Socioeconomic disadvantage is associated with prevalence of developmental language disorders, but not rate of language or literacy growth in children from 4 to 11 years: evidence from the Surrey Communication and Language in Education Study (SCALES)

Courtenay Frazier Norbury, DPhil^{1,2}, Sarah Griffiths, PhD¹, George Vamvakas, MSc³, Gillian Baird, OBE, FRCPCH⁴, Tony Charman, PhD⁵, Emily Simonoff, MD³, and Andrew Pickles, PhD³

Affiliations:

1 Psychology and Language Sciences, University College London, UK

2 Department of Special Needs Education, University of Oslo, Oslo, Norway

3 Biostatistics, King's College London, London, UK

4 Newcomen Centre, Guys & St Thomas NHS Trust, London, UK

5 Department of Psychology, Psychiatry and Neuroscience, King's College London, London, UK

Abstract (word count 300)

Objectives. The purpose of this study was to determine the changing prevalence of developmental language disorders at different quintiles of the Income Deprivation Affecting Children Index (IDACI), a measure of neighbourhood deprivation. In addition, this study investigated the long term association of IDACI rank with growth in language and literacy skills for children with and without language disorder over a six year period.

Design. Prospective, population-based, longitudinal cohort study.

Setting. State-maintained primary schools in Surrey, England.

Participants and procedure. Teachers rated the language skills of 7267 children starting a state-maintained school in 2011 (aged 4;9-5;10, 59% of all eligible children). Comprehensive language and literacy assessment was conducted with a monolingual sub-sample in Year 1 (n = 529, age 5-6), Year 3 (n = 499, age 7-8), and Year 6 (n = 384, age 10-11).

Analytic methods. Logistic regression determined the association of IDACI scores and teacher-rated language proficiency. Structural Equation Models using auxiliary variables estimated the association of IDACI and prevalence of developmental Language Disorder (LD) in Year 1, and IDACI and language and literacy growth from Years 1 – 6.

Results. Predicted probability of language disorder was 2.5 times greater at the 10th centile of IDACI rank (.19 [.11, .27]) versus the 90th centile (.07 [.04, .09]). IDACI rank did not associate with growth in raw scores on measures of vocabulary, grammar, or word reading. Socioeconomic gaps in vocabulary and grammar were ameliorated when language status at school entry was accounted for, but persisted for word reading.

Conclusions. The association of neighbourhood disadvantage with language and literacy primarily reflects higher rates of language disorder in areas of socio-economic deprivation. Interventions that alleviate deprivation and enhance the language and literacy experiences of disadvantaged children

could reduce socioeconomic attainment gaps. However, the persistence of language disorder suggests on-going support is required to attenuate personal and societal cost.

Funding statement. This work was funded by grants from the Economic and Social Research Council: ES/R003041/1 (Norbury); NIHR KCL/South London and Maudsley NHS Foundation Trust Biomedical Research Centre and Senior Investigator Awards NF-SI-0617-10120 (Pickles) and NIHR200242 (Simonoff) and the Wellcome Trust: WT094836AIA (Norbury). For the purpose of Open Access, the authors have applied a CC BY public copyright licence to any Author Accepted Manuscript version arising from this submission.

Competing interests statement: The authors have no competing interests to declare.

Data sharing statement: The anonymised dataset is available from [<https://osf.io/hdcfu/>]. The dataset does not contain data for 12 participants for whom parents refused consent for data sharing. IDACI rank scores are reported in quintile bands to preserve anonymity.

Strengths and limitations of this study

- Strengths of this prospective longitudinal study are the large sample size and the detailed assessment and characterisation of language disorder that is consistent with current international standards in diagnosis
- The auxiliary variable approach implemented here provides more efficient and precise estimation of baseline language status and language growth in the population relative to traditional survey methods employing inverse-probability weights.
- IDACI rank is routinely collected by UK government departments, thus increasing potential for shaping and evaluating the impact of policy changes aimed at reducing socioeconomic-related attainment gaps.
- We are not able to disentangle the direct effects of neighbourhood deprivation from shared parental determinants and future studies employing family control designs are needed.
- Relatively few children were in the lowest IDACI quintiles or living in abject poverty, which may underestimate the proportions of children with language disorder in those communities.

