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# Social inequalities in cognitive scores at age 16: The role of reading

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**September 2013**

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## Abstract

This paper examines socio-economic inequalities in cognitive test scores at age 16 for a nationally representative cohort of people born in Britain in 1970 (the 1970 British Cohort Study). At age 16, the respondents took tests in vocabulary, spelling and mathematics. This allows us to explore whether inequalities due to social background are similar across the three domains of vocabulary, spelling and mathematics, or whether they differ and to what extent these inequalities are accounted for by family material and cultural resources, as well as by children's own reading. Finally, our longitudinal analysis addresses the question of the extent to which differences in test scores are determined by age 10; and which factors are linked to a growth in differentials during adolescence. We show that childhood reading is linked to substantial cognitive progress between the ages of 10 to 16.

## Non-technical summary

Does reading for pleasure increase the rate of children's learning? This paper addresses this question using data from a nationally representative cohort of people born in 1970 (the 1970 British Cohort Study). Our analyses are based on a sample of around 6,000 cohort members who took cognitive tests in vocabulary, spelling and mathematics at age 16.

We control for a large set of cognitive measures at the ages of 5 and 10, in order to look at cognitive development between the ages of 10 and 16. We found that reading for pleasure at the ages of 10 and 16 had a substantial influence on cognitive progress across the three scores, but was largest in the case of vocabulary. Summing the effects for reading books often at age 10, reading books more than once a week at age 16, and reading newspapers more than once a week at 16, the total is equivalent to a 14.4 percentage point advantage in vocabulary, 9.9 percentage points in maths, and 8.6 percentage points in spelling. This is controlling for parental social background and parents' own reading behaviour. The influence of reading for pleasure was greater than that for having a parent with a degree – this equated to an advantage in progress of 4.2 percentage points for vocabulary, 3.0 percentage points for mathematics and 1.8 percentage points for spelling.

Key findings:

- Parents' education was far more important for children's performance in cognitive tests than parents' economic resources, measured as social class, income and home ownership.
- Parents' education and parents' own reading had more influence on vocabulary scores than on maths and spelling.
- Having older siblings was more strongly negative for children's vocabulary scores than for their maths and spelling scores.
- Reading for pleasure had a powerful influence on children's cognitive development, especially in terms of their vocabulary.
- Socio-economic differences in children's test scores were not largely accounted for by parents' reading or children's own reading.

## Introduction

Persistent socio-economic inequalities in educational attainment and cognitive scores have been documented by many studies over the years, and the explanation of these social inequalities is one of the central problems within the sociology of education (Halsey, et al. 1980). Debate continues regarding the relative importance of economic and cultural resources in determining class differentials in educational outcomes.

Research has demonstrated the importance of the home reading culture for children's early cognitive scores (Byford, et al. 2012). Studies focussing on children's own reading have faced challenges in unpacking the reciprocal relationship between ability and participation in reading (Cunningham and Stanovich 1998). Reviews of the literature find extensive evidence for an association between reading frequency and reading attainment, (for example see Twist, et al. 2007), but note the difficulty in establishing whether reading frequency actually leads to improved attainment in the absence of compelling longitudinal evidence (Clark and De Zoysa 2012; Clark and Rumbold 2006; Department for Education 2012; Department for Education Education Standards Research Team 2012). While some longitudinal studies on reading exist, they have typically been small scale, covered relatively short periods, and lacked controls for socio-economic background (Taylor, et al. 1990). In the wider literature on cultural reproduction, some studies have assessed the role of children's reading in their educational and occupational attainment (Cheung and Andersen 2003; Georg 2004; Jaeger 2011; Sullivan 2001), but as far as we are aware, ours is the first to take a life course approach to reading and cognitive development over time. In this paper, we focus on the potential role of both parents' and children's reading in explaining differentials in cognitive tests at age 16 for a cohort of children born in 1970. The BCS70 is a large, nationally representative, longitudinal birth cohort study, with rich measures of both cognition and home background, which provides some strong advantages in tackling these questions.

