range of comparable information on family background and individual characteristics known to be related to child behaviour and cognitive development. By comparing across generations, we can ascertain how far vocabulary acquisition in the teenage years is a function of age or birth cohort and how far it is consistently associated with a child's behaviour in early life across generations. Although it may seem inequitable to compare average vocabulary scores of 14- with 16-year-olds, with the older BCS70 teenagers being expected to have higher average scores given their greater exposure to both language and learning, we know that language development skills are very stable in adolescence (Bornstein *et al.*, 2014, 2016). More specifically, in assessments that capture different aspects of vocabulary understanding that are part of the established British Ability Scales (BAS) II (Elliott, 1996) or III (Elliott & Smith, 2011), namely Word Definitions and Verbal Similarities, the difference in mean ability scores for average (50th percentile) performing teenagers aged 16 or 14 was no more than 10, with scores having the potential to range from 10 to 250 plus (see pp. 76 and 80 in the BAS3 scoring folder;

Elliott, 2013).[1] Therefore, whilst acknowledging this age difference across the generations, we answer the following research questions:

- To what extent is a child's behaviour at school entrance associated with their score on a vocabulary assessment in adolescence?
- Does this relationship stand once a child's personal characteristics and family-level indicators of socioeconomic status are accounted for?
- Does this relationship stand once a child's earlier vocabulary acquisition is also accounted for?
- How does this relationship vary across generations?

Data

We use data from two longitudinal British birth cohort studies, which have followed up children born in 1970 and 2000/2. We look at teenage vocabulary scores across a range of family background and individual characteristics from data broadly 'matched' across the studies. Whilst most measures are very similar, we collapsed some answer categories to maximise comparability. Any remaining differences are highlighted. The data is merged into a single data file.

1970 cohort: The 1970 British Cohort Study (BCS70)

The 1970 British Cohort Study (BCS70) follows the lives of more than 17,000 people born in England, Scotland and Wales in one week of 1970 (Elliott & Shepherd, 2006). Since the birth survey in 1970, there have been nine waves at ages 5, 10, 16, 26, 30, 34, 38, 42 and 46–48, when 8,581 study members participated. Over the cohort members' lives, the BCS70 has collected information on health, physical, educational and social development, and economic circumstances among other factors. We use information from the first four waves, from parents and cohort members (University of London, 2013, 2016a, b, 2020a).

2000/2 cohort: The Millennium Cohort Study (MCS)

The Millennium Cohort Study (MCS) is a longitudinal study of approximately 19,000 babies born to families living in the UK between September 2000 and January 2002 (Plewis, 2007; Connelly & Platt, 2014; Joshi & Fitzsimons, 2016). Data has been collected when the children were aged around 9 months, 3, 5, 7, 11, 14 and 17 when approximately 10,700 study members participated. We draw on information from parents and children from sweeps that took place at 9 months, 5, 11 and 14 years (University of London, 2017a,b,c, 2020b).

Our samples include those living in Great Britain in the first survey (those living in Northern Ireland in MCS were excluded for comparability). In BCS70 we also exclude those who had died by age 16 (3.6%), with the overwhelming majority of these having died during the first few days or months of life (as enrolment in MCS was conditional on being alive at 9 months, this exclusion did not apply). The sample size for BCS70 is n = 15,678, for MCS n = 16,628. We used multiple imputation (MI) to

deal with attrition and item non-response to restore sample representativeness, adopting a chained equations approach (White *et al.*, 2011) under the assumption of 'missing at random' (MAR), which assumes that the most important predictors of missing data are included in our models. In order to maximise the plausibility of the MAR assumption, we also included a set of auxiliary variables in our imputation model (see Mostafa *et al.*, 2020; Silverwood *et al.*, 2020). All reported analyses are averaged across 20 replicates based upon Rubin's rule for the efficiency of estimation under a reported degree of missingness across the whole data of around 0.20 (Little & Rubin, 2002). Analyses were carried out in Stata 15 (StataCorp, 2017).

The MCS analyses are additionally weighted to adjust for the survey's stratified clustered sampling design (Plewis, 2007).

Measures

Vocabulary

In 1986 BCS70 cohort members, then aged 16, had their vocabulary assessed via the 75-item Applied Psychology Unit (APU) Vocabulary Test, a standardised test produced by the University of Edinburgh (Closs & Hutchings, 1976), where each item was a word followed by a multiple-choice list from which the respondent had to choose, from a set of five synonyms, the one with the same meaning as the first word. Test items became progressively more difficult, and 15 minutes were permitted to answer the questions. Scores ranged between 0 and 74, with a mean of 42.5 (SD = 12.7) and a median of 43. See Parsons (2014) and Moulton *et al.* (2020) for further details.

In 2015/6, aged 14, MCS cohort members had their vocabulary assessed from a subset of 20 questions that had been chosen from the BCS70 vocabulary assessment, and delivered in the same format, albeit on a computer tablet rather than on paper as for BCS70. Four minutes were allowed to answer the 20 questions. Answers were coded incorrect (0) or correct (1) and were summed together. Mean scores from responses to these 20 items were significantly higher in BCS70 (10.19, SD = 4.20) than in MCS (7.09, SD = 2.62).

We initially planned to compare vocabulary performance across the same 20 questions in both cohorts, but after running exploratory factor analysis (EFA) on the items in MPlus (Version 8; Muthén & Muthén, 2017), we derived harmonised scales for both cohorts based on 12 questions, giving a score range from 0 to 12. We checked for measurement invariance to see if teenagers in the two cohorts had understood the task, or the meaning of an individual word, in a conceptually similar manner. The items achieved both metric and scalar invariance, which allows for direct comparison of both the mean vocabulary scores (descriptive analysis) and the regression coefficients (multivariate analysis) across the two cohorts, showing how the association between behaviour problems and vocabulary acquisition may have changed over time. (See Appendix 1 for further details of the individual items and measurement invariance results.) Like the 20-item scale, mean scores in the 12-item scale were significantly higher in the BCS70 cohort (6.99, SD = 2.85) than in MCS (5.44, SD = 2.23).

Behaviour problems

We measure behaviour problems at age 5 in BCS70 using the Rutter behaviour scales (Rutter *et al.*, 1970) and in MCS, the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997, 2001). The SDQ was developed from the long-established Rutter questionnaires (Rutter *et al.*, 1970; Elander & Rutter, 1996). The Rutter *parental questionnaire*, or *Child Scale A*, has 31 descriptions of behaviour in three sections and the SDQ has 25 questions that are divided into five scales of five questions each. Fourteen very similar questions were included in both, which covered four of the five SDQ scales: conduct (5 MCS, 6 BCS), hyperactivity (3), emotional (3) and peer problems (2). We concentrate here on conduct and hyperactivity problems (the selected questions are detailed in Appendix 2) as initial exploration showed there was no association between emotional problems and vocabulary scores, and a reliable scale could not be produced from two peer questions. In the SDQ there are three answer categories for each question: not true (0), somewhat true (1) and certainly true (2); in the Rutter questionnaire behavioural adjustment is similarly measured on a three-category scale: Does not apply (0), Applies somewhat (1) and Certainly applies (2). After running EFA on the items, we derived harmonised scales for both cohorts based on three comparable questions in each scale. Scores were summed across questions in each subscale, with a high score indicating higher problems. Scores ranged from 0 to 6, and mean scores in both scales were higher in the older cohort. We again checked for measurement invariance and found metric but not scalar invariance for the two scales (see Parsons *et al.*, 2021 for further details). This supports the findings in Attanasio *et al.* (2018), which also compares BCS70 and MCS socioemotional scores.

Additional controls

In our analyses we include a wide range of individual and family background characteristics that our review of the literature has shown to be associated with both cognitive development and behaviour problems. The individual characteristics are gender, ethnicity, birthweight, whether first-born child, duration of breastfeeding, age in months (MCS only, due to lack of variation in BCS70), measures of earlier vocabulary and language skills at age 5 and 10/11. At age 5, for BCS70, this was the English Picture Vocabulary Test (EPVT), a measure of receptive vocabulary (Brimer & Dunn, 1962) and is a UK version of the Peabody Picture Vocabulary Test (Dunn *et al.*, 1965). For the MCS, expressive vocabulary was measured using the naming vocabulary subtest of the BAS II (Elliott, 1996). Note that receptive and expressive vocabulary measures tend to be moderately to highly correlated (e.g. Conway *et al.*, 2017). At age 10 children in BCS70 completed the Shortened Edinburgh Reading Test, a test of word recognition (Godfrey Thompson Unit, 1978), and at age 11 MCS children completed the BAS II Verbal Similarities, which measures 'crystallised intelligence' (Elliott, 1996). For further details of the BCS70 assessments see Parsons (2014), and for MCS assessments see Connelly (2013).

Measures of family socioeconomic circumstances are taken from the first survey in each study, or if not available, from when the measure was first asked. This included

parental occupation and educational qualifications, family income, housing, overcrowded living conditions and maternal mental well-being. This was measured by the Malaise Inventory in BCS70 (Rodgers *et al.*, 1999; Rutter *et al.*, 1970) and by the Kessler scale in MCS (Kessler *et al.*, 2003). We did not include a measure of paternal mental health as this was not available for BCS70.

Table 1 shows the distribution of cohort members across all measures included in the analysis. Reflecting the increased value attached to qualifications and the shift towards white-collar occupations that has occurred in developed countries from the 1980s (for UK figures, see Holmes & Mayhew, 2012), 44% of MCS parent(s) held a degree-level qualification and 46% were in managerial or professional occupations. This compared to 14% and 18% of BCS parent(s), respectively. Other society-level changes are reflected in fewer MCS children living in an overcrowded home (24% to 40%) and more living in single-parent households (14% to 6%). The other notable difference between the cohorts was the high proportion of BCS children who had never been breastfed—63% compared to 28% of MCS, and the higher proportion of non-white cohort members in MCS—13% to 4%.

Results

Descriptive statistics

For each cohort, we show the mean (raw) vocabulary scores at age 14 or 16 for each of the individual (Table 2) and family characteristics (Table 3).

In both cohorts, children with higher conduct and hyperactivity problems at age 5 had significantly lower vocabulary scores in their teenage years compared to their peers with few or no behaviour problems at age 5. Similarly, children with mothers with high psychological distress also had significantly lower teenage vocabulary scores compared to children with mothers who had fewer symptoms of psychological distress.

Low birthweight children had significantly lower vocabulary scores in both cohorts, whereas being breastfed for longer was associated with higher vocabulary scores. Being first-born was associated with higher vocabulary scores and BAME with lower scores. There was no difference by gender in either cohort.

Socioeconomic advantage, as captured by higher parental occupation class, educational qualifications and family income, home ownership and not living in an overcrowded home, was associated with higher mean vocabulary scores in adolescence. Single parenthood was associated with lower vocabulary scores in MCS.

In terms of cohort differences, mean vocabulary scores for BCS were higher than those for MCS for all child and all comparable family characteristics.

Regression results

We next estimated a series of ordinary least squares regression models for vocabulary score and its association with child behaviour (model 1), first adjusting for the child's individual characteristics (model 2), family socioeconomic background including maternal depressive symptoms (model 3), child's vocabulary at age 5 (model 4) and

Table 1. distribution of cohort members across all covariates by cohort

	BCS %	MCS %	
Child characteristics			
Behaviour problems (5)			
Conduct (0–6)			
0	.21	.31	
1	.26	.28	
2	.28	.22	
3	.16	.12	
4+	.09	.07	
Hyperactivity (0–6)			
0	.18	.26	
1	.24	.27	
2	.26	.19	
3	.16	.15	
4+	.16	.13	
Gender			
Male	.51	.51	
Female	.49	.49	
Ethnicity			
White	.96	.87	
BAME	.04	.13	
Birthweight			
Normal	.94	.93	
Low birthweight	.06	.07	
Breast Fed			
Never	.63	.28	
<1 month	.16	.23	
<3 months	.10	.14	
> 3 months	.11	.35	
Birth Order			
Older siblings	.61	.57	
1st born	.39	.43	
Family Characteristics			
Social class (RGSC) (0)			Social class (NSSEC) (9mths)
Other	.82	.54	Not in work/Intermediate
Professional/Managerial	.18	.46	Hi Man/Prof
Parent Highest Qual (5)			Parent Highest Qual (5)
No quals/Vocational	.39	.15	No quals/NVQ1
OLevels [NVQ2]	.35	.25	NVQ2
ALevels [NVQ3]	.12	.16	NVQ3
Degree + [NVQ4+]	.14	.44	NVQ4+
Income (banded) (10)			Income [grouped to BCS dist] (9mths)
<£50	.07	.05	Lowest 5%
£50-£99	.30	.23	23%
£100-£149	.34	.36	37%
£150-£199	.17	.20	20%
£200+	.12	.16	Highest 16%
Housing Tenure (5)			Housing Tenure (9mths)
Other	.44	.36	Own

Table 1. (Continued)

	BCS %	MCS %	
Own	.56	.64	Other
Overcrowded Home (5)			Overcrowded Home (9mths)
<1 person per room	.60	.76	<1 person per room
1+ person per room	.40	.24	1+ person per room
Parents (0)			Parents (9mths)
Two-parents	.94	.86	Two-parents
Single parent	.06	.14	Single parent
Mother mental well-being [Malaise] (5)			Mother mental well-being [Kessler] (5)
Not depressed	.81	.81	Not depressed
Depressed (8+)	.19	.19	Depressed (6+)

child's vocabulary at age 10 or 11 (model 5). The results are shown in Table 4 (for BCS70) and in Table 5 (for MCS), which includes the coefficients for child conduct and hyperactivity problems from the five regression models. This shows how the direct relationship between behaviour problems and vocabulary acquisition changes once the inter-related family socioeconomic and individual characteristics are taken into account.

Behaviour problems at school entrance are related to teen*age vocabulary scores. In both cohorts, even when individual characteristics and family circumstances are acc*ounted for (model 3), a child with behaviour problems at school entry age 5 is significantly more likely to have poorer vocabulary in adolescence.

When earlier measures of their vocabulary are taken into account, a child with conduct or hyperactivity problems remains more likely to have lower mean vocabulary scores as a teenager in both cohorts. However, given that early behaviour problems interfere with learning ability, captured here by the assessment of vocabulary at age 5, 10 or 11, the relationship between early behaviour and teenage vocabulary skills may well be an underestimation when earlier vocabulary is included (models 4 and 5).

A central question for this article was to examine if the association between behaviour problems and vocabulary differed across generations. By concentrating on (95%) confidence intervals around the coefficients in model 3—when individual characteristics and family circumstances are accounted for—we find evidence that whereas conduct problems had an equally negative association in both cohorts, early hyperactivity problems had a stronger negative association on later vocabulary acquisition for the younger cohort. This remained the case when earlier vocabulary performance at age 5 and age 10 or 11 was taken into account.

In terms of the magnitude of the effect size, and again concentrating on model 3, for each 1-point increase in conduct problems, children in BCS70 knew 0.17 words less at age 16 compared to 0.08 words less in MCS at age 14. For each 1-point increase in hyperactivity problems, children in MCS have 0.15 words less at age 14 compared to 0.06 words less in BCS at age 16. Although these differences may seem relatively small, they translate to a child with severe—a score of 6—conduct (BCS) or hyperactivity (MCS) problems knowing approximately one word less in a test of 12

Table 2. Mean raw vocabulary score at age 16 (BCS) or age 14 (MCS) by child characteristics

	Vocabulary score (0–12)	
	BCS	MCS
Behaviour problems (5)		
Conduct (0–6)		
0[1]	7.57	5.95[†]
1	7.24*	5.51*,[†]
2	6.89*	5.18*,[†]
3	6.56*	4.98*,[†]
4+*,[†]	6.12*	4.63*,[†]
Hyperactivity (0–6)		
0[1]	7.28	6.05[†]
1	7.31	5.58*,[†]
2	6.85*	5.29*,[†]
3	6.87*	5.09*,[†]
4+	6.54*	4.70*,[†]
Gender		
Male[1]	6.99	5.43[†]
Female	6.99	5.49[†]
Ethnicity		
White[1]	7.05	5.49[†]
BAME	5.56*	5.24
Birthweight		
Normal[1]	7.05	5.48[†]
Low birthweight	6.21*	5.16*,[†]
Breastfed		
Never[1]	6.67	4.80[†]
<1 month	7.20*	5.22*,[†]
<3 months	7.57*	5.49*,[†]
> 3 months	7.97*	6.13*,[†]
Birth order		
Older siblings[1]	6.72	5.32[†]
First-born	7.42*	5.64*,[†]
Vocabulary[2] (5)		
Lowest quintile[1]	5.45	4.04[†]
2nd	6.28*	4.70*,[†]
3rd	6.99*	5.18*,[†]
4th	7.63*	5.58*,[†]
Highest quintile	8.46*	6.42*,[†]
Vocabulary[3] (10 or 11)		
Lowest quintile[1]	5.03	4.03[†]
2nd	6.23*	4.89*,[†]
3rd	7.00*	5.36*,[†]
4th	7.56*	5.93*,[†]
Highest quintile	8.57*	6.61*,[†]

[1]Reference category.

[2]BCS70 children completed the English Picture Vocabulary Test (Brimer & Dunn, 1962); MCS children the BAS Naming Vocabulary Test (Elliott, 1996). Both provide an assessment of expressive verbal ability.

[3]BCS70 children completed the Shortened Edinburgh Reading Test: a test of word recognition (Godfrey Thompson Unit, 1978); MCS children the BAS II Verbal Similarities, which measures 'crystallised intelligence' (Elliott, 1996). For further details of the BCS70 assessments see Parsons (2014) and for the MCS assessments see Connelly (2013).

*Indicates significantly different ($p < 0.05$) from reference category.

[†]Indicates mean scores significantly different across cohorts.

Table 3. Mean raw vocabulary score at age 16 (BCS) or age 14 (MCS) by family characteristics

BCS categories	Vocabulary score (0–12) BCS	MCS	MCS categories
Social class (RGSC) (0)			*Social class (NSSEC) (9 months)*
Others[1]	6.72	4.89	[1]Not in work/intermediate
Professional/managerial	8.22*	6.12*	Higher manual/professional
Parent highest qualification (5)			*Parent highest qualification (5)*
No qualifications/vocational[1]	6.05	4.33	[1]No qualifications/NVQ1
O Levels [NVQ2]	7.06*	4.97*	NVQ2
A Levels [NVQ3]	7.83*	5.24*	NVQ3
Degree+ [NVQ4+]	8.74*	6.19*	NVQ4+
Income (banded) (10)			*Income [grouped to BCS distribution] (9 months)*
[7%] <£50[1]	6.08	4.61	[1]Lowest 5%
[30%] £50–£99	6.42	4.70	23%
[34%] £100–£149	6.99*	5.35*	37%
[17%] £150–£199	7.58*	5.89*	20%
[12%] £200+	8.14*	6.53*	Highest 16%
Housing tenure (5)			*Housing tenure (9 months)*
Own[1]	7.56	5.79[†]	[1]Own
Other	6.28*	4.87*,[†]	Other
Overcrowded home (5)			*Overcrowded home (9 months)*
<1 person per room[1]	7.51	5.62[†]	[1]<1 person per room
1+ person per room	6.23*	4.92*,[†]	1+ person per room
Parents (0)			*Parents (9 months)*
Two parents[1]	7.01	5.58[†]	[1]Two parents
Single parent	6.67	4.68*,[†]	Single parent
Mother mental well-being [Malaise] (5)			*Mother mental well-being [Kessler] (5)*
Not depressed[1]	7.17	5.54	[1]Not depressed
Depressed (8+)	6.23*	5.10*	Depressed (6+)

[1]Reference category.
*Indicates score significantly different ($p < 0.05$) from reference category.
[†]Indicates score significantly different across cohorts (assessed when measures are identical: housing tenure, overcrowded home, parents).

words compared with children with no conduct (1.02 words BCS) or hyperactivity (0.90 words MCS) problems. When considering the combined impact of conduct and hyperactivity problems on vocabulary, the regression results indicate that it is identical in both generations ($\beta = 0.23$), which translates to 1.4 words less for those with severe conduct and hyperactivity problems.

To formally assess if the association between vocabulary acquisition and early behaviour problems differed across generations, and to answer our final research question of whether vocabulary scores varied across generations, we re-ran all regression models but included a cohort identifier in the modelling. Table 6 shows that in the initial model (model 1) the more recent, albeit younger, MCS cohort scored, on average, 1.54 fewer words out of a maximum of 12 than teenagers from 30 years

Table 4. Regression results: raw vocabulary score at age 16 (BCS70)

	Model 1	Model 2	Model 3	Model 4	Model 5
Conduct score [0–6]	−0.30***	−0.28***	−0.17***	−0.14***	−0.11**
	[−0.36, −0.24]	[−0.34, −0.21]	[−0.24, −0.11]	[−0.21, −0.08]	[−0.18, −0.05]
Hyperactivity score [0-6]	−0.08*	−0.09**	−0.06*	−0.04	−0.04
	[−0.13, −0.02]	[−0.15, −0.03]	[−0.11, −0.00]	[−0.10, 0.01]	[−0.09, 0.01]
Included in the modelling					
Individual characteristics		YES	YES	YES	YES
Family characteristics			YES	YES	YES
Vocabulary (5)				YES	YES
Vocabulary (10)					YES
R^2	0.024	0.075	0.160	0.217	0.280
N	15,678	15,678	15,678	15,678	15,678

Note: Individual characteristics: gender, ethnicity, birth order (first-born), birthweight, breastfed. Family characteristics: parent(s)' occupation, parent(s)' qualifications, family income, single parent, housing tenure, overcrowded home, mother mental well-being. 95% CIs in parentheses.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Table 5. Regression results: raw vocabulary score at age 14 (MCS)

	Model 1	Model 2	Model 3	Model 4	Model 5
Conduct problems [0–6]	−0.19***	−0.14***	−0.08***	−0.07**	−0.05*
	[−0.24, −0.15]	[−0.18, −0.10]	[−0.13, −0.04]	[−0.11, −0.03]	[−0.09, −0.00]
Hyperactivity problems [0–6]	−0.21***	−0.19***	−0.15***	−0.11***	−0.09***
	[−0.25, −0.18]	[−0.22, −0.15]	[−0.18, −0.12]	[−0.14, −0.08]	[−0.12, −0.06]
Included in the modelling					
Individual characteristics		YES	YES	YES	YES
Family characteristics			YES	YES	YES
Vocabulary (5)				YES	YES
Vocabulary (11)					YES
R^2	0.048	0.096	0.148	0.220	0.264
N	16,628	16,628	16,628	16,628	16,628

Note: Individual characteristics: gender, ethnicity, birth order (first-born), birthweight, breastfed. Family characteristics: parent(s)' occupation, parent(s)' qualifications, family income, single parent, housing tenure, overcrowded home, mother mental well-being. Vocabulary includes age at test. 95% CIs in parentheses.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Table 6. Raw vocabulary score at age 16 (BCS) or 14 (MCS)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Cohort identifier	−1.54***	−1.66***	−1.94***	−2.31***	−2.24***	−2.09***
[0 = BCS; 1 = MCS]	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
Conduct problems [0–6]		−0.25***	−0.21***	−0.14***	−0.11***	−0.08***
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Hyperactivity problems [0–6]		−0.14***	−0.13***	−0.09***	−0.06***	−0.05**
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Included in the modelling						
Individual characteristics			YES	YES	YES	YES
Family characteristics				YES	YES	YES
Vocabulary (5)					YES	YES
Vocabulary (10 or 11)						YES
R^2	0.102	0.130	0.169	0.226	0.284	0.335
N	32,306	32,306	32,306	32,306	32,306	32,306

Note: Individual characteristics: gender, ethnicity, birth order (first-born), birthweight, breastfed. Family characteristics: parent(s)' occupation, parent(s)' qualifications, family income, single parent, housing tenure, overcrowded home, mother mental well-being. Standard errors in parentheses.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

previously. This gap in vocabulary actually increased to over two words (2.09) when all other characteristics in the modelling were taken into account, including earlier vocabulary acquisition. (Complete regression results from the final model are also included in Appendix 3.) This increase is because MCS had more advantaged characteristics in many respects, such as more highly educated parents, and therefore the vocabulary gap increased rather than decreased once these were taken into account. By including an interaction term between cohort and (both) conduct and hyperactivity scores, we found a positive and significant interaction for conduct problems (0.13, $p < 0.001$), suggesting that increased conduct problems had less of a negative association with vocabulary acquisition in the younger cohort. The interaction between cohort and hyperactivity problems was not significant.

Discussion

In this study we have estimated the relationship between behavioural problems in early childhood and teenage vocabulary acquisition. We compared the relationships across two generations of British children born 30 years apart. A great strength of this research lies in the fact that we were able to employ identical measures of vocabulary performance and (near identical) measures of early life conduct and hyperactivity problems by age and across cohorts. All three measures achieved measurement invariance and were therefore comparable across cohorts.

However, it needs to be acknowledged that given our data is derived from an observational longitudinal study, bias due to unmeasured confounding cannot be ruled out. As in any longitudinal survey, missing data due to attrition is unavoidable.

We employed multiple imputation, augmenting our models with auxiliary variables in the imputation phase to maximise the plausibility of the MAR assumption and restore sample representativeness, but bias due to a non-ignorable missing data-generating mechanism cannot be ruled out.

Given this caveat, we found a strong relationship between behaviour problems at school entrance, age 5 and teenage vocabulary scores in both generations, which although somewhat attenuated once we controlled for a wide range of inter-related family background and individual characteristics, remained significant. Findings suggest that children with severe early behaviour problems in each generation—conduct problems in BCS70, hyperactivity problems in MCS—know the meaning of one word less, out of a total of 12 words in adolescence, than their peers with no behaviour problems in early childhood.

A further limitation is that our findings can only be generalised to those born in Britain in 1970 or in 2000/2, or close to these years, and the potential impact of the difference in age at assessment of the adolescents in the two cohorts must be acknowledged, as perhaps the words in the assessment may have been more familiar with teenagers born in 1970 than 2000/2. However, when considering vocabulary knowledge across generations, the two words fewer that the more recent generation knew on average cannot be underestimated or explained away by their younger age. Two words fewer out of a maximum of 12 represents a substantial 17% gap in vocabulary acquisition. Evidence from the established BAS Word Definitions and Verbal Similarities assessment scales (Elliott, 1996; Elliott & Smith, 2011) suggests that mean ability scores for average performing 14- and 16-year-olds differ by 10, which represents a knowledge gap of just 4%. We also established that the lower scores in the younger generation were not due to a stronger association between vocabulary and behaviour problems, as the significant interaction with conduct problems indicated a weaker gradient. However, we do acknowledge that the results would be more robust if the identical assessment of vocabulary had included a wider range of words. Given the constraints of respondent burden, particularly in cognitive testing with young people, a shorter scale was used with the MCS cohort. We acknowledge that this provides a limited sample of the young person's vocabulary, which could potentially affect the results. We also acknowledge of course that language changes over time, which could raise a concern regarding the historical versus contemporary usage of the test items. However, we have assessed this using Google NGram and found no cause for concern (see Appendix 4).

Although vocabulary acquisition can continue to develop into adulthood (Sullivan & Brown, 2015) and is more robust to decline than other cognitive measures (Rabbitt, 1993), it is also relatively robust and so the earlier a rich vocabulary is acquired the better. Given that knowledge of words is both an adjunct to knowledge of concepts and assists further learning (Hirsch, 1983), all future learning will be made easier with greater language acquisition and a wider range of opportunities will present to children as they progress through schooling and transition into post-compulsory trajectories.

In the UK, academic success at age 16 is increasingly key for adolescents to make successful transitions from school to adulthood, and we know the importance vocabulary and language skills hold for later academic attainment (e.g. Parsons *et al.*, 2011;

Sullivan *et al.*, 2017). As such, given we have shown that today's teenagers have a lower command of vocabulary than teenagers 30 years prior, the results hold particular importance for education policies today and suggest that children with behaviour problems at school entrance may require additional input at school to support the development of their vocabulary. Behaviour problems and a poor grasp of language can exist concurrently for some children at school entrance, and lead to a child failing to meet early expected achievement targets (Whiteside, 2017). Teachers are well placed to identify children with problematic behaviour, and they could ask parents about any concerns over their child's behaviour. This could accelerate access to formal assessment and follow-on interventions to help address the problems and reduce symptoms. As socioeconomic disadvantage more often than not accompanies children with behaviour problems and/or poor vocabulary acquisition at school entrance, to best support children and their families, it is vital that policy solutions consider the holistic nature of a child's family environment. By doing this, children will have a better chance of avoiding the range of social and economic disadvantages in adult life research has shown to be associated with early behaviour problems (Goodman *et al.*, 2011; Washbrook *et al.*, 2013; Ploubidis *et al.*, 2020) and poor language acquisition (Law *et al.*, 2009; Schoon *et al.*, 2010a,b; Parsons *et al.*, 2011; Sullivan *et al.*, 2017).

NOTE

[1] The BAS3 had a standardised sample of 1,480 children aged 3 to 17:11 as a normative frame of reference.

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Appendix 1

Table A1.1 gives the individual vocabulary assessment items showing the proportions selecting each answer option in each cohort. **Bold** indicates correct option

Table A1.1. Individual vocabulary assessment items

WORD	OPTIONS	BCS%	MCS%
QUICK	ALWAYS	0.18	0.33
	BEST	0.14	0.20
	NEAT	0.45	0.13
	SICK	0.22	0.16
	FAST	99.01	99.18
TIDINGS	STEPS	3.09	18.20
	REASON	6.90	22.68
	JETTY	5.31	12.10
	MOUNTAINS	1.95	11.25
	NEWS	82.75	35.77
CONCEAL	ADVISE	3.10	5.77
	HIDE	89.85	76.82
	GATHER	2.21	6.49
	FREEZE	1.59	2.21
	CONCILIATE	3.25	8.72
UNIQUE	SEVERAL	1.31	2.10
	MATCHLESS	82.18	70.10
	SIMPLE	5.09	8.61
	ANCIENT	8.17	6.22
	ABSURD	3.26	12.97
DUBIOUS	TAWNY	3.00	7.69
	OBSTINATE	8.90	13.16
	GLOOMY	5.19	24.16
	MUDDY	1.63	3.28
	DOUBTFUL	81.29	51.71
TRIVIAL	TREFOIL	6.11	9.05
	ALLUVIAL	10.71	19.19
	TRIFLING	55.89	34.64
	ECCENTRIC	16.88	29.13
	TAWDRY	10.41	7.99
ORTHODOX	**CONVENTIONAL**	68.61	48.76
	ANGULAR	5.13	13.41
	BOHEMIAN	8.90	9.91
	LITURGICAL	10.95	17.05
	AMAZING	6.41	10.88
PLAUSIBLE	AGGRESSIVE	6.38	8.74
	HUMANE	12.20	16.89
	SHALLOW	6.60	13.05
	WIDE	4.59	5.83
	CREDIBLE	70.22	55.49
SIGNIFY	DETER	8.34	9.23
	SUBSCRIBE	21.40	19.27

Table A1.1. (Continued)

WORD	OPTIONS	BCS%	MCS%
	AVAIL	7.25	14.85
	SUBMIT	13.00	42.39
	DENOTE	50.01	14.25
CONSPICUOUS	PLOTTING	12.63	23.50
	GARGANTUAN	3.67	4.74
	SUSPICIOUS	40.00	51.06
	PROMINENT	41.82	15.03
	DESERVED	1.79	5.68
PRECEDENCE	GUESS	6.84	16.10
	PRIORITY	66.37	40.03
	CLEVERNESS	12.14	24.12
	SYMPATHY	7.39	13.60
	REGALIA	7.26	6.15
IMPLICATE	INGEST	17.00	11.09
	INVOLVE	56.03	38.70
	PRODUCE	11.66	26.34
	MALFORMED	5.70	9.93
	DEVIATE	9.62	13.95
INDIFFERENT	SIMILAR	31.30	41.68
	DISILLUSIONED	6.09	9.09
	INEQUITABLE	10.64	16.25
	IDENTICAL	18.26	22.11
	UNINTERESTED	33.72	10.87
CREDULOUS	APT	6.55	4.88
	GENUINE	24.42	36.95
	OPPOSED	9.49	17.04
	GULLIBLE	27.23	18.38
	TRUSTWORTHY	32.31	22.75
SEETHE	SOFTEN	13.96	24.58
	MOW	9.59	7.20
	BOIL	52.08	23.03
	SURROUND	9.75	22.17
	PERCEIVE	14.62	23.02
OBSOLETE	EXECRABLE	10.59	13.05
	SECRET	21.85	29.22
	INNOCUOUS	19.52	22.45
	RIGID	9.17	14.47
	REDUNDANT	38.87	20.81
ERUDITE	**LEARNED**	25.12	22.36
	SPASMODIC	17.27	15.87
	SUPERFLUOUS	19.73	18.28
	PATHETIC	24.99	28.69
	SPURIOUS	12.89	14.80
PROSAIC	**COMMONPLACE**	17.37	13.55
	FLOWERY	22.86	17.38
	LAUDABLE	19.84	22.24
	POETICAL	30.21	29.44
	SPACIOUS	9.71	17.38

Table A1.1. (Continued)

WORD	OPTIONS	BCS%	MCS%
ASCETIC	ARTISTIC	19.21	36.39
	DISSOLUTE	27.25	19.77
	AUSTERE	28.51	18.48
	ANTIPATHETIC	16.20	20.06
	CHARLATAN	8.84	5.30
PUSILLANIMOUS	LOUD	28.28	24.04
	LIVING	13.20	14.53
	TIMID	26.72	28.60
	AVERSE	21.33	24.42
	CORRECT	10.47	8.42

Exploratory factor analyses

A number of exploratory factor analyses were carried out to assess how items load for each cohort on one factor. Firstly, for all 20 items (model 1). Items VOC14, VOC18, VOC19 and VOC20 were then excluded due to low loadings (model 2). For MCS, three further items had very low loading on one-factor results (VOC06 = 0.071*, VOC10 = 0.177*, VOC12 = 0.070*). A further EFA excluded these and also VOC13, as loaded negatively when looking at two-factor results (model 3). Fit statistics for these three models are included in Table A1.2. Model fit statistics from model 3 results are satisfactory.

Table A1.2. Exploratory factor analysis results

	BCS	MCS
Model 1		
CHI^2 (DF)	1,300.901 (170)	1,853.415 (170)
RMSEA	0.034	0.030
CFI	0.964	0.846
TLI	0.959	0.827
SRMR	0.064	0.066
Model 2		
CHI^2 (DF)	757.968 (104)	1,446.594 (104)
RMSEA	0.033	0.033
CFI	0.978	0.877
TLI	0.975	0.859
SRMR	0.060	0.071
Model 3		
CHI^2 (DF)	343.918 (54)	398.102 (54)
RMSEA	0.031	0.024
CFI	0.984	0.962
TLI	0.980	0.953
SRMR	0.058	0.058

Measurement invariance

Measurement invariance tests were carried out on model 3. Configural and metric invariance were achieved and borderline scalar invariance (a). After releasing one item (item 2), the model fit improved to be able to argue that scalar invariance was achieved (b).

Table A1.3. CONFIGURAL * METRIC * SCALAR INVARIANCE

	CONFIGURAL	METRIC	SCALAR(a)	SCALAR(b)
CHI^2 (DF)	744.269 (108)	1,260.571 (119)	2,506.243 (130)	1,970.756 (df 129)
RMSEA	0.027	0.034	0.047	0.042
CFI	0.977	0.958	0.912	0.932
TLI	0.971	0.953	0.911	0.930
WRMR	2.74	3.908	5.549	4.910
DIFFTEST		321.882 (11)	1190.628 (11)	691.90 (df 10)

Appendix 2

Table A2.1. Comparable Rutter and SDQ questions

BCS: Rutter	MCS: SDQ
Conduct (3 questions)	*Conduct* (3 questions)
Irritable. Is quick to fly off the handle	Often has temper tantrums or hot tempers
Is often disobedient	Is generally obedient, usually does what adults request[i]
Often tells lies	Often lies or cheats
Hyperactivity (3 questions)	*Hyperactivity* (3 questions)
Very restless. Often running about or jumping up and down. Hardly ever still	Is restless, overactive, cannot stay still for long
Is squirmy or fidgety	Is constantly fidgeting or squirming
Tends to be fearful or afraid of new things or new situations	Is nervous or clingy in new situations, easily loses confidence

[i]Reverse coded.

Appendix 3

Table A3.1. Results of final regression models—all variables

	Teenage vocabulary scores		
	BCS	MCS	Both
Cohort (BCS = 0; MCS = 1)			−2.09***
			(0.06)
Behaviour			
Conduct [0–6]	−0.11**	−0.05*	−0.08***
	(0.03)	(0.02)	(0.02)
Hyper [0–6]	−0.04	−0.09***	−0.05**
	(0.03)	(0.02)	(0.02)
Mother mental health	−0.05	0.10	0.01
	(0.09)	(0.06)	(0.05)
Child characteristics			
LBW	−0.28*	0.00	−0.15
	(0.14)	(0.09)	(0.08)
Breastfed	0.10**	0.16***	0.13***
	(0.03)	(0.02)	(0.02)
BAME	−0.22	0.26***	0.18*
	(0.22)	(0.07)	(0.07)
First-born	0.37***	0.03	0.20***
	(0.07)	(0.05)	(0.04)
Female	0.18**	0.02	0.11**
	(0.07)	(0.05)	(0.04)
Family circumstances			
Income	0.02	0.11***	0.04
	(0.04)	(0.03)	(0.02)
Crowded home	−0.23**	0.02	−0.15**
	(0.08)	(0.06)	(0.05)
Single parent	0.04	−0.05	0.05
	(0.24)	(0.08)	(0.09)
Own home	0.13	−0.12	0.05
	(0.07)	(0.07)	(0.05)
Parents' qualifications	0.34***	0.15***	0.25***
	(0.04)	(0.03)	(0.03)
Professional or managerial	0.21*	0.25***	0.18***
	(0.09)	(0.05)	(0.05)
Vocabulary			
Vocab 5	0.48***	0.52***	0.50***
	(0.04)	(0.03)	(0.03)
Vocab 10 or 11	0.84***	0.55***	0.71***
	(0.04)	(0.03)	(0.02)
_cons	6.26***	4.50***	6.40***
	(0.15)	(0.12)	(0.10)
R^2	.280	.264	.335
N	15,678	16,628	32,306

Standard errors in parentheses.
*$p < 0.05$,
**$p < 0.01$,
***$p < 0.001$

Appendix 4

Google NGram Viewer: Trends in word usage over time

Usage of the following words from 1986 to 2008: quick, tidings, conceal, unique, dubious, trivial, orthodox, plausible, signify, conspicuous, precedence, implicate, indifferent, credulous, seethe, obsolete, erudite, prosaic, ascetic, pusillanimous