Investigating how vocabulary relates to different dimensions of family socio-economic circumstance across developmental and historical time

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Abstract

Social inequalities in child vocabulary persist, despite decades of efforts to understand and reduce them. Different dimensions of socioeconomic circumstances (SEC), such as parent education, income, occupational status, wealth and relative neighbourhood deprivation, are likely to represent different mechanisms of effects on child vocabulary. We investigate which aspects of SEC relate to vocabulary, and whether this is stable over developmental and historical time. Data from two large, national datasets were analysed: the 1970 British Cohort Study (born 1970; N= 14,851) and the Millennium Cohort Study (born 2000-01; N=17,070). Substantial individual differences in vocabulary (ages 3–14) were explained by multiple indicators each making a unique contribution, most notably parent education (partial R^2:6.4%-8.5%), income (partial R^2: 4.3%-6.4%), and occupation (partial R^2: 5.3-8.1). Inequalities were generally stable over developmental and historical time. However, findings suggest a need to focus on widening inequalities both towards the start and end of compulsory schooling.

Introduction

Children need good language skills in order to be able to access education and, in turn, the labour market (Law, Charlton, & Asmussen, 2017; Oxford University Press, 2018). For decades, studies have observed social inequalities in vocabulary size (Hart & Risley, 1995b; Pace, Luo, Hirsh-Pasek, & Golinkoff, 2017) and policy makers have sought educational interventions to reduce these disparities (Bercow, 2018). Yet randomised controlled trials suggest that such interventions have mixed success (Law, Charlton, Dockrell, et al., 2017). To assist in better directing future research and better targeting interventions, we address three fundamental questions using large, nationally representative, longitudinal UK datasets. First, are all indicators of socioeconomic circumstance (SEC) equal in predicting vocabulary outcomes? Second, does the relation between SEC and language development stay constant over developmental time? And third, is the relation between SEC and language development changing over historical time as our economy becomes increasingly knowledge based and hourglass-shaped?

While caregiver education, occupational status, income, wealth and neighbourhood disadvantage statistics are all often used as interchangeable indicators of SEC, each dimension reflects access to different resources that may affect language development (Duncan & Magnuson, 2012). Some have argued that caregiver education is the most relevant SEC indicator for language development as it is most directly related to the *quality* of the language learning environment and/or language related genetic factors (Hirsh-Pasek et al., 2015; Hoff, 2013; Hoff, Laursen, & Bridges, 2012). However, no empirical work has explicitly tested this claim in nationally representative samples and there are plausible pathways by which other indicators of SEC may also exert effects on vocabulary. First, income may affect language development through the availability of learning resources in the household (Duncan, Magnuson, & Votruba-Drzal, 2017; Washbrook & Waldfogel, 2011).

Second, the family stress model posits that economic difficulty can influence parenting through its harmful effect on emotions, behaviours and relationships (Conger & Donnellan, 2007). This in turn can affect language development via the interactions parents have with their children (Perkins, Finegood, & Swain, 2013). Therefore, family wealth could be a protective mechanism, acting as a safeguard against any negative effects of sudden income losses, such as unexpected unemployment (Grinstein-Weiss, Williams Shanks, & Beverly, 2014; Killewald, Pfeffer, & Schachner, 2017). Third, occupational status reflects one's social position in the labour market, as well as power and status (Sullivan, Ketende, & Joshi, 2013). It is thought that people's social networks generally consist of people who are similar to them in terms of occupational status, known as occupational homophily. (Griffiths, Lambert, & Tranmer, 2011; McPherson, Smith-Lovin, & Cook, 2001). This may be indirectly related to language development, as children will adopt styles of speech and vocabulary used by their parents when talking to them and when talking to individuals in their social network (Sullivan, 2007). Finally, developmental theory emphasises how the immediate caregiving environment is nested within broader societal and cultural spheres (Bronfenbrenner, 1979; Rowe & Weisleder, 2020). As a proxy for this wider environment, neighbourhood-level statistics (such as the UK Indices of Multiple Deprivation) may additionally predict language development (Bennetts et al., 2022; Neuman, Kaefer, & Pinkham, 2018). Directly comparing the predictive value of different SEC indicators is a pre-requisite for understanding why vocabulary inequalities exist and which mechanisms to target in order to support development. Our first goal was thus to test whether five key indicators of SEC (caregiver education, income, wealth, occupational status and neighbourhood deprivation) each predict unique variance in child vocabulary and how much relative variance is predicted by each.

Compelling arguments have been made in favour of early intervention to prevent social disadvantage affecting language before children reach formal education (Doyle,

Harmon, Heckman, & Tremblay, 2009), yet there is also evidence that the SEC gap in vocabulary is pronounced among adolescents (Spencer, Clegg, & Stackhouse, 2012; Sullivan & Brown, 2015). In fact, we do not know if or when the word gap shrinks or widens as children grow up. Nor do we know whether the predictive value of different SEC indicators remains stable over developmental time. For example, while caregiver education may be important during the early years, it has been proposed that family wealth may be a more important predictor of outcomes in adolescence and early adulthood. This might be because wealth facilitates access to high quality secondary education or other forms of academic support (Pfeffer, 2018). It is thus possible that the relative effect of different dimensions of SEC changes throughout development. Our second goal was therefore to test whether social disparities in language development have narrowed or widened over developmental time, from early childhood to mid-adolescence, for a contemporary generation born at the start of the 21st Century.

Large societal changes in the UK have seen an increase in the proportion of parents who have attended university and a reconfiguration of the economy such that fewer people are in middle-ranked jobs, with more in lower grade employment on the one hand and in the higher managerial and professional occupations on the other (often characterised as a move to an hourglass economy; Bolton, 2012; Holmes & Mayhew, 2012). Many more jobs are now also knowledge-based, making language and cognitive skills of great importance for the UK economy (Beddington et al., 2008; Deloitte, 2016), and putting pressure on parents to support their children's cognitive development to open doors to the labour market. Income inequality increased in the UK in the 1980s and 1990s, and at the start of the millennium, income polarisation appeared to increase (those with the highest average incomes appeared to experience the largest increases, whilst those with lower average incomes experienced declines in their income; Dorling et al., 2007). These broad shifts in society have the potential

to change the association between different measures of SEC and language development. Our third goal was thus to test whether the relations between different SEC indicators and language development have become more or less pronounced over historical time, comparing children born at the turn of this century with those born in 1970.

In a series of pre-registered analyses, we met the first two goals by analysing data from the Millennium Cohort Study (17,070 children born between 2000-02; MCS2001). We then compared these contemporary trends with those in a cohort born 30 years prior using data from the 1970 British Cohort Study (15,817children born in 1970; BCS1970, and 16,020 children in the MCS2001). Both studies contain measures of vocabulary at multiple ages and we use these an indicators of general language ability —different measures of formal language tend to load on to the same factor (Fricke et al., 2017), meaning that vocabulary is likely to be a good proxy for broader language ability.

Materials and Methods

Data

We used data from two large nationally representative UK birth cohort studies: the Millennium Cohort Study (MCS2001 cohort) and the 1970 British Cohort Study (BCS1970 cohort). Addressing research questions 1-3 involved analyses of the MCS2001 cohort data only, due to the availability of multiple SEC indicators in this cohort, allowing us to examine the unique contribution of different SEC indicators to inequalities in language ability in a contemporary cohort. In addressing research question 4 we used data from the MCS2001 and BCS1970 cohorts in a cross-cohort comparison. The use of these two datasets for a cross-cohort comparison allows us to examine inequalities in language ability in two generations born 30 years apart, during a period which has seen changes to occupational and educational structures in the UK.

MCS2001. The Millennium Cohort Study is a longitudinal birth cohort study of 19,518 young people, from 19,244 families, born across England, Scotland, Wales and Northern Ireland between 2000-02 (Connelly & Platt, 2014). To date there have been six sweeps of data collection conducted when cohort members were aged 9 months and ages 3, 5, 7, 11 and 14 years. More information on the MCS2001cohort can be found here: https://cls.ucl.ac.uk/cls-studies/millennium-cohort-study/.

BCS1970. The 1970 British Cohort Study is a longitudinal birth cohort study of 16,571 children who were born during one week in 1970 in England, Scotland and Wales (Elliott & Shepherd, 2006). It has 4 childhood sweeps (data collected at birth and 5, 10 and 16 years). More information on the BCS1970 cohort can be found here: https://cls.ucl.ac.uk/cls-studies/1970-british-cohort-study/

Sample selection. We selected all cohort members with a response on at least one of the language tasks at the time points considered - ages 3, 5, 11 or 14 (RQ 1-3, MCS2001 cohort only) and age 5, 10 or 16 (BCS1970) and ages 5, 11 or 14 MCS2001) for the cross-cohort comparison. Where cohort members were twins, triplets or there were multiple cohort members from the same family, one of these members was selected at random.

Measures

Vocabulary measures (MCS2001 cohort only).

The MCS2001cohort members completed a battery of cognitive tests throughout childhood and into early adolescence. Full details about the completed vocabulary tests can be found in supplementary methods.

At ages 3, 5 and 11, subscales of the British Ability Scale II (BAS II) were completed (Elliott, Smith, & McCulloch, 1996). The British Ability Scales consist of a series of tests measuring cognitive ability and educational attainment, between ages 2 years 6 months to 7 years 11 months. Progression through these tests depends on performance, and poor

performance may result in a different, easier set of items being administered. Cohort members were born over a 1.5 year period (September 2000-January 2002) and assessed over a range of months, so age at the time of testing may differ between cohort members. Therefore, we used t-scores (as published in the data), which are adjusted for item difficulty and age. These were converted to *z* scores for analyses.

Ages 3 & 5. Cohort members completed the Naming Vocabulary BAS II subscale, as a measure of expressive vocabulary. Cohort members were shown a series of images and were asked to name each item in the image (Moulton et al., 2020).

Age 11. Cohort members completed the Verbal Similarities BAS II subscale. This is a measure of verbal reasoning and verbal knowledge. Sets of three words were read out to the cohort member, usually by the interviewer, and cohort members had to say how the words were related to each other (Moulton, 2020).

Age 14. Word Activity task. This test was a subset of items from the Applied Psychology Unit (APU) Vocabulary Test (Closs, 1986). Cohort members were given a list of 20 target words, each presented alongside 5 other words. Cohort members had to choose the word which meant the same, or nearly the same as the target word, from the 5 options (Moulton, 2020). Total scores out of 20 were converted into *z* scores for analyses.

Vocabulary measures (cross-cohort comparison).

For the cross-cohort comparison, we considered vocabulary at three time points in each cohort: age 5 (both cohorts; defined as early language ability), ages 10/11 (BCS1970 and MCS2001cohorts respectively, referred to as late childhood language ability) and ages 16/14 (BCS1970 and MCS2001cohorts respectively, referred to as adolescent language ability). There is no age 3 data for the BCS1970 cohort, hence the earliest language measure considered in the cohort comparisons is age 5.

Early language ability. For the BCS1970 cohort, receptive vocabulary was measured at age 5 using the English Picture Vocabulary Test (EPVT), a UK version of the Peabody Picture Vocabulary Test (Brimer & Dunn, 1962; Dunn, Dunn, Bulheller, & Häcker, 1965). Cohort members were shown 56 sets of four diverse images and heard a specific word associated with each set of four images. They were asked to select one picture that matched the presented word and were awarded one point for every correct response (Sullivan, Moulton, & Fitzsimons, 2021). For the MCS2001cohort, expressive vocabulary was measured using the naming vocabulary sub-test of the BAS II (Elliott et al., 1996). We adjusted for age in months at the time of the test in both cohorts. All scores and ages were converted to *z* scores for analyses.

Late childhood language ability. When the BCS1970 cohort members were aged 10, they completed the BAS word similarities subscale (Elliott, Murray, & Pearson, 1979). The test was made up of 21 items, each of which consisted of three words. The teacher read these sets of items out loud and cohort members had to a) name another word that was consistent with the three words in the item and b) state how the words were related. In order to receive a point, cohort members had to correctly answer both parts of the question (Moulton, 2020). Details on the scoring of this vocabulary measure and the SPSS syntax used can be found in appendix 3 of "Childhood Cognition in the 1970 British Cohort Study" (Parsons, 2014). When MCS2001cohort members were aged 11, they completed the BAS II verbal similarities subscale (detailed above). As already mentioned, test scores for the MCS2001cohort were adjusted for item difficulty. In both cohorts, we controlled for age at the time of the test and converted all scores to *z* scores.

Adolescent language ability. When aged 16, BCS1970 cohort members completed the APU Vocabulary Test (Closs, 1986). This consisted of 75 items: an item consisted of a target word, presented with a multiple-choice list, from which cohort members had to select a

word that meant the same as the target word (Moulton, 2020). These items got progressively harder throughout the test. Details on the scoring of this vocabulary test can be found in appendix 3 (Parsons, 2014). When MCS2001cohort members were aged 14, they completed the Word Activity Task (detailed above). Words used in the Word Activity Task were a subset of the words used in the BCS1970 cohort Vocabulary Test, which cohort members completed aged 16 (Moulton, 2020). Scores were adjusted for age and converted to *z* scores for analyses.

Measures of socioeconomic position.

Analysis of MCS2001 cohort only.

Five indicators of family SEC were used: parent education, family income, wealth, occupational status and relative neighbourhood deprivation. Operationalisation of these variables is as follows.

Parent education. As a measure of parent's education when cohort members were aged 3, highest parent NVQ (National Vocational Qualification) level was used (both academic and vocational qualifications derived into NVQ levels 1-5, with level 5 equating to higher qualifications). It is worth noting that the NVQ levels derived in MCS2001 data differ from those defined by the UK Government (https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels). In the MCS2001 data, these are:

NVQ level 0: none of these/other qualifications
NVQ level 1: GCSE grades D-G, NVQ/ SVQ/ GSVQ level 1
NVQ level 2: GCSE grades A-C, trade apprenticeships, NVQ/ SVQ/ GSVQ level 2
NVQ level 3: A/ AS/ S levels, NVQ/ SVQ/ GSVQ level 3
NVQ level 4: first degree, diplomas in higher education, professional qualifications at degree level
NVQ level 5: higher degree

To contextualise for readers not familiar with the UK system, GCSEs (or the Scottish equivalent) are subject-specific qualifications. The majority of children will take 9 GCSEs in

the academic year they turn 16. A-levels are also subject specific and most people continuing in school on an academic route will specialise to take three subjects at the age of 18. A range of non-vocational qualifications are available at both stages, yielding the mapping noted above. We compared how well *maternal education* and *highest household education* (I.e., the educational qualification of the most qualified parent in the household) predicted vocabulary at each age (see supplementary file section 3) and, based on findings that highest household education consistently accounted for the most variance in vocabulary at each age, we use a measure of highest parent education in our analyses.

Family income. Here we used UK OECD weighted income quintiles at child age 3 (an indication of household income 1=lowest, 5=highest, accounting for family size). If data was missing, OECD weighted income quintiles at child age 9 months were used instead.

Wealth. **Here we used a** measure of total net wealth, taken from the age 11 sweep of the MCS2001 cohort — when cohort members were aged 11, parents reported on their savings and assets, total debts owed, the value of their house and the amount of outstanding mortgage owed on their home for the first time. This measure was derived from 4 variables: amount outstanding on all mortgages, house value, amount of investments and assets, and amount of debts owed. Outstanding mortgages were subtracted from the house value, to give a measure of housing wealth. In cases where families were not homeowners, they were given a housing wealth value of 0. Debts owed were taken from the amount of investments and assets, to give a measure of financial wealth. In cases where families reported having no savings or debts, they were given a financial wealth value of 0. Housing wealth and financial wealth were then summed to give an overall measure of total net wealth. Our measure of wealth was heavily positively skewed, in line with the distribution of wealth in the general population, which is heavily influenced by extreme values of the top 1% (Killewald, 2017). Total net wealth was therefore split into quintiles for our analyses.

Occupational status. Here we used the highest household occupational status (National Statistics Socioeconomic Classification (NS-SEC) 3 categories: higher managerial; intermediate; routine, with a fourth category for those who were unemployed) at child age 3 years. If data were missing, occupational status at child age 9 months was used instead.

Relative neighbourhood deprivation. Indices of multiple deprivation (IMD) are the government official measure of relative deprivation (Mclennan et al., 2019). Based on an individual's postcode (at the level of the street), these are used to rank small areas or neighbourhoods in England, Scotland, Wales and Northern Ireland from the least deprived to the most deprived area. The IMD is a broad conceptualisation of deprivation, including a wide variety of living circumstances, rather than just a lack of income for adequate financial resources, which often defines people living in poverty. However, people can be considered deprived if they do not have access to any type of resource, not just income (Mclennan, 2019). Therefore, we used IMD deciles at child age 3 (with 1= most deprived and 10=least deprived) as a measure of relative neighbourhood deprivation.

Cross-cohort comparison.

The SEC indicators used in RQ1-RQ3 include the full set of five SEC indicators (parent education, income, wealth, occupational status and neighbourhood deprivation), enabling us to consider the multi-faceted nature of SEC. However, they are not all directly comparable to the data available in the BCS1970 cohort. Therefore, for RQ4, we used a subset of SEC indicators to ensure comparability, to the best of our ability, across the two cohorts. Harmonisation of these measures can be found in Table 1; data harmonisation is the process of making data from different sources (such as different cohorts) more similar to improve comparability between cohorts (O'Neill, Kaye, & Hardy, 2020).

Parental education. The highest academic qualification achieved by a parent in the household when the cohort member was aged 5. Where this information is missing, information from previous sweeps was used.

Occupational status. Highest household occupational status at age 5. For the BCS1970 cohort, this was ascertained with the Registrar General's classification. For the MCS2001 cohort, the NS-SEC classification system was used. Where this information is missing, information from previous sweeps was used.

Family income. UK OECD weighted income quintiles at age 10 (BCS1970) and 11 (MCS2001) were used as an indication of household income 1=lowest, 5=highest, accounting for family size). The BCS1970 first measured family income when cohort members were aged 10, hence we take this information from the age 10 (BCS1970) and age 11 (MCS2001) sweeps for the cross-cohort comparison.

Potential confounders.

We adjusted for gender (male= 0, female=1), ethnicity and whether English was spoken as an additional language (EAL) in the home (1= only English, 2=English and another language, 3=Only another language). Harmonisation of these measures for RQ4 can be found in Table 1.

Table 1: Cross-cohort Harmonization of Variables.

Measure	BCS1970	MCS2001	Harmonised
Age 5 language ability	EPVT. Continuous measure.	Naming vocabulary. Continuous measure.	Total vocabulary score: continuous cohort specific standardised *z* score
Late childhood language ability	Age 10. BAS word similarities	Age 11. BAS II verbal similarities	Total vocabulary score: continuous cohort specific standardised *z* score
Adolescent language ability	Age 16. Vocabulary Test	Age 14. Word activity task,	Total vocabulary score: continuous cohort specific standardised *z* score. Note that a harmonized version of the BCS1970 Vocabulary Test with the same words included in the MCS2001 Word activity

			task was also created, however this correlated 0.93 with the full BCS1970 measure, so we did not conduct this sensitivity analysis.
Occupational status at birth	Age 5. Registrar General's classification. 5 classes: 1. professional 2. managerial, other professionals 3. non-manual skilled, skilled manual 4. semi-skilled workers 5.unskilled workers 6. Full/part time students or volunteers with no paid employment *Note: students/volunteers were categorised as unemployed as they have no paid employment.*	Age 5. NS-SEC 5 classes: 1. Higher managerial/admin/professional 2. intermediate 3. small employers/self-employed 4. lower supervisory and technical occupations 5. semi-routine and routine This 5-class version was collapsed into a 3-class version, as shown here: https://www.ons.gov.uk/methodology/classificationsandstandards/otherclassifications/thenationalstatisticssocioeconomicclassificationnssecrebasedonsoc2010#classes-and-collapses	Composite variable, with a 4th category for unemployment: BCS1970: • Professional & Managerial • Skilled • Semi-skilled and unskilled • Unemployed MCS2001: • Higher managerial • Intermediate • Routine • Unemployed *Note: The convention used in the MCS2001 was used for the occupational status variables from both cohorts, for ease.*
Parental education: highest educational qualification (highest household level)	• No qualifications • Vocational qualifications • O levels • A-levels • State registered nurse • Certificate of education • Degree +	• None of these qualifications • GCSE grades D-G • O level/GCSE grades A-C • A/AS/ S Levels • Diplomas in higher education • First degree • Higher degree • Other academic qualifications (incl.overseas)	No qualifications/low level qualifications O levels/GCSE grades A*-C A levels/earning a degree – post 16 education university level qualifications
Family Income	Weekly Income Bands (midpoint for each band) (Age 10) • Under £35 pw (£17) • £35 - £ 49 pw (£42) • £50-£99 pw (£74.50) • £100 - £149 pw (124.50) • £150 - £199 pw (174.50) • £200 - £ 249 pw (224.50) • > £250 pw (£275)	Annual Income Bands (midpoint for each band) (Age 11) 1. < £ 3,000 (£1500) 2. £3,000- £6,999 (£5000) 3. £ 7,000 - £ 10,499 (£8750) 4. £ 10,500 - £ 12,499 (£11500) 5. £ 12,500 - £ 13,999 (£13250) 6. £ 14,000 - £ 14,999 (£14500) 7. £ 15,000 - £ 19,499	OECD equivalization was applied to the midpoint of each income band in each cohort separately, and these equivalized values were converted into quintiles to give OECD equivalised quintiles: 1. Quintile 1 (Most Deprived) 2. Quintile 2 3. Quintile 3 4. Quintile 4 5. Quintile 5 (Least Deprived)

		(£17250) 8. £ 19,500 - £ 23,499 (£21500) 9. £ 23,500 - £ 27,499 (£25500) 10. £ 27,500 - £ 30,499 (£29000) 11. £ 30,500 - £ 34,499 (£32500) 12. £ 34,500 - £ 39,999 (£37250) 13. £ 40,500 - £ 47,999 (£44250) 14. £ 48,000 - £ 53,999 (£51000) 15. £ 54,000 - £ 62,999 (£58500) 16. £ 63,000 - £ 82,999 (£73000) 17. £ 83,000 - £ 114,999 (£99000) 18. £ 115,000 - £ 149,999 (£132500) 19. more than 150,000 (£150000)	
Ethnicity	European UK European Other West Indian Indian-Pakistani Other Asian African Other	White Mixed Indian Pakistani and Bangladeshi Black or Black British Other Ethnic group (incl. Chinese, Other)	Categorical measures collapsed into 0=White, 1=Minority
Language spoken at home	English Welsh-Gaelic Hindi-Urdu Greek-Turkish Chinese-Oriental African Language European Language	Yes - English only Yes - English and other language(s) No - other language(s) only	Categorical measures collapsed into 0= Monolingual English 1= Other language

Data analysis

All analyses were pre-registered on the Open Science Framework website (https://osf.io/482zw/).

Missing data strategy. Missing data in all analyses was accounted for with multiple imputation using chained equations with the *mice* package in R (van Buuren & Groothuis-Oudshoorn, 2011).

Analysis of MCS2001 cohort only. Each dataset was imputed 25 times, as this was greater than the percentage of missing data (10.6%)(White, Royston, & Wood, 2011). There

was no missing data for gender or neighbourhood deprivation and the percentage of missing data was less than 1% for ethnicity and EAL status. . 14.71% of vocabulary scores at age 3 were missing, 12.41% of age 5 vocabulary scores were missing, 23.92% of age 11 vocabulary scores were missing and 36.88% of age 14 vocabulary scores were missing. We conducted a series of sensitivity checks whereby we repeated the analyses on a dataset which had complete cases for vocabulary at ages 3, 5, 11 and 14 (see supplementary files 11-14 respectively). Missing data among the components of our wealth variable were also high (30.73% (outstanding mortgage); 27.57% (house valuation); 39.85% (total savings); and 28.99 (total debts owed)). We therefore conducted sensitivity analyses where we considered all cohort members with a response to at least one wealth component variable and at least two wealth variables (see supplementary files sections 15-16 respectively). Overall, these sensitivity checks revealed a similar pattern of results to the main analyses.

Combined sampling and attrition weights were applied to the data to account for the stratified clustered design of MCS2001cohort data and the oversampling of subgroups, as well as for missing data due to attrition.

Cross-cohort comparison. Each dataset was again imputed 25 times, as this was greater than the percentage of missing data in each cohort (6.7% MCS2001cohort, 21.3% BCS1970 cohort (White, 2011). For the MCS2001cohort, 6.67% of age 5 vocabulary scores were missing, 18.93% of age 11 vocabulary scores were missing and 32.74% of age 14 vocabulary scores were missing. For the BCS1970 cohort, 20.12% of age 5 vocabulary scores were missing, 6.89% of age 10 vocabulary scores were missing and 63.92% of age 16 vocabulary scores were missing (as a result of the teachers strike in 1986). Full proportions of missing data in both cohorts can be found in Supplementary File X, Again, combined sampling and attrition weights available in MCS2001 data were applied to data from this cohort. The BCS1970 cohort does not have the same sample design as the MCS2001cohort

and thus sample weights are not necessary. However, attrition weights to account for non-response between birth and age 5 were created and included in analyses for BCS1970 cohort data (see supplementary methods for details).

Analyses.

Analytic sample.

To address the first two research questions in a contemporary cohort, we analysed the data of 17,070 children in the MCS2001 (all cohort members with a response on at least one of the language tasks at ages 3, 5, 11 or 14). 49.05% of cohort members were female, 85.97% were of White ethnicity and 88.49% did not speak English as an additional language. Demographic differences between the children included in the analytic samples for Research Questions 1-3 and the full MCS cohort are negligible (see table S1, supplementary file section 2).

For the cross-generation comparison, we analysed the data of 14,851children in the BCS1970 and 16,020 children in the MCS2001 with harmonised measures (cohort members with a response on at least one vocabulary task administered in early childhood, late childhood and/or adolescence; see Table 3 for details of harmonisation). 49.45% of BCS1970 cohort members were female, 93.52% were of White ethnicity and 94.97% did not speak English as an additional language. In the cross-cohort comparison, 48.67% of MCS cohort members were female, 86.03% were of White ethnicity and 88.64% did not speak English as an additional language. Demographic differences between the children included in the analytic samples for Research Question 4 and the full MCS and BCS cohorts were also negligible (see table S2, supplementary file section 2).

Descriptive Statistics.

Descriptive statistics were calculated across the 25 imputed datasets. Analytical samples were compared to the full cohort samples to see if there were any differences in

characteristics of those included in the analyses. Mean language scores for each SEC group are reported.

Inequalities in vocabulary at ages 3, 5, 11 and 14: what is the variation captured by each indicator of SEC individually?

Language scores at ages 3, 5, 11 and 14 were considered as separate outcome variables. For each age, separate models with each SEC predictor in turn (parent education, income, wealth, occupational status and neighbourhood deprivation, each in a separate model) were built to assess the unadjusted relationship between each predictor and language at each time point. Potential confounding variables were then added to each of the models.

A drop-one analysis was used to assess the unique contribution of each predictor; a model with all 5 SEC predictors was compared to models with each predictor removed in turn. This was done for each age (3, 5, 11 and 14). Improvements in fit were assessed using model comparisons for imputed data, using the method of Meng and Rubin (Meng & Rubin, 1992) . If the five-predictor model was a better fit to the data than the four-predictor model following the removal of an SEC indicator, then the SEC variable that was dropped can be said to account for significant unique variance in language ability at that age. Partial R^2 values for each SEC indicator are reported, indicating the proportion of variance explained by each SEC predictor, above that of the potential confounding variables.

How does a composite measure of overall socioeconomic position perform relative to individual measures and combinations of measures?

A latent composite factor of SEC was created using confirmatory factor analysis (see supplementary methods for details). This composite factor was then included as the predictor variable in four separate regression models (each one considering vocabulary at each age), adjusting for the potential confounding variables. Relative AIC values were used to compare the marginal predictive value of each SEC predictor. These were calculated for each imputed

dataset for each single-predictor model, the composite model and a model with all indicators included simultaneously (Schomaker & Heumann, 2014) and means and confidence intervals of these values across the imputed datasets are reported. This allowed us to consider whether the composite measure provides an equivalent or better fit to the data, compared to all predictors included simultaneously, and in relation to each individual predictor.

How does the relationship between SEC measures and vocabulary change over developmental time? (Vocabulary at ages 3, 5, 11 and 14)

Here we addressed whether or not one's position in the language distribution changes at each age, and how much of this is a function of SEC. The models from RQ1 are used to answer this question. Due to the different measures of language ability available at each age, we were unable to model longitudinal changes in language development. However, because the outcome variable of language ability at each age is standardised to the same scale, the coefficients are directly comparable. We also compared the standardised coefficients from the models in RQ2, which consider our composite factor of SEC, allowing us to establish the best predictor across developmental time.

How has the relationship between SEC measures and vocabulary changed with historical time? (Comparison of two nationally representative cohorts, born 30 years apart)

We had 3 separate outcome variables in each cohort (early childhood language ability, late childhood language ability and adolescent language ability). We built three regression models per outcome, one with occupational status as the predictor variable, one with parent education as the predictor variable, and finally with family income as the predictor variable. Because our measures of language ability were standardised within each cohort, we were able to directly compare coefficients between cohorts and establish the rate of inequality in language ability at each age in the two cohorts.

Results

Which SEC measures predict child vocabulary?

As can be seen in Table 2, for every SEC measure, the mean vocabulary score is greater with each increase in SEC group, with the highest mean vocabulary scores in the highest SEC group.

Table 2: Means (±SD) and 95% CIs for language scores in each SEC group at each age (MCS2001 cohort)

	Proportion (%) or Mean(±SD) [95% CIs]			
SEC Indicator	*Age 3 Vocabulary*	*Age 5 Vocabulary*	*Age 11 Vocabulary*	*Age 14 Vocabulary*[1]
Parent Education				
Parent education (NVQ1)	45.24(10.28) [44.61;45.87]	49.78(10.51) [49.14;50.43]	54.97(10.14) [54.35;55.6]	6.12(2.38) [5.97;6.27]
Parent education (NVQ2)	47.91(10.63) [47.59;48.23]	52.79(10.29) [52.48;53.1]	56.83(9.9) [56.53;57.12]	6.53(2.35) [6.46;6.6]
Parent education (NVQ3)	49.62(10.64) [49.23;50.01]	54.24(10.14) [53.86;54.61]	58.36(9.35) [58.01;58.7]	6.81(2.43) [6.72;6.9]
Parent education (NVQ4)	52.35(10.74) [52.07;52.63]	57.54(10.18) [57.28;57.81]	60.76(8.97) [60.53;60.99]	7.57(2.65) [7.5;7.64]
Parent education (NVQ5)	53.47(11.47) [52.82;54.11]	59.56(10.48) [58.97;60.14]	63.26(8.66) [62.77;63.74]	8.53(2.9) [8.37;8.69]
Parent education (none of these/overseas)	41.3(11.55) [40.79;41.8]	46.4(11.66) [45.9;46.91]	54.11(10.9) [53.64;54.58]	5.96(2.27) [5.86;6.06]
Income				
Income (Quintile 1)	44.26(11.49) [43.9;44.62]	49.45(11.3) [49.1;49.8]	55.7(10.62) [55.37;56.03]	6.28(2.35) [6.2;6.35]
Income (Quintile 2)	47.31(11.09) [46.99;47.64]	52.19(10.71) [51.88;52.5]	57.05(9.83) [56.76;57.33]	6.67(2.46) [6.6;6.75]
Income (Quintile 3)	51.18(10.65) [50.83;51.54]	55.97(10.18) [55.63;56.31]	59.05(9.35) [58.74;59.36]	7.08(2.54) [7;7.17]

Income (Quintile 4)	52.58(10.38) [52.22;52.94]	57.44(10.06) [57.1;57.79]	60.37(9.21) [60.05;60.69]	7.51(2.69) [7.42;7.61]
Income (Quintile 5)	53.65(10.32) [53.19;54.12]	59.48(9.78) [59.04;59.92]	62.64(8.46) [62.26;63.02]	7.99(2.79) [7.86;8.12]
Wealth				
Wealth (Quintile 1)	46.5(11.05) [46.19;46.82]	51.55(10.68) [51.25;51.86]	56.09(10.18) [55.8;56.38]	6.52(2.44) [6.45;6.59]
Wealth (Quintile 2)	46.71(11.29) [46.23;47.19]	51.49(11.11) [51.02;51.96]	56.56(10.15) [56.13;56.99]	6.48(2.4) [6.38;6.58]
Wealth (Quintile 3)	49.63(11.2) [49.26;50.01]	54.31(10.76) [53.95;54.67]	58.64(9.51) [58.32;58.96]	6.93(2.5) [6.85;7.02]
Wealth (Quintile 4)	50.75(11.18) [50.37;51.12]	55.68(10.75) [55.32;56.04]	59.59(9.58) [59.27;59.91]	7.16(2.57) [7.08;7.25]
Wealth (Quintile 5)	52.54(10.99) [52.17;52.91]	58.09(10.59) [57.74;58.45]	61.49(8.96) [61.19;61.79]	7.78(2.8) [7.69;7.88]
Occupational Status				
Occupational Status (Unemployed)	44.18(11.07) [43.82;44.54]	48.91(10.9) [48.56;49.27]	55.03(10.61) [54.69;55.38]	6.21(2.4) [6.13;6.29]
Occupational Status (Routine)	47.33(11.09) [46.99;47.67]	52.21(10.7) [51.88;52.54]	56.82(9.92) [56.52;57.13]	6.57(2.38) [6.5;6.65]
Occupational Status (Intermediate)	50.12(10.97) [49.74;50.5]	54.67(10.63) [54.3;55.04]	58.7(9.42) [58.38;59.03]	6.88(2.46) [6.8;6.97]
Occupational Status (higher managerial)	52.75(10.64) [52.48;53.01]	58.28(9.96) [58.03;58.53]	61.28(8.87) [61.06;61.5]	7.74(2.71) [7.67;7.8]
Relative Neighbourhood Deprivation				
Relative neighbourhood deprivation (most deprived)	43.7(11.64) [43.28;44.13]	48.69(11.2) [48.27;49.1]	54.91(10.6) [54.52;55.3]	6.27(2.39) [6.18;6.36]
Relative neighbourhood deprivation (10 - < 20%)	45.77(11.82) [45.3;46.25]	50.54(10.97) [50.09;50.98]	57.07(10.08) [56.67;57.48]	6.59(2.43) [6.49;6.69]

Relative neighbourhood deprivation (20 - < 30%)	48.01(11.1) [47.53;48.5]	53.13(10.6) [52.66;53.59]	57.64(9.94) [57.2;58.07]	6.74(2.54) [6.63;6.85]
Relative neighbourhood deprivation (30 - < 40%)	49.07(11.21) [48.54;49.61]	53.77(10.53) [53.27;54.27]	58.38(10.08) [57.9;58.86]	6.88(2.58) [6.76;7]
Relative neighbourhood deprivation (40 - < 50%)	49.56(10.97) [49;50.12]	54.49(10.89) [53.94;55.04]	58.38(9.12) [57.92;58.84]	6.95(2.53) [6.82;7.08]
Relative neighbourhood deprivation (50 - < 60%)	50.5(10.92) [49.93;51.06]	55.55(10.47) [55.01;56.1]	58.89(9.92) [58.37;59.4]	7.04(2.54) [6.91;7.17]
Relative neighbourhood deprivation (60 - < 70%)	51.48(10.58) [50.88;52.08]	56.35(10.37) [55.76;56.94]	60.16(9.96) [59.59;60.72]	7.25(2.7) [7.09;7.4]
Relative neighbourhood deprivation (70 - < 80%)	52.14(10.49) [51.56;52.72]	57.49(10.57) [56.91;58.08]	60.15(9.03) [59.65;60.65]	7.5(2.67) [7.35;7.65]
Relative neighbourhood deprivation (80 - < 90%)	52.19(10.33) [51.64;52.73]	57.55(10.2) [57.01;58.09]	60.16(9.08) [59.68;60.64]	7.48(2.57) [7.34;7.61]
Relative neighbourhood deprivation (least deprived)	53.61(9.94) [53.09;54.13]	58.93(9.55) [58.43;59.43]	61.45(8.68) [61;61.9]	7.75(2.79) [7.6;7.89]

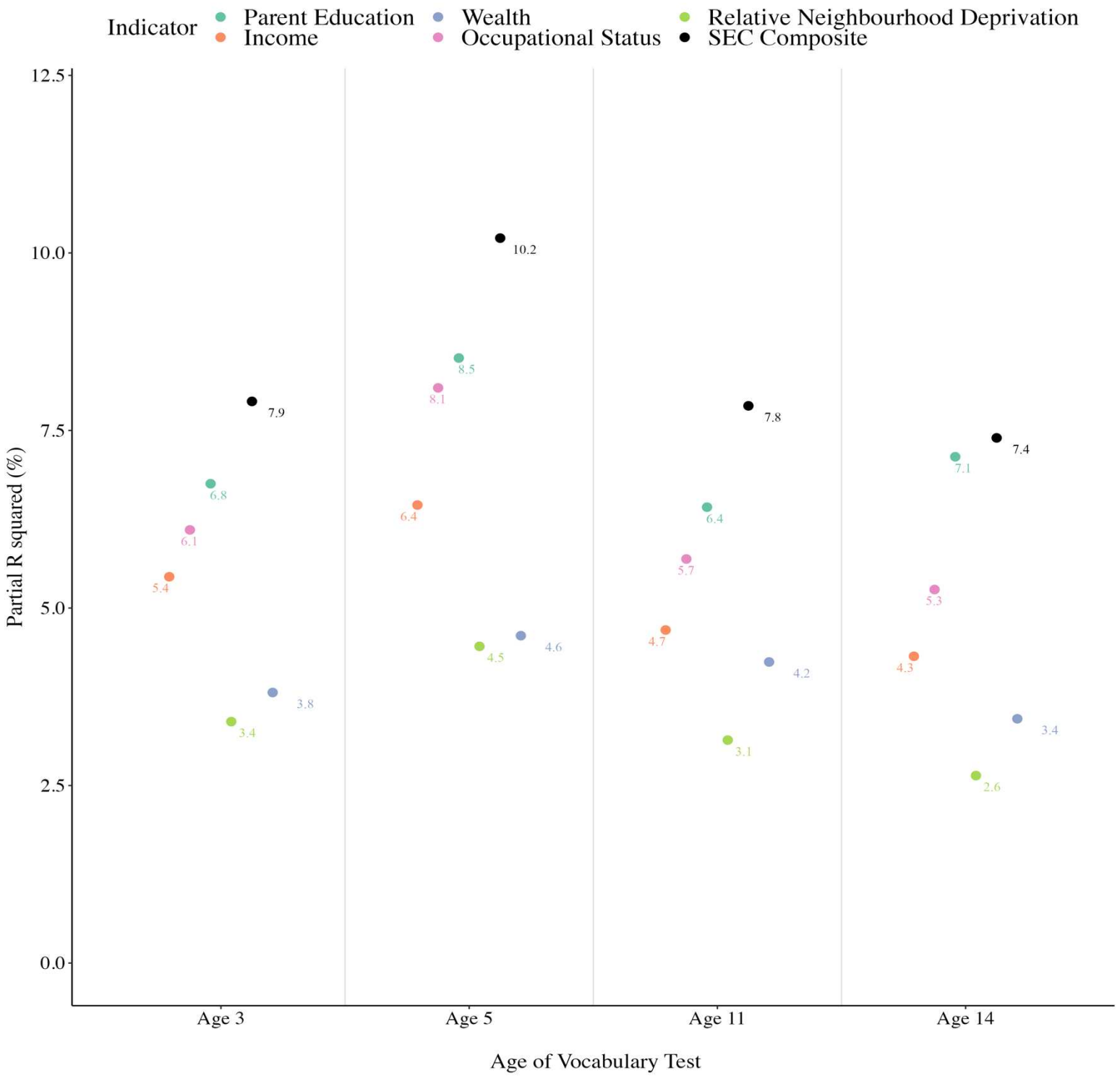
[1]Note: different standardised vocabulary tests were used at different ages, hence the lower mean score at 14 years.

To assess the unique contribution of each predictor at each age, a model with all five SEC predictors was compared to models with each predictor removed in turn. Improvements in fit were assessed using model comparisons for imputed data, using the method of Meng and Rubin (Meng, 1992). This drop-one analysis revealed that caregiver education, income, wealth, and occupational status accounted for significant unique variance in vocabulary at all

ages (see supplementary file section 4). Neighbourhood statistics accounted for significant variance in vocabulary at ages 3, 5 and 11.

Figure 1 presents partial R^2 values indicating the proportion of variance explained by each SEC predictor, above that of potential confounding variables (sex, ethnicity, and whether English is spoken as an Additional Language (EAL) in the home). Caregiver education explains the largest proportion of variance in vocabulary at each age (between 6.4% and 8.5% of variance), closely followed by income and occupational status, and at ages 11 and 14, wealth. Relative neighbourhood deprivation consistently contributes the least variance in vocabulary scores, regardless of age.

Figure 1: Variance explained by SEC Indicators in Predicting Vocabulary in MCS2001 Cohort



Partial R^2 values for separate models predicting vocabulary at ages 3, 5, 11 and 14, for 5 separate SEC indicators and a composite SEC indicator. Models adjusted for potential confounding variables of sex, ethnicity and English as an additional language (EAL).

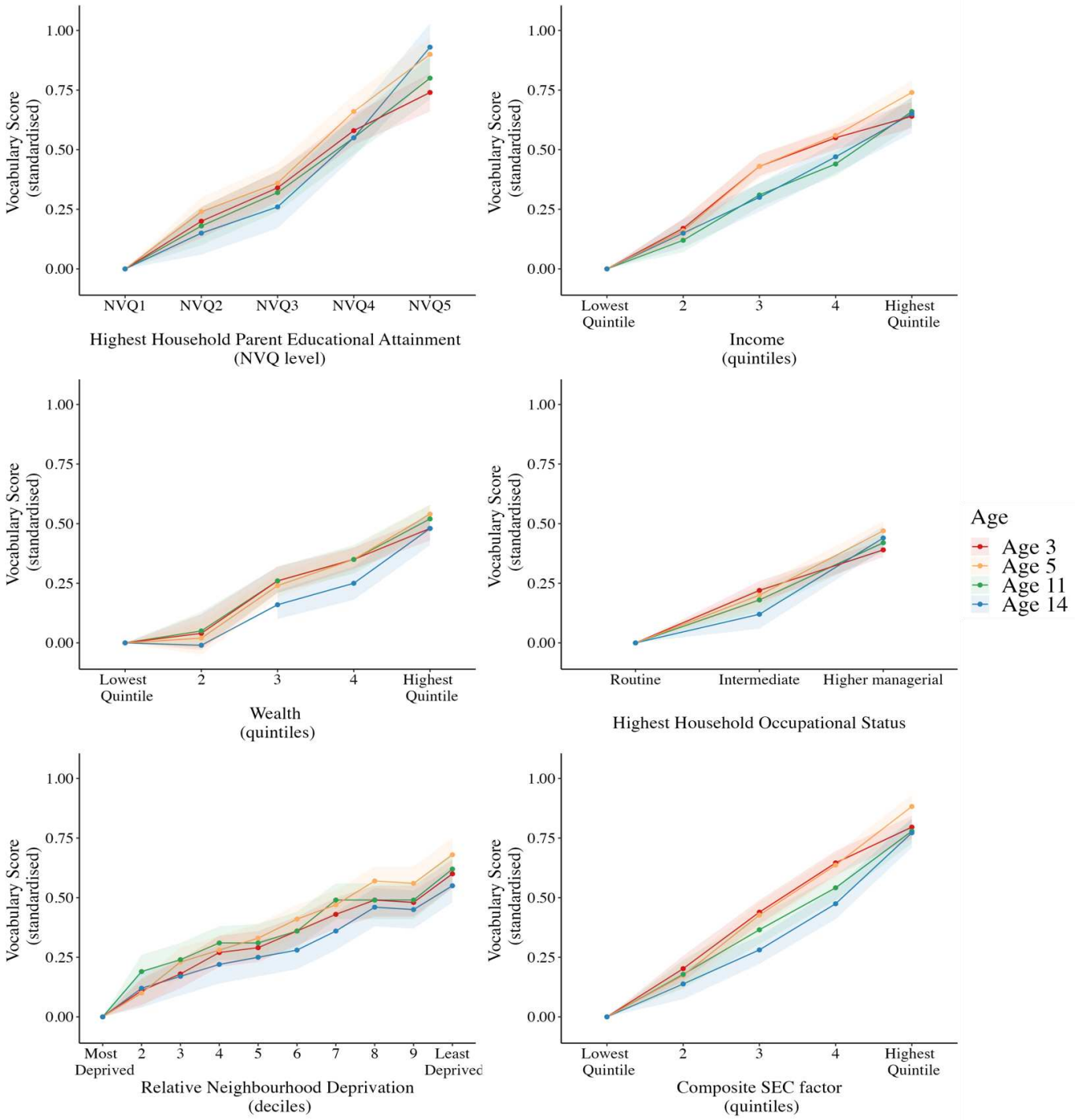
Reducing individual indicators to a single composite factor may afford us an efficient way of communicating and understanding inequalities in vocabulary but we do not yet know whether such composites explain more variance than certain SEC indicators considered alone and/or are equivalent to models with each predictor considered separately. Confirmatory factor analysis was therefore used to create a composite variable of SEC (see supplementary methods), which was then included as the predictor in an adjusted model predicting language at ages 3, 5, 11 and 14. Regardless of age, compared to each individual measure, the composite factor was a better fit to the data at all ages (see table S4 in supplementary file section 5) and explained 7.4-10.2% of variance in language across ages. However, a model with each SEC measure included simultaneously explained more variance than a model with just the composite measure and control variables (see table S5 in supplementary file section 5). This indicates that if one needs to identify a single variable for use in analyses, then a composite variable would be a better choice than any of the original individual predictors. In the absence of such a constraint, including a set of multiple predictors would be preferable.

Does the relationship between SEC and child vocabulary change over developmental time from age 3 to 14 years?

Figure 2 shows the relationships between each SEC indicator and vocabulary at each age (coefficients and 95% CIs plotted; see also Table S6, supplementary file section 6). Because vocabulary scores were converted to *z* scores, the coefficients indicate the change in vocabulary in units of standard deviation (SD) associated with different levels of each predictor. A steeper slope indicates greater inequalities. Inequalities in vocabulary size are consistently narrowest at age 3 and widen by age 5. They then persist throughout childhood and into adolescence, regardless of the SEC indicator used. The relation between SEC and age 14 vocabulary displays a discontinuity not seen for the other ages, with the line appearing

shallow for the lower SEC groups and steeper between the higher SEC groups. It is nonetheless clear that across childhood, inequalities in vocabulary have not substantially changed in this cohort; gaps in vocabulary size have not narrowed over time.

Figure 2: Associations between SEC indicators and vocabulary at ages 3, 5, 11 and 14 in the MCS2001 cohort



β coefficients and 95% confidence intervals for vocabulary at ages 3, 5, 11 and 14, plotted as a function of each SEC indicator. Coefficients adjusted for potential confounding variables of sex, ethnicity, and English as an additional language (EAL).

Given that the SEC measures used in the above analyses were collected when cohort members were aged 3, it is plausible that this pattern of results is due to the proximity of the SEC measures to the developmental stage at which vocabulary was measured. Therefore, we conducted a sensitivity analysis with age 14 SEC indicators predicting age 14 vocabulary. Overall, despite some inequalities appearing to be wider based on age 14 SEC measures, the proximity of the SEC measure to age 14 vocabulary does not affect the main pattern of results (see supplementary file section 7).

Does the relationship between SEC and child vocabulary change with historical time?

The caregivers of children in the MCS2001 cohort are noticeably different to those of the BCS1970 cohort when compared on the basis of the SEC measures available for both cohorts. More parents of the BCS1970 cohort held no or low-level qualifications compared to parents of the MCS2001 cohort (which is to be expected given changes in the age of compulsory schooling). Furthermore, proportionally more parents from the BCS1970 cohort were in intermediate occupations, whereas more parents from the MCS2001 cohort were in either routine or higher managerial occupations (which is expected given that the UK is becoming more of an hourglass economy; see Table 3; Holmes & Mayhew, 2012). For all SEC measures, the mean vocabulary score was greater with each increase in SEC group in both cohorts, with a higher mean score in the highest SEC groups (see table S9, supplementary file section 8).

Table 3: Descriptive Statistics in MCS2001 and BCS1970 for the cross-cohort comparison

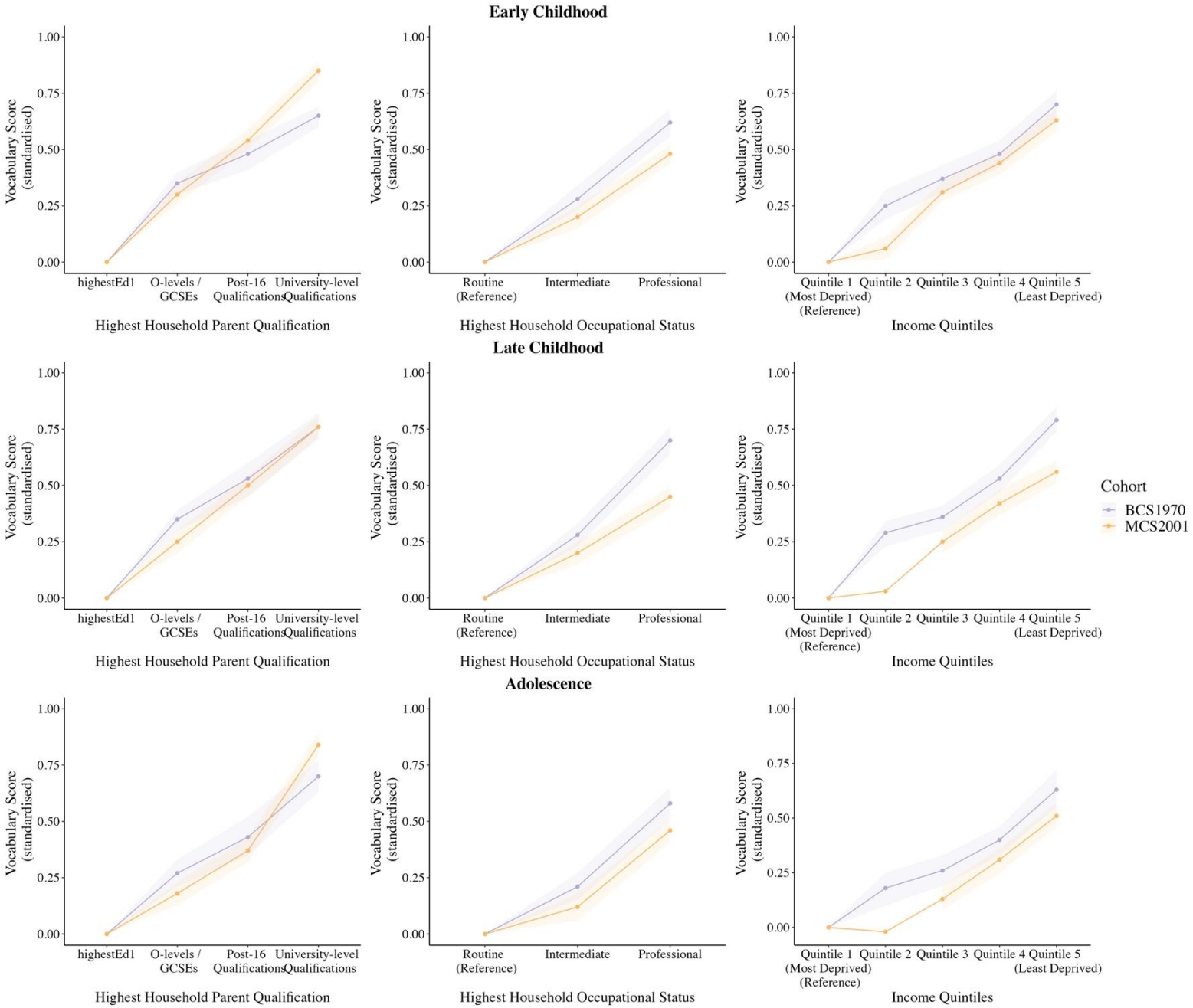
Variable	*Proportion (%) or Mean(±SD) [95% CIs]*	
	BCS1970 (N = 14,851)	*MCS2001 (N = 16,020)*
Demographics		
Sex (Male)	50.55	51.33
Sex (Female)	49.45	48.67
Ethnicity (White)	93.52	86.03
Ethnicity (Minority)	6.48	13.97
Language Status (English only)	94.97	88.64
Language Status (English as Additional Language)	5.03	11.36
Socioeconomic Circumstances		
Parent Education (no/low level)	54.49	21.14
Parent Education (O-levels/GCSEs grades A*-C)	20.23	32.1
Parent Education (ost-16 quals)	7.66	21.85
Parent Education (university level quals)	17.62	24.92
Income Quintile 1	21.31	19.67
Income Quintile 2	19.81	19.58
Income Quintile 3	20.84	20.44
Income Quintile 4	20.68	20.07
Income Quintile 5	17.36	20.24
Occupational Status (routine)	14.32	22.47

Occupational Status (intermediate)	50.88	18.98
Occupational Status (higher managerial)	33.63	38.76
Occupational Status (unemployed)	1.16	19.78

Descriptive statistics combined across 25 imputed datasets. Descriptive statistics are sample and attrition weighted (MCS2001 cohort) and attrition weighted (BCS1970 cohort)

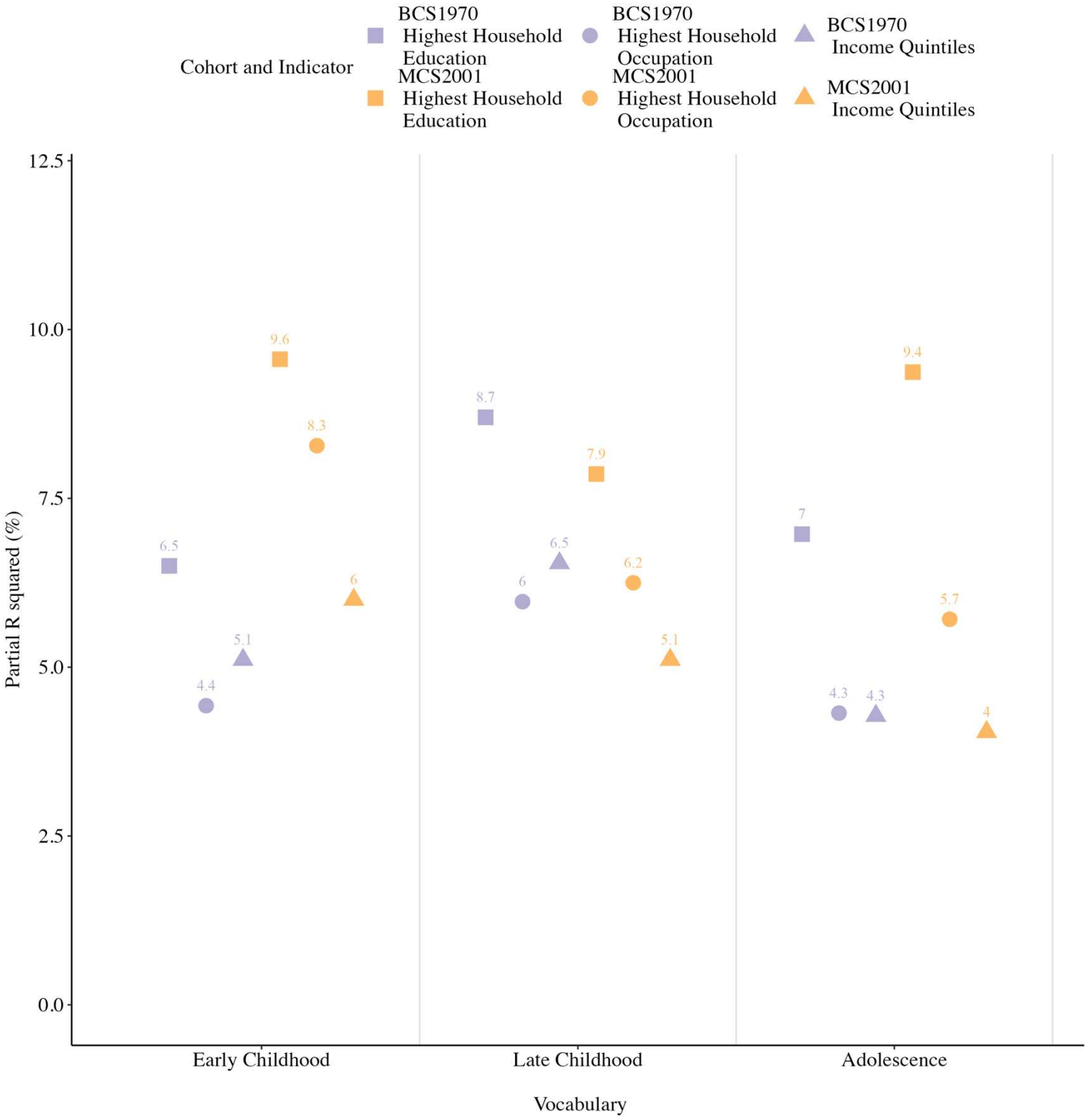
As can be seen in Figure 3, vocabulary scores generally increased with SEC regardless of indicator and cohort (also see table S10, supplementary file section 8). The overall picture is thus one of continuity of social inequality across the generations. Nonetheless, compared to their BCS1970 counterparts, MCS2001 cohort members whose parents had university level qualifications were at a clearer advantage in terms of their language ability in early childhood and adolescence. In contrast, inequalities in vocabulary based on occupational status and income are wider for the BCS1970 cohort at all ages, as indicated by the steeper slopes for this cohort. As can be seen from partial R^2 values (Figure 4), inequalities are substantial in both cohorts. There is no evidence of a decrease in SEC inequalities over the 30-year period and there is even some evidence that inequalities may have widened in early childhood, with SEC indicators explaining more variance in the MCS2001 cohort for this age point. Whereas for the BCS1970 cohort SEC indicators explained most variance in late childhood, for the contemporary MCS2001 cohort, SEC indicators explained most variance in early childhood.

Figure 3: Associations between SEC and language ability in the MCS2001 and BCS1970 cohorts in early childhood, late childhood, and adolescence



Vocabulary in early childhood (top), late childhood (middle) and adolescence (bottom), plotted as a function of highest household parent education (left), highest household occupational status (middle), and income (right) in two cohorts. Data are β coefficients and 95% confidence intervals. Coefficients adjusted for potential confounding variables (sex, ethnicity, English as an additional language and age at time of vocabulary test).

Figure 4: Variance in language explained by SEC indicators in the MCS2001 and BCS1970 cohorts



Partial R^2 values (having adjusted for potential confounders of sex, ethnicity, English as additional language and age at time of vocabulary test) for highest household education and highest household occupational status predicting vocabulary in early childhood, late childhood, and adolescence.

To examine whether our findings were robust to changes in the distribution of education and occupation measures or to the ethnic composition of the UK during the period separating the BCS1970 and MCS2001 cohorts, we conducted two sensitivity checks. First, highest household occupational status and highest household educational attainment were converted to Ridit scores to aid comparability across cohorts (see supplementary file, section 9; Donaldson, 1998). Second, we restricted our analyses to those of a White ethnicity only (see supplementary file, section 10). Neither analysis resulted in a change in the pattern of results observed.

Discussion

Using two UK national birth cohorts, we analysed the relation between multiple SEC indicators and vocabulary across childhood and across generations and found that (i) all SEC measures predict unique variance at most timepoints and there is generally a monotonic step up in child language for each step up on any given SEC measure. Parent education has the greatest predictive value (closely followed by income, wealth, and occupation) and neighbourhood deprivation the least; (ii) inequalities persist from ages 3 to 14 years, with SEC indicators explaining most variance in vocabulary scores at 5 years and an accelerated increase in vocabulary at the higher ends of the socio-economic scale at 14 years; and (iii) across three decades, observed inequalities have generally been stable, but the advantage associated with having parents with higher levels of education has increased.

Overall, the SEC predictor that explains the most variance in child vocabulary across development is caregiver education. However, income, wealth, and occupational status also uniquely predicted large amounts of variance. For all of these indicators, a step up from each level to the next was associated with a substantial step up in vocabulary. This pattern of monotonic increase occurred for all SEC indicators. Thus while most research exploring differences in child language and in the quality and quantity in child directed speech tends to

compare higher and lower SEC groups(Fernald, Marchman, & Weisleder, 2013; Hart & Risley, 1995a; Hirsh-Pasek, 2015; McGillion, Pine, Herbert, & Matthews, 2017; Rowe, 2012; Schwab & Lew-williams, 2016), our findings suggest differences exist across the range of the SEC measures, rather than just between those at the top and bottom of the distribution. Each of these SEC indicators deserve particular attention in the effort to unpick *why* SEC is related to child vocabulary so as to be able to find mechanisms for effective interventions. Caregiver education has been argued to be the most relevant SEC marker for child development (Hoff, 2013, 2012) because it is associated with caregiver-child interactions and parent knowledge about development (Rowe, 2012, 2018). Parent vocabulary mediates the relation between parent education and child vocabulary ability (Sullivan, 2021), as well as mediating the relationship between the home learning environment and vocabulary. Parents with strong language skills are more likely to participate in reading with their child and may also be more successful in engaging their children in such activities, compared to parents with poor language skills (Sullivan, 2013). The role of genetics should also be considered here, as language ability is observed to be partly heritable (Chow & Wong, 2021). Prising apart the relative influence of heredity and culture is challenging, given the interplay between the two (Scarr & Mccartney, 1983): caregivers and infants with different genetic profiles shape learning environments differently to one another. Unravelling this will require rich data sets that include information regarding interaction dynamics.

While income explained about 6% of variance in children's vocabulary, family wealth explained less (about 3-4%), particularly early in childhood. Income is often assumed to affect vocabulary outcomes through the provision of learning resources (Duncan, 2017; Washbrook, 2011). Wealth is usually operationalized as total assets net of outstanding total debt (Killewald, 2017) and while one might assume this would act in a similar way to income, it may only become a predictor of outcomes in late adolescence-early adulthood,

through access to quality secondary education in expensive neighbourhoods (Department for Education, 2017a; Machin, 2011) or financial assistance with higher education (Moulton, Goodman, Nasim, Ploubidis, & Gambaro, 2021; Pfeffer, 2018). Whereas in the UK, most wealth is concentrated in housing (with financial wealth only prominent at the top of the distribution), in the US, financial wealth is more common (Cowell, Karagiannaki, & McKnight, 2019; Office for National Statistics, 2019). International comparisons of the relative predictive value of different SEC indicators, alongside qualitative studies, have the potential to shed light on the mechanisms via which these SEC indicators are likely affecting language acquisition and inequalities.

In the contemporary British cohort, inequalities in language ability widen between the ages of 3 and 5. This supports arguments for testing early interventions that seek to avoid inequalities becoming entrenched before children access formal schooling. There is also a clear advantage among 14-year-olds of having parents with a higher level of education. By this age, some adolescents may have vocabulary abilities exceeding those of their parents. Exposure to language occurs in increasingly diverse settings throughout the school years, including via interactions with peers, teachers, and written sources such as books and the internet (Sullivan, 2021). As children progress through school, vocabulary development (at least as measured by standardised tests) becomes more dependent on exposure to new words through reading, than oral language (Elleman, Oslund, Griffin, & Myers, 2019). It is plausible that these sources of input are influenced by SEC. For example, the availability of books and vocabulary-rich online content may be higher among higher SEC children. Children from disadvantaged backgrounds may require more support to acquire particular seams of vocabulary (Sullivan, 2021) and yet the type of school attended and the level of support available may differ based on SEC. For example, higher SEC children are more likely to attend private or higher quality schools than their lower SEC counterparts (Dearden,

Ryan, & Sibieta, 2011) and parents of children at high performing schools are more likely to invest in educational materials and support, such as books and private tuition (Attanasio, Boneva, & Rauh, 2018). There are also SEC disparities in the amount of homework support adolescents receive at home, not only through tuition but also in terms of additional hours spent on school work (Jerrim, 2017). While universal education aims to address inequalities in educational opportunity in the UK, when it comes to vocabulary, disparities clearly persist throughout formal schooling. Further support across the lifespan and particularly in the early years and during adolescence is likely necessary to improve educational outcomes and open up employment opportunities (Deloitte, 2016).

Finally, cross-cohort comparisons suggest that inequalities in childhood language are generally similar across generations, despite decades of policy to reduce these inequalities. Nonetheless, there were some differences between the two cohorts: occupational status is becoming less valuable as a predictor, while parental university level qualifications are more clearly associated with better early child and adolescent language in contemporary society. Family income appears to be a slightly stronger predictor of early childhood language in the MCS2001 cohort, but a stronger predictor of late childhood and adolescent language in the BCS1970 cohort. It is possible that these measures are changing in the extent to which they are reliable indicators of the proximal causal factors that explain language learning (such as the caregiving / cultural environment and genetic factors). For example, the move to a more hour-glass shaped economy might mean that occupational status no longer differentiates households' social milieu as well as it once did. Likewise, while many once left the educational system even when they had the academic potential to go on, now with more opportunity to stay in education longer, this measure might better differentiate families along the lines of cognitive ability and educational aspiration. Finally, in the US, financial investments in children increased at the top of the income distribution with the rise of income

inequality, between 1970 and 2000 (Kornrich & Furstenberg, 2013); it is possible that corresponding increases in parental investments in children have also occurred in the UK, perhaps increasing the importance of income as a predictor of early childhood vocabulary in the MCS2001 cohort compared to the BCS1970 cohort. Alternatively, it might be that the relative importance of the various proximal causal mechanisms themselves is changing with time.

Limitations and strengths.

While vocabulary is the most commonly used measure of language ability in research, especially with regards to inequalities, and is highly correlated with other aspects of language ability (Fenson et al., 1994), it should be recognised that the vocabulary measures used at each age were necessarily different, meaning we could not assess within-child change in vocabulary scores throughout childhood. However, our focus was on the extent of inequalities at each age and by using a standardised score, we were able to make comparisons that reflect population distributions in these language outcomes. Despite extensive efforts to harmonise our variables, historical changes particularly regarding occupational status and parent education make it difficult to definitively compare results across the two cohorts, and such differences should be kept in mind when interpreting results. Nonetheless, when we conducted a sensitivity analysis using Ridit scores as a means of standardising SEC indicators, this revealed a similar pattern of results. Finally, as with any longitudinal analysis, missing data had to be accounted for. Less advantaged individuals tend to be underrepresented in subsequent sweeps of cohort studies (Elliott & Shepherd, 2006; Mostafa & Wiggins, 2014). Further, a teachers strike in 1986 resulted in large amounts of missing data for the adolescent vocabulary measure in the BCS1970 (63.92%). To address this, our analyses were attrition weighted and we used multiple imputations with a rich set of auxiliary indicators to account for missing data, which is considered to be the best approach for

appropriately dealing with such missingness Little & Rubin, 2002). Despite these limitations, the strengths of this research lie in the use of large, nationally representative birth cohort studies with rich information on childhood SEC and researcher-collected, gold standard language measures throughout childhood. Although findings are generalisable to the United Kingdom and hold relatively stable across generations, they may not be generalisable beyond the UK.

Finally, it is important to note that we used measures from standardised tests of vocabulary as a proxy for language ability generally. However, it has long been argued that children from lower SEC backgrounds may have unique verbal strengths and capabilities, for example in terms of their discourse skills, compared to middle class children, which are not captured by standardised tests(Heath, 1983; Hoff, 2013; Rogoff et al., 2017). Nonetheless, the vocabulary measures reported reflect skills that (rightly or wrongly) are likely important for accessing education.

Implications.

The current findings have several important implications. First parent education level, income and occupational status all explain substantial unique variance in child language. This suggests it is well worth testing the causal effects of supporting caregiver education (through lifelong learning) and/or caregiver understanding, motivation, and confidence in supporting child language development (through parenting support). Equally, it is worth testing the effect of reducing poverty – defined as low income relative to a norm (see the Baby's First Years project in the US for a move in this direction (Baby's First Years, 2018). Despite efforts to reduce poverty in the UK, it is ever-present: 22% of the UK population and 30% of children were living in relative poverty (after housing costs) in 2018-19 (Francis-Devine, 2020). Beyond political choices regarding wealth redistribution, educational attainment is claimed to be the key factor causing poor children to become poor adults (DWP, 2014). Since

language is the foundation for reading ability and success in education (Public Health England, 2020), and our cross-cohort comparison revealed inequalities in vocabulary are persistently wide across time, targeting these sustained inequalities is assumed to be important in reducing the intergenerational transmission of poverty (Joseph Rowntree Foundation, 2016).

Second, since inequalities in vocabulary widen markedly between the ages of 3 and 5, it remains important to target this age group. A two-pronged approach is likely necessary whereby family support is provided at the same time as increasing the quality of provision in early years settings (Department for Education, 2017b; Gambaro, Stewart, & Waldfogel, 2015). Regarding the first prong, we need to test ways of creating sustained support for families that leads to lasting cognitive benefits (e.g. testing the BBC's UK-wide Tiny Happy People programme; Tiny Happy People, 2021). For the second prong, we need to test ways of improving the consistency and quality of pre-school education to help inequalities becoming entrenched before entry to formal schooling. Quality pre-school provision benefits language development (Becker, 2011; Schmerse, 2020) and is an important factor in supporting later educational attainment, particularly for disadvantaged SEC children (Department for Education, 2015). The introduction in the UK of the National Childcare Strategy in 1998 has made early years education a focus of policy making, particularly with respect to the availability, affordability and quality of education (Department for Education, 2017c). However, quality is inconsistent across different early years settings (Gambaro, 2015) such that it is now included in the Ofsted Education Inspection Framework (Ofsted, 2019). One cause for optimism on this front is that a recent large-scale evaluation has found that the Nuffield Early Language Intervention (NELI) is effective in promoting language skills of children entering formal education in England (West et al., 2021).

Third, inequalities in vocabulary remain wide throughout childhood and the relative advantage of having parents with higher levels of education accelerates in adolescence as children near the point of being able to leave the education system. However, most language assessments and interventions do not go beyond the early years (Bercow, 2018). Since language skill is important for accessing many employment opportunities, not to mention taking part in wider activities, seeking out effective ways to support adolescent language development is important (Bercow, 2018; Spencer, 2012).

Fourth, the fact that inequalities generally persist over historical time might be taken to support proposals that interventions to lift the language skills of more disadvantaged children need to be ambitious and scaled up considerably (Greenwood, Schnitz, Carta, Wallisch, & Irvin, 2020; List, Pernaudet, & Suskind, 2021; Wake et al., 2012). A recent evaluation of a prominent UK intervention, Sure Start, suggests it benefitted child physical health (for example, reduced hospitalisations) and did so most for those living in disadvantaged areas (Cattan, Conti, Ginja, & Farquharson, 2019). However, the benefits for cognitive outcomes are currently less clear (Melhuish, Belsky, & Leyland, 2010), perhaps because of a struggle to reach populations who would have derived the maximum benefit (Law, Parkin, & Lewis, 2012). The current analyses suggest that to have a chance of making a difference we would need to test a multi-pronged approach implemented at a meaningful scale and for the long term so as to reap sustained benefits and see the next generation of children reach their potential.

Conclusion

To sum up, the substantial individual differences we observe in child and adolescent language are explained by several SEC indicators each making their own unique contribution, most notably caregiver education, income and occupational status. Inequalities are generally stable over developmental and historical time, and are monotonic, with each step up in SEC

predicting a step up in language. The current evidence suggests a need to focus on the widening of inequalities as children enter compulsory education and as they prepare to leave it. This supports calls to test the effects of reduced poverty, increased caregiver lifelong learning, improved early parenting support, improved quality of preschool education and sustained educational support through adolescence. Tests would need to provide evidence of both causal efficacy and acceptability to those they are intended to help. To succeed on both these fronts, the current evidence suggests we need to be ambitious.

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Data, code and materials availability statement

Data: The data used in this paper are held by the UK data service (UKDS; https://ukdataservice.ac.uk). Users of these datasets must agree to an End User License before accessing the data. The datasets can be accessed by creating an account, setting up a project, adding the relevant datasets to the project and agreeing to the End User License for each dataset to be downloaded. Because of restrictions put in place by the UKDS, we are unable to provide a direct link to the data. However, we have provided a note on the datasets used in the GitHub repository for this project (https://github.com/emmathornton/inequalities-vocabulary), which details each dataset required.

Code: All code for this paper can be found on GitHub: https://github.com/emmathornton/inequalities-vocabulary

Ethics statement

Analyses in this paper consist entirely of secondary data analysis of previously collected publicly-available data, therefore no ethical approval was sought.

Authorship and Contributorship Statement

All authors approved the final version of the manuscript.

Conceptualization: ET, DM, PP, CB
Methodology: ET, DM, PP, CB
Data Wrangling: ET
Formal analysis: ET, CB
Visualization: ET
Supervision: DM, PP, CB
Writing—original draft: ET
Writing—review & editing: ET, DM, PP, CB
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