The most prominent theory emphasising the importance of cultural resources, Bourdieu's theory of cultural reproduction (Bourdieu and Passeron [1977] 1990) has been operationalised in various ways, but increasingly researchers are critical of a narrow interpretation of cultural capital as consisting in 'beaux arts' elite cultural activities, and suggest that cultural capital should be seen as including knowledge and skills which are rewarded within the education system (Crook 1997; De Graaf, et al. 2000; Farkas 2003; Ganzeboom 1982; Lareau and Weininger 2003; Sullivan 2001). Previous studies have found that books in the home and reading behaviour, but not 'beaux arts' participation, help to explain social differentials in children's educational outcomes (De Graaf, et al. 2000; Sullivan 2001). Reading differs from beaux arts participation in that it develops linguistic ability and wider cultural knowledge. Bourdieu's discussion of cultural capital emphasises the importance of language as the key to success in school (Bourdieu, et al. 1994) (p.21). Hirsch (1983) also emphasises vocabulary, though from a different perspective, on the grounds that knowledge of words is both an adjunct to knowledge of concepts and assists further learning. From a theoretical point of view, it has been argued that reading should be a particularly important driver of vocabulary development, given the paucity of vocabulary used in speech compared to books, even comparing children's books to adult speech (Cunningham and Stanovich 1998). In this paper, we are able to address whether the socio-

economic and cultural factors driving vocabulary are essentially the same as those driving other academic skills, such as mathematics, or whether they differ.

The processes through which parents transmit educational advantage to their children are multiple and complex. Not discounting the roles of factors such as genetics, parents' physical and mental health, schooling, etc., parental practices and attitudes are clearly important. Lareau (2003) stresses the deliberate efforts made by middle-class parents to cultivate their children's talents and abilities, and terms this parenting style 'concerted cultivation'. Concerted cultivation is clearly important, and is reflected in such activities as reading to the child. But, as we have argued elsewhere (Sullivan 2007), passive cultural transmission is also important. Children pick up styles of speech, vocabulary and forms of reasoning simply by hearing their parents talk, and also pick up reading habits through seeing their parents read, and having reading materials readily available in the home. We may expect passive cultural transmission to be most important in the case of linguistic skill, since studies have found huge differences in the number of different words that children are exposed to in middle and working class homes (Hart and Rinsley 1995). Vocabulary is transmitted within the home almost constantly, without any conscious effort. In contrast, while parents may well seek to promote their children's success in subjects such as mathematics, this must typically be done consciously, with discrete time set aside for the task. Should we therefore expect wider disparities according to parental cultural resources in children's linguistic ability than in their abilities in mathematics? This paper investigates this question.

Influences on cognitive scores and changes in these scores may be expected to differ according to the nature of the assessment, and the demands the assessment makes on processing capacity or problem solving as opposed to knowledge (Richards and Sacker 2003). The tests we analyse here are tests of vocabulary, spelling and maths. Of these, vocabulary most clearly reflects linguistic competence, which we expect to be developed within the home and through reading rather than primarily through schoolwork. An advantage for our purposes of the vocabulary test used here is that it is purely a test of linguistic competence, with no verbal reasoning element. Spelling is explicitly taught at school, but may also be expected to be influenced by reading habits. Both the spelling test and the vocabulary test are purely dependent on recall, while the maths test can be seen as a test of problem solving, although of course background knowledge is important here too.

The growth in cognitive inequalities according to socioeconomic status during the early years is well established (Feinstein 2003; 2004; Fogelman 1983; Sullivan, et al. in press). Here we examine the extent to which social inequalities continue to grow during adolescence, and whether cultural or economic resources can account for this growth.

## Research questions

This paper explores patterns of inequalities across three test score outcomes available for the BCS70 cohort at age 16: vocabulary, spelling and mathematics.

1. Are inequalities due to parental social background similar across the three domains of vocabulary, spelling and mathematics, or do they differ? We hypothesize that parental education (but not indicators of material resources) will be more strongly linked to the vocabulary score than to the maths and spelling scores.
2. Are inequalities due to parental social background mediated by parental reading environment, behaviour and ability? We hypothesise that the link between parental education and children's test scores is more likely to be mediated in this way than the links between parental social class and income and children's test scores.
3. Is the influence of parental reading environment, behaviour and ability mediated by children's own reading behaviour?
4. Which factors are linked to changing test scores between the ages of 10 and 16? In particular, is the child's own reading linked to cognitive progress?

## Data and variables

The 1970 British Cohort Study (BCS70) follows the lives of more than 17,000 people born in England, Scotland and Wales in a single week of 1970 (Elliott and Shepherd 2006). Over the course of cohort members' lives, the BCS70 has collected information on health, physical, educational and social development, and economic circumstances among other factors. Since the birth survey in 1970, there have been eight surveys (or 'waves') at ages 5, 10, 16, 26, 30, 34, 38 and 42. An understanding of the educational progress of this cohort during their childhood is vital to understanding their later life course trajectories.