Introduction

Developmental language disorders are common, multifactorial conditions that affect understanding and comprehension of one's native language. Language disorder is influenced by both genetic and environmental risks(1) and affects approximately one in every 14 children(2). Increasingly recognised as a public health concern(3), language disorder represents significant economic cost to society, through increased adverse mental health outcomes(4), reduced opportunities for employment(5), and increased risk of involvement with youth justice(6). Language disorder is a core component of a constellation of risk factors (including cognitive delay and poor self-control) that when combined with family adversity, increase probability of lifelong social and health disadvantage, with large economic burden in adulthood(7).

The association between poor language and socio-economic disadvantage has often been attributed to quantitative and qualitative differences in the language input children receive(8). However, this association may also be driven by increased genetic susceptibility to language disorder, the interplay between genes and environment(9), and the impact of poverty on the development of neurobiological systems that support language acquisition and language processing(10). Formal schooling represents an opportunity to enhance the language environments of disadvantaged children, but language, literacy, and attainment gaps between the most and least advantaged children are remarkably persistent(11). Less is known about how socioeconomic factors relate to the rate of growth in language and literacy skills over time. Children living in extreme poverty experience slower rates of language growth and widening language gaps with peers on measures of receptive vocabulary(12). This has been linked to inconsistent access to education provision via persistent school absence, school exclusion, or dropping out of school at an early age. However, where children access universal, high-quality education provision, socio-economic status has not been found to modulate estimates of language stability(13), nor rate of vocabulary growth in children with or without language disorder(14).

Despite widely reported socio-economic attainment gaps, developmental outcomes for children from disadvantaged communities are extremely variable and may be shaped by additional child-intrinsic factors, such as age, sex, or co-morbid conditions, or extrinsic environmental factors such as home environment or access to language-rich resources in the community. The neurocognitive effects of many socio-economic risks are sex dependent and have greater negative impacts on males(15). Sex-specific effects on language may be exacerbated by social factors related to gender, such as differences in how adults communicate with boys and girls, and different expectations for language competence.

In this prospective longitudinal study, we linked teacher report of language proficiency at the end of the first year of formal schooling to neighbourhood deprivation for a large, population-based cohort. We then followed a monolingual subsample of this cohort from the beginning to the end of primary school. We investigated whether prevalence of language disorder varied as a function of neighbourhood deprivation, and whether this relationship was moderated by child sex and age. Finally, we investigated the association between neighbourhood deprivation and growth in measures of receptive vocabulary, grammar (sentence recall), and word reading from start to end of primary school, taking account of language-status at school entry. This will elucidate whether socioeconomic attainment gaps in language and academic skills are evident when cases of language disorder are taken into account.

Methods

Study Design and Methods

The Surrey Communication and Language in Education Study (SCALES) is a population based cohort study following child language development from school-entry (age 4-5 years) to the end of primary school (age 10-11 years). Data were obtained between May-July 2012 for 7,267 children (aged 4;9-5;10) who started a state-maintained reception classroom in Surrey during 2011-2012 (response rate: 61% of all eligible schools, 59% of the total population of children starting school in Surrey in 2011)(2). A monolingual English-speaking sub-sample was selected for in-depth assessment in Year 1 (5-6 years; n=529), Year 3 (7-8 years; n=499), and Year 6 (10-11 years; n=389) using

stratified random sampling. Initial strata identified children who were reported as having ‘no phrase speech’ and were not yet combining words into phrases or sentences (No Phrase Speech, $n=89$, 1.2%), those attending special schools for severe learning disabilities ($n=31$, 0.4%, including 19 NoPhraseSpeech) and those for whom English was an additional language ($n=782$, 10.7%, including 27 NoPhraseSpeech). For remaining monolingual children, sex and age specific cut-off scores on the CCC-S identified children with teacher ratings of low language proficiency. In total, 636 children (including 48 NoPhraseSpeech) were sampled from the remaining 6454, with a higher sampling fraction for children with poor language (40.5% for boys, 37.5% for girls) versus remaining children (4.3% for boys, 4.2% for girls).

Consent procedures and study protocol were developed in consultation with Surrey County Council and approved by the Royal Holloway Ethics Committee (where the study was initiated) in Year 1 and the UCL Research Ethics Committee in Year 6 (9733/002). Opt-out consent was obtained for teachers to report anonymous questionnaire data to the research team; 22 parents did not consent and were not included. Informed consent was obtained from parents before in-depth assessments in Year 1 and Year 6. Verbal assent was obtained from children prior to each assessment. Children were given certificates and small prizes at the end of each assessment session.

Procedures

Household postcodes were obtained from school staff at study intake and used to identify neighbourhood deprivation rank scores. Teachers rated child language proficiency during the last term of reception year (May-July, 2012). In-depth assessment and classification of children took place during Year 1. Further assessments were conducted in Years 3 and 6, in a quiet room at the child’s school.

Language Assessment and Language Disorder Classification

In reception, teachers completed the Children’s Communication Checklist-Short (CCC-S), a 13-item checklist measuring language and communication skills in everyday contexts (maximum score = 39). Higher scores indicate lower language proficiency and children scoring at or above the 90th centile were deemed to have low language.

The Income Deprivation Affecting Children Index is a UK Government measure of socio-economic status reflecting neighbourhood deprivation obtained from home postcodes(16). England is comprised of 32,844 neighbourhoods ranked on seven weighted indices of deprivation: [1] income; [2] employment; [3] health and disability; [4] access to education, skills and training; [5] barriers to housing and services; [6] crime; and [7] living environment deprivation. Index scores in England range from 1 (most deprived) to 32844, and in this sample ranged from 731 (most deprived) to 32474 (most affluent)(see Supplemental Material Figure 1 for distribution of participants by IDACI quintile).

Diagnostic assessment included five language composites (see (2) for details) tapping three domains of language (vocabulary, grammar, narrative) in two modalities (comprehension and production).

Criteria for language disorder were two or more composite scores of $-1.5SD$ or more below the population mean, with non-verbal ability scores above the 3rd centile. Our criteria therefore deviate from previous population cohorts(17,18) in using more stringent language criteria but more inclusive non-verbal ability criteria. This is consistent with internationally agreed diagnostic standards that do not require discrepancy between verbal and non-verbal abilities(19). Using this algorithm, 9.92% of the SCALES cohort were identified as having a language disorder in Year 1.

Longitudinal analysis focused on changes in raw scores of the Receptive One Word Picture Vocabulary Test(20), the School-age Sentence Imitation Test (a measure of expressive grammar)(21), and the Castles and Coltheart Test-2 which measures single word reading of non-words, regular words and exception words(22). For brevity, results on the Sentence Imitation Test are reported in Supplementary Materials. Word reading is reported as this test was not included in the diagnostic algorithm for language disorder, and is closely aligned with educational attainment.

We employed reverse order testing at successive test waves to yield a variable testing lag and a wider age range across the sample. We accounted for this by modelling individual child age, rather than test time in growth models.

Statistical Analyses

Our first analysis makes use of all available screening data ($n = 7267$) and employs logistic regression to estimate the change in probability of scoring above the 90th centile on the CCC-S by standardised IDACI rank. This model was adjusted for age, sex, and English as an additional language, and results are reported as odds ratios (ORs) with 95% CIs.

Next, we model growth in raw scores on measures of vocabulary, sentence recall, and word reading taken from the monolingual, stratified sub-sample in Year 1 (baseline), Year 3, and Year 6 of primary school. Traditionally, inference about a survey population from a stratified sub-sample is done via use of weights. An alternative approach, which yields unbiased but more efficient estimates(23) is through the incorporation of auxiliary information in the analysis model. This information comes in the form of variables measured in the whole sample that are correlated with the observed measures of interest that are available only in the sub-sample. Our analyses utilise the CCC-S questionnaire as an auxiliary variable, which was instrumental to the selection of our sub-sample. Since the CCC-S was measured at the screening stage, it was allowed to be associated with quantities measured at Year 1 assessment, first as an indicator of language baseline (the latent intercept, or baseline, of a language growth curve) and secondly as directly predictive of measures obtained at that time: language disorder status, vocabulary, sentence recall, and word reading (see Figure 1). All models were estimated by maximum likelihood using Stata 15.1 `gsem`(24) with results from the `margins` command shown in Figures 3 and 4.

The overall model included as one component a logistic model for the change in probability of meeting criteria for language disorder with decreasing IDACI rank, accounting for age and sex. A second component is a growth curve model with random (latent) intercept, which allows for variable child baseline scores, and a random (latent) linear slope, which allows for child specific rates of language growth, around a quadratic (curved) mean trend in raw scores for receptive vocabulary, sentence recall, and word reading scores over a six-year period. We report models that included IDACI and sex as predictors of both baseline scores and growth curves to determine if socioeconomic status affects initial level and/or rate of change in raw scores on measures of vocabulary, sentence recall, or word reading. We then entered initial language disorder status into the growth model to

determine whether having a language disorder attenuated any effect of IDACI rank on language and reading measures.

****Figure 1. Conditional Growth Curve Model with Auxiliary Variable: Generalised structural equation model to predict growth in raw scores of Language Tests (LT) from Year 1 (age 5-6), Year 3 (age 7-8) and Year 6 (age 10-11). Children's Communication Checklist-Short score (ccc) from study intake indicated as age0 (age 4-5) is included as an auxiliary variable to account for study design and attrition. This figure represents model 2 in Table 3 with sex and IDACI as predictors of the latent intercept (I) for baseline language skills which then develop with an individual specific (latent) linear slope(S) around a potentially quadratic (curved) mean trend (measuring rate of change over time, or growth). Developmental language disorder (dld) is both associated with ccc and raw test scores at baseline (I) but also acts also as a possible predictor of later language and literacy test scores. ****

Results

Lower IDACI rank (i.e. greater deprivation), younger age, having English as an additional language and male sex all increased the risk of teacher rated low language proficiency at school entry (Table 1). The predicted probability of having teacher rated low language proficiency more than doubles as one moves from the centre of the highest IDACI quintile (least deprived) to the centre of the lowest (most deprived) (Figure 2). Predicted probabilities at the centre of each IDACI rank quintile for males and females separately are reported in supplementary Table S1.

***Figure 2. Predicted probability of being at or above the 90th centile for CCC-S (indicative of low language proficiency) by IDACI rank for males and females separately, adjusted for age and EAL status. Point estimates are given for middle of each IDACI quintile (10th, 30th, 50th, 70th and 90th centiles). ***

Table 1. Demographic characteristics of children assessed on teacher-rated Children's Communication Checklist-Short, grouped according to those below the 90th centile and those scoring 90th centile and above (indicative of low language proficiency). Continuous variables reported as Mean (standard deviation); categorical variables reported as N (percent of language proficiency group).

	no language concern	low language proficiency	Odds ratio (95% CI)
N	6490	777	
CCC-2 raw score	7.01 (6.15)	28.77 (5.78)	
Standardised IDACI rank (SES)	0.04 (0.99)	-0.31 (1.04)	0.756 [0.701 0.815]
Age (months)	64 (3.55)	63 (3.28)	0.887 [0.867, 0.907]
Male	3198 (49.28%)	516 (66.41%)	2.113 [1.801, 2.485]

English as Additional Language	584 (9%)	198 (25.48%)	3.282 [2.709, 3.966]
--------------------------------------	----------	--------------	----------------------

In the logistic regression component of the structural equation model with auxiliary variables, younger age, male sex and lower IDACI rank are associated with LD status (Table 2). The predicted probability of LD diagnosis increases at least 2.5 times from the centre of the highest IDACI quintile (least deprived) to the centre of the lowest (most deprived) (Figure 3). Predicted probabilities at the centre of each IDACI rank quintile for males and females separately are reported in supplementary Table S1.

Table 2. Demographic characteristics of monolingual children that took part in in-depth assessment presented for those with and without Language Disorder (LD). Continuous variables reported as Mean (standard deviation); categorical variables reported as N (percent of language group).

	No LD	LD	Unadjusted Odds ratio (95% CI)
N	393	136	
Standardised IDACI rank (SES)	0.11 (0.95)	- 0.42 (0.99)	0.58 [0.48, 0.72]
Age (months)	64 (3.49)	64 (3.43)	0.99 (0.94,1.05)
Male	195 (49.62%)	84 (61.76%)	1.64 (1.10,2.44)

Figure 3. Predicted probability of Language Disorder (LD) diagnosis at the average age (64 months) in Year 1 by IDACI rank for males and females separately. Point estimates are given for middle of each IDACI quintile (10th, 30th, 50th, 70th and 90th centiles).

Raw scores for vocabulary, sentence recall and word reading scores at each time point are reported in supplementary material Table S3, stratified by sex and LD status. Table 3 reports output from Model 1 for vocabulary and wording reading (for sentence recall see supplementary Table S5), indicating that while IDACI rank and sex predicted raw scores in Year 1, neither predicted rate of growth (change in raw score) from Year 1 to Year 6. Model 2 additionally included LD status as a predictor of baseline scores and growth. Unsurprisingly, LD status predicted baseline scores on all three measures. However, its inclusion ameliorated the effect of IDACI rank on baseline language scores, while IDACI remained an important predictor of word reading. LD status did not predict growth on any measure. For word reading only, baseline scores negatively predicted growth, indicating that

those with lower word reading scores in Year 1 experienced greater improvement in reading from Year 1 to Year 6, irrespective of IDACI rank.

Table 3. Selected coefficients (standard errors) from structural equation random effect growth curve models for vocabulary and word reading raw scores with child age (complete output for all three variables, including Sentence Recall, supplementary Tables S4–S6). Model 1 includes sex and IDACI ranks scores as predictors of the baseline raw scores for vocabulary and word reading and the rate of change (growth). Model 2 includes Language Disorder (LD) status predicting baseline and growth between primary school Year 1 and Year 6. * $p < .05$

		Receptive vocabulary		Word Reading	
		Model 1	Model 2	Model 1	Model 2
	Age	0.88 (0.047)*	0.94 (0.039)*	1.95 (0.068)*	1.93 (0.055)*
	Age ²	-0.003 (0.0005)*	-0.003 (0.0005)*	-0.016 (0.0007)*	-0.016 (0.0007)*
	LD		-22.76 (1.34)*		-26.64 (3.54)*
Baseline	Sex	-3.85 (1.10)*	-6.80 (0.712)*	-5.71 (1.95)*	-14.12 (1.52)*
	IDACI	2.88 (0.552)*	0.68 (0.432)	5.46 (0.98)*	2.48 (0.954)*
Growth	Intercept	0.001 (.001)	0.003 (0.002)	-0.003 (0.0009)*	-0.005 (0.001)*
	sex	0.02 (0.03)		0.04 (0.03)	
	IDACI	0.01 (0.01)		-0.003 (0.02)	
	LD		-0.015 (0.029)		0.046 (0.040)

Figure 4. Raw scores and fitted lines from Conditional Growth Curve Model with Auxiliary Variables including neighbourhood deprivation (IDACI) as a predictor of baseline raw scores and LD status as a predictor of both baseline and growth curves for a) Receptive Vocabulary and b) Word Reading scores.

Discussion

Children experiencing socio-economic disadvantage are more likely than affluent peers to have significantly lower levels of language at the start of formal schooling. Our novel contribution is to demonstrate that this relationship is largely accounted for by the concentration of children meeting internationally agreed diagnostic standards for developmental language disorder (LD) in areas of disadvantage. Predicted probabilities of meeting criteria for LD increase at least 2.5 times from the lowest IDACI quintile to the highest, with 13% (girls) to 25% (boys) from the lowest 10th centile of IDACI compared to 5% (girls) to 8% (boys) in the highest quintile.

The association of IDACI with vocabulary and sentence recall disappeared when LD-status was taken into account, and was attenuated for word reading. In addition, the rate of change in language and literacy scores (i.e. growth) was consistent across the socio-economic spectrum, with LD persisting throughout the primary school years, providing further evidence that language disorder is a stable, biologically-based condition(1).

Improving social mobility and reducing the economic and societal impacts of inequality is an international priority and improving access to high-quality education has been highlighted as critical for all economies(25). Language is a foundational skill that reliably predicts children's ability to access and benefit from such educational opportunities, including the development of literacy. Our findings are consistent with previous large-scale investigations demonstrating that once children start formal schooling, language trajectories are remarkably stable(13) and predictive of educational outcomes in middle childhood(26). This may indicate a time-limited period of neural plasticity in the pre-school years in which language trajectories may be more malleable(13). Alternatively, increased stability after school entry may reflect the benefit of freely available, high-quality, and universal education, which may serve to equalise the rate of language growth across the spectrum of ability and socio-economic circumstance. In different cultural contexts, poverty-related gaps in language growth are evident when universal education is not consistently accessed(12). However, even with high quality educational provision, narrowing language and achievement gaps is clearly challenging.

When educational experience is more equal, observed differences between children may be attributable to variation in genetic influences(27). Our findings are consistent with the view that socio-economic associations with language may reflect shared genetic risk factors, as well as environmental transmission that may be fully or partially due to genetic confounding (e.g. gene x environment correlations) that impact on home language environments(9). For example, young people with LD have generally poorer language and literacy outcomes, are more likely to leave school with fewer academic qualifications, and are more likely that peers to be engaged in low-pay employment(5). As parents, they pass both genetic and environmental characteristics to their children. These children may in turn play a less active role in initiating communicative exchanges with their caregivers, and thus limiting opportunities for parents to comment on objects or activities within the child's environment. Ultimately these interacting genetic and environmental factors increase risk of perpetuating intergenerational cycles of language and socio-economic challenge.

Implications for policy and practice

A critical question is whether and what environmental modifications could alter this cycle and whether there is a critical period in which to do so. Pre-school interventions that involve parent communication training and/or nursery-led language groups can have immediate and positive, though modest, impacts on child language(28). Health surveillance and early intervention could usefully be targeted in regions of deprivation and family control designs should be employed to elucidate how biological and environmental risk factors may relate to variable response to treatment(9), enabling fine-tuning of intervention programmes. However, in order to narrow language and attainment gaps, children with LD must acquire language at a faster rate than peers. We question how realistic this is in a whole class environment and suggest that individualised interventions in combination with enhanced teacher training(29) may be required to increase language competence for disadvantaged children. In developing tailored interventions, it is also notable that a sizeable proportion of children from disadvantaged neighbourhoods had language scores within the typical range and all made equivalent progress in language and literacy relative to more advantaged peers. Investigation of the

genetic and environmental characteristics of this language-resilient group could identify mutable mechanisms for language change through population health programmes.

Finally, the persistence of LD in this study and other cohorts(13,26) suggests that even with early intervention, many children will require on-going language, education, and social support to attenuate negative sequelae of language disorder. While pre-school language interventions can improve targeted language skills, there is less robust evidence that these gains transfer to other scholastic skills such as reading(28) and enriched pre-school programmes are susceptible to fade-out effects in the longer term(30). Aligning early intervention and later clinical and educational supports throughout primary school will be critical to maximising investment in early years provision with the goal of improving social mobility.

Strengths and limitations of this study

The strengths of this prospective study are the large sample size and the detailed assessment and characterisation of language disorder that is consistent with international standards in diagnosis(19). The study employed both teacher report and direct assessment of language competence, and we report changes in raw scores over six years in receptive vocabulary, expressive grammar and word reading. In addition, the longitudinal follow-up spanned the entirety of primary school education, providing rare evidence of the relationship between neighbourhood disadvantage, language and literacy growth, and the persistence of LD. IDACI rank was chosen as our metric of socio-economic status because neighbourhood deprivation is consistently found to relate to long term health and economic inequality, as well as language deficit(10). IDACI rank is routinely collected by UK government health and education departments, so has the potential for planning and evaluating the impact of policy changes aimed at improving child language outcomes.

This study is limited in that we are not able to disentangle the direct effects of neighbourhood deprivation from shared parental determinants and future studies employing family control designs are needed(9). An association of socio-economic status and language growth may be evident if more proximal measures, such as maternal education or the quantity and quality of parent language input,

are employed. Although our sample includes children across the socio-economic spectrum, we have relatively few children in the lowest IDACI quintiles or living in abject poverty, which may underestimate the proportions of children with language concerns in those communities. All children had access to universal education and, at this age, persistent absence and school drop-out was uncommon. The effects of disadvantage on language growth are likely more evident in populations experiencing extreme poverty, or where access to basic health and education services are more variable(12).

Conclusion

Although language disorder is present across socio-economic strata, it is significantly more common in areas of neighbourhood disadvantage, and persists from the beginning to the end of primary education. The presence of language disorder fully accounted for socio-economic associations with language and partially accounted for socio-economic associations of word reading at school entry. However, neither LD status nor IDACI rank influenced rate of language or literacy growth. Health and education policies that address social mobility will need to consider supports for language throughout the lifespan, especially as the nature of language needed for academic and social success itself changes as children grow into adults.

Author contributions

CFN, AP, GB, TC and ES originally conceived the SCALES study and obtained the funding from Wellcome and the ESRC.

CFN, SG, AP and GV contributed equally to the preparation of this manuscript. CFN and SG planned this study, collected the data, contributed to statistical analyses and drafted the manuscript. AP and GV conducted and reported the statistical analyses and assisted in drafting the manuscript.

GB, TC, and ES provided extensive comments on earlier drafts of this manuscript.

The authors also gratefully acknowledge the assistance of Surrey County Council, and particularly Jennifer Charters, Virginia Martin, Cheryl Dyer and Barbara Paulger in facilitating school

participation. They also thank Debbie Gooch for her contributions to the Reception and Year 1 testing waves and Laura Lucas for her excellent project management and data collection in Year 6. Finally, they extend a warm thank you to the schools, teachers, families and children who took part.

References

1. Bishop DVM. What Causes Specific Language Impairment in Children? *Curr Dir Psychol Sci*. 2006 Oct;15(5):217–21.
2. Norbury CF, Gooch D, Wray C, Baird G, Charman T, Simonoff E, et al. The impact of nonverbal ability on prevalence and clinical presentation of language disorder: evidence from a population study. *J Child Psychol Psychiatry*. 2016 Nov;57(11):1247–57.
3. Law J, Reilly S, Snow PC. Child speech, language and communication need re-examined in a public health context: a new direction for the speech and language therapy profession: Child speech, language and communication need in the context of public health. *Int J Lang Commun Disord*. 2013 Sep;48(5):486–96.
4. Yew SGK, O’Kearney R. Emotional and behavioural outcomes later in childhood and adolescence for children with specific language impairments: meta-analyses of controlled prospective studies: SLI and emotional and behavioural disorders. *J Child Psychol Psychiatry*. 2013 May;54(5):516–24.
5. Conti-Ramsden G, Durkin K, Toseeb U, Botting N, Pickles A. Education and employment outcomes of young adults with a history of developmental language disorder. *Int J Lang Commun Disord*. 2018 Mar;53(2):237–55.
6. Hughes N, Chitsabesan P, Bryan K, Borschmann R, Swain N, Lennox C, et al. Language impairment and comorbid vulnerabilities among young people in custody. *J Child Psychol Psychiatry*. 2017 Oct;58(10):1106–13.
7. Caspi A, Houts RM, Belsky DW, Harrington H, Hogan S, Ramrakha S, et al. Childhood forecasting of a small segment of the population with large economic burden. *Nat Hum Behav*. 2017 Jan;1(1):0005.
8. Schwab JF, Lew-Williams C. Language learning, socioeconomic status, and child-directed speech: Language learning, socioeconomic status, and child-directed speech. *Wiley Interdiscip Rev Cogn Sci*. 2016 Jul;7(4):264–75.
9. Hart SA, Little C, van Bergen E. Nurture might be nature: Cautionary tales and proposed solutions [Internet]. *PsyArXiv*; 2019 Aug [cited 2020 Jul 7]. Available from: <https://osf.io/j5x7g>
10. Jensen SKG, Berens AE, Nelson CA. Effects of poverty on interacting biological systems underlying child development. *Lancet Child Adolesc Health*. 2017 Nov;1(3):225–39.
11. Chmielewski AK. The Global Increase in the Socioeconomic Achievement Gap, 1964 to 2015: *Am Sociol Rev* [Internet]. 2019 May 16 [cited 2020 Jul 7]; Available from: <https://journals.sagepub.com/doi/10.1177/0003122419847165>
12. Lervåg A, Dolean D, Tincas I, Melby-Lervåg M. Socioeconomic background, nonverbal IQ and school absence affects the development of vocabulary and reading comprehension in children living in severe poverty. *Dev Sci*. 2019 Jun 14:e12858.
13. Bornstein MH, Hahn C-S, Putnick DL. Long-term stability of core language skill in children with contrasting language skills. *Dev Psychol*. 2016 May;52(5):704–16.

14. Beitchman JH, Jiang H, Koyama E, Johnson CJ, Escobar M, Atkinson L, et al. Models and determinants of vocabulary growth from kindergarten to adulthood. *J Child Psychol Psychiatry*. 2008 Jun;49(6):626–34.
15. Barbu S, Nardy A, Chevrot J-P, Guellaï B, Glas L, Juhel J, et al. Sex Differences in Language Across Early Childhood: Family Socioeconomic Status does not Impact Boys and Girls Equally. *Front Psychol* [Internet]. 2015 Dec 2 [cited 2020 Jul 7];6. Available from: <http://journal.frontiersin.org/Article/10.3389/fpsyg.2015.01874/abstract>
16. McLennan D, Barnes H, Noble M, Davies J, Garrett E, Dibben C. The English Indices of Deprivation 2010 [Internet] [Internet]. London: Crown; [cited 2020 Jul 7]. Available from: [https://risweb.st-andrews.ac.uk/portal/en/researchoutput/the-english-indices-of-deprivation-2010\(af4f62e9-8f1e-4fdf-8196-00ec7049c23a\)/export.html](https://risweb.st-andrews.ac.uk/portal/en/researchoutput/the-english-indices-of-deprivation-2010(af4f62e9-8f1e-4fdf-8196-00ec7049c23a)/export.html)
17. Tomblin JB, Records NL, Buckwalter P, Zhang X, Smith E, O'Brien M. Prevalence of Specific Language Impairment in Kindergarten Children. *J Speech Lang Hear Res*. 1997 Dec;40(6):1245–60.
18. Beitchman JH, Nair R, Clegg M, Patel PG. Prevalence of Speech and Language Disorders in 5-Year-Old Kindergarten Children in the Ottawa-Carleton Region. *J Speech Hear Disord*. 1986 May;51(2):98–110.
19. Bishop DVM, Snowling MJ, Thompson PA, Greenhalgh T, Consortium C. CATALISE: A Multinational and Multidisciplinary Delphi Consensus Study. Identifying Language Impairments in Children. *PLOS ONE*. 2016;11(7):e0158753.
20. Martin NA, Brownell R. Expressive/Receptive One-Word Picture Vocabulary Test. Fourth. Austin, Texas: PRO-ED; 2010.
21. Marinis T, Chiat S, Armon-Lotem S, Piper J, Roy P. School-Age Sentence Imitation Test-English 32 (SASITE32) [Internet]. 2011. Available from: <https://researchcentres.city.ac.uk/language-and-communication-science/veps-very-early-processing-skills/veps-assessments>
22. Castles A, Coltheart M, Larsen L, Jones P, Saunders S, McArthur G. Assessing the basic components of reading: A revision of the Castles and Coltheart test with new norms. *Aust J Learn Difficulties*. 2009 May;14(1):67–88.
23. Graham JW. Adding Missing-Data-Relevant Variables to FIML-Based Structural Equation Models. *Struct Equ Model Multidiscip J*. 2003 Jan;10(1):80–100.
24. Rabe-hesketh S, Skrondal A, Pickles A, Rabe-hesketh S, Skrondal A, Pickles A. Year Paper GLLAMM Manual.
25. World Economic Forum. The Global Social Mobility Report 2020Equality, Opportunity and a New Economic Imperative [Internet]. World Economic Forum; 2020 [cited 2020 Jul 7]. Available from: http://www3.weforum.org/docs/Global_Social_Mobility_Report.pdf
26. Eadie P, Bavin EL, Bretherton L, Cook F, Gold L, Mensah F, et al. Predictors in Infancy for Language and Academic Outcomes at 11 Years. *Pediatrics* [Internet]. 2021 Feb 1 [cited 2021 Mar 10];147(2). Available from: <https://pediatrics.aappublications.org/content/147/2/e20201712>
27. Sokolowski HM, Ansari D. Understanding the effects of education through the lens of biology. *Npj Sci Learn*. 2018 Oct 1;3(1):1–10.

28. Rogde K, Hagen ÅM, Melby-Lervåg M, Lervåg A. The effect of linguistic comprehension instruction on generalized language and reading comprehension skills: A systematic review. *Campbell Syst Rev*. 2019;15(4):e1059.
29. Goldfeld S, Snow P, Eadie P, Munro J, Gold L, Le HND, et al. Classroom Promotion of Oral Language (CPOL): protocol for a cluster randomised controlled trial of a school-based intervention to improve children's literacy outcomes at grade 3, oral language and mental health. *BMJ Open*. 2017 Nov 20;7(11):e016574.
30. Abenavoli RM. The mechanisms and moderators of “fade-out”: Towards understanding why the skills of early childhood program participants converge over time with the skills of other children. *Psychol Bull*. 2019 Dec;145(12):1103–27.