The 1970 cohort study is rich in cognitive test scores throughout the early years, and the early test scores (up to age ten) have been analysed extensively, including influential work by Feinstein (2003; 2004). The cognitive scores at age ten have also been used as predictors of adult outcomes, including in employment (Breen and Goldthorpe 2001) and health (Batty, et al. 2007). There has been relatively little research carried out using the age 16 test scores (though see Duncan, et al. 2012), partly because the arithmetic dataset was not deposited until 2008. One of the purposes of the current paper is to draw attention to the age 16 cognitive scores and to illustrate their utility.

The 1986 follow-up of BCS70 employed sixteen separate survey instruments, and response rates varied across these instruments, ranging from 3, 816 for the educational (teachers') questionnaire to 8, 993 for the maternal self-completion (Goodman and Butler 1987). Nevertheless, the 1986 sample is more representative in terms of the birth characteristics of the sample in 1970 than any other wave of the study excluding the birth wave (Mostafa and Wiggins draft). Nearly six thousand (5, 979) respondents have a valid score for at least one of the age 16 vocabulary, maths and spelling tests.

It is important to acknowledge that people's levels of motivation and compliance will affect their scores in cognitive tests. We do not interpret these tests as tests of innate intelligence, but as tests of capability and motivation to complete a particular task under given conditions.

### Dependent variables: Cognitive test scores at age 16

In 1986, the BCS70 cohort members took a total of nine cognitive tests, five of which were included in the student test booklet. Of the nine tests, only two, spelling and vocabulary, were initially deposited, with arithmetic deposited more recently (Closs and Hutchings 1976; Dodgeon 2008). The other test scores have not yet been deposited.

Arithmetic was assessed using the Applied Psychology Unit (UPU) Arithmetic test - a 30 minute assessment comprising 60 multiple choice items covering arithmetic, probabilities and area. One point was given for each correct response.

Spelling was assessed by two tests (A and B). Each consisted of 100 words which the respondent had to code as correctly or incorrectly spelled. Respondents had 10 minutes to complete each test. The scores from the two tests were totalled to give an overall score out of 200.

Vocabulary was assessed using a 75 item test where each item was a word followed by a multiple-choice list from which the respondent must pick the one with the same meaning as the first word.

Full documentation for all tests is available on the CLS website at www.cls.ioe.ac.uk

**Table 1: Age 16 Arithmetic, Spelling and Vocabulary Scores**

| | n | Min. | Max. | Mean. | Std. Deviation |
|---|---|---|---|---|---|
| Artithmetic | **3676** | **0** | **60** | **36.8** | **11.8** |
| Spelling | **5649** | **0** | **199** | **164.7** | **25.0** |
| ***School version*** | *3699* | *0* | *198* | *164.3* | *20.8* |
| ***Home version*** | *1950* | *0* | *199* | *165.5* | *31.4* |
| Vocabulary | **5756** | **0** | **75** | **42.6** | **12.8** |
| ***School version*** | *3829* | *0* | *72* | *40.2* | *11.3* |
| ***Home version*** | *1927* | *0* | *75* | *47.4* | *14.2* |

The number of study members taking each test and descriptive statistics are shown in Table 1. It was initially intended that all tests would be taken within schools under examination conditions. Guidance for teachers supervising the tests was provided in the *Information Manual for Teachers*, which is included in the documentation available on the CLS website. However, due to fieldwork difficulties in 1986, including a teachers' strike, it became necessary to send a proportion of cohort members a 'home-pack,' which included the vocabulary and spelling tests for completion at home, in relatively uncontrolled conditions. There was no home version of the arithmetic test. Table 1 shows that on the vocabulary test at least, those completing the test at home achieved higher scores on average than those completing the test at school ($p<0.01$). Appendix A1 shows logit response models for response to all of the tests and any of the tests in terms of the birth characteristics of the 1970 sample[i]. Respondents who took all the tests (i.e. those who took the tests at school) were no more highly selected than the 1986 sample as a whole. There was some additional selectivity into returning the home test, with girls being substantially more likely to return a home test than boys. For study members who were sent the tests at home, compliance is likely to have been more variable than for those who were administered the tests at school. This differential non-response is likely to be an important factor in the higher average scores reported in the home version tests, alongside the possibility of help from parents or other forms of cheating. Our analyses includes an investigation of both the full sample taking each test and the subsample who completed the school version, as a robustness check for issues of differential response and patterns of completion on the home version.

## Independent variables

This section outlines the predictors to be used in the regression models presented in the results section of this paper. There are a number of variables included in the analysis for which data is missing for significant number of cases (as can be seen in the frequency tables below). Dummy variables indicating missing data were included for all independent variables in our analyses. This allows us to include cases with missing values within the analytical sample, and also investigate the extent to which missing values may be predictive of our outcome variables.

## Socio-economic background, sex and siblings

The household's economic resources are reflected by social class, income and housing tenure are captured at age ten (1980). Social class is based on the NS-SEC categorisation, which groups occupations according to their employment relations and conditions (Goldthorpe 1997). NS-SEC at age 10 has been derived recently for BCS70 (Gregg, et al. 2012). Based on initial analyses revealing little predictive power for a more fine-grained treatment of social class and income, we treat social class as a binary, and use three income categories. Housing tenure reflects home ownership versus renting at age 10. Home ownership can be seen as a proxy for wealth. Parents' education is coded as the highest qualification of the mother or father (whichever of the two is higher). As income is gross rather than equivalised, it is important to account for household composition, and of course it is well established that siblings are important in their own right (Nisbet 1953). As sex-stereotypes regarding cognition in the mathematical and linguistic domains were even more entrenched for this cohort than for contemporary children, it will be interesting to examine whether sex is linked to the actual cognitive scores achieved.

**Table 2: Socio-economic background, sex and siblings**

| | n | % |
|---|---|---|
| ***Child sex*** | | |
| Male | 2602 | 43.5 |
| Female | 3377 | 56.5 |
| | | |
| ***Parental Social Class (Age 10)*** | | |
| Missing | 387 | 6.5 |
| NS-SEC 1-3 (Employers, managerial, professional and intermediate occupations) | 2630 | 44.0 |
| NS-SEC 4-8 (Lower occupational categories and long-term unemployed) | 2962 | 49.5 |
| | | |
| ***Parental highest qualification (Age 10)*** | | |
| Missing | 155 | 2.6 |
| No qualifications | 153 | 2.6 |
| Other qualification | 1021 | 17.1 |
| Vocational/apprentice | 1261 | 21.1 |
| O-level or equivalent | 580 | 9.7 |
| A-level or equivalent | 143 | 2.4 |
| Nurse | 159 | 2.7 |

| | n | % |
|---|---|---|
| Teaching qualification | 848 | 14.2 |
| Degree+ | 1659 | 27.7 |
| | | |
| ***Gross family income per week (Age 10)*** | | |
| Missing | 1107 | 18.5 |
| £150 or more | 1531 | 25.6 |
| £100-£149 | 1696 | 28.4 |
| Under £100 | 1645 | 27.5 |
| | | |
| ***Tenure (Age 10)*** | | |
| Missing | 709 | 11.9 |
| Homeowner | 3605 | 60.3 |
| Renter / Other | 1665 | 27.8 |
| | | |
| ***Number of adults in household (Age 10)*** | | |
| Missing | 671 | 11.2 |
| One | 306 | 5.1 |
| Two | 4739 | 79.3 |
| More than 2 | 263 | 4.4 |
| | | |
| ***Number of younger siblings in household (Age 10)*** | | |
| Missing | 671 | 11.2 |
| One | 2058 | 34.4 |
| 2 or more | 691 | 11.6 |
| None | 2559 | 42.8 |
| | | |
| ***Number of elder siblings in household (Age 10)*** | | |
| Missing | 671 | 11.2 |
| 1 | 1891 | 31.6 |
| 2 or more | 1114 | 18.6 |
| None | 2303 | 38.5 |

## Home reading culture

We are able to provide a relatively thorough operationalisation of the home reading culture compared to many previous studies (see table 3). We include not just reading to the child, but also parental reading behaviour, reading materials in the home and parental reading ability. Although parental reading ability and habits and reading materials available in the home are captured when the cohort member is age 16, we consider these to be variables which would be unlikely to be subject to significant change during the preceding years of the cohort member's life and therefore do not see it as problematic to treat these variables as predictors of outcomes at age 16. We acknowledge the drawback that we have no measure of books in the home, a variable which has been shown to be a powerful predictor of children's educational attainment internationally (Chiu and Chow 2010; Evans, et al. 2010).

## Reading to the child

When the cohort members were aged 5, mothers were asked on how many days of the last 7 the child had been read to (home interview 1975).

## Reading habits

The mother was asked whether she and her husband read books or magazines (maternal self-completion, 1986). These variables unfortunately do not reflect the frequency of reading, only whether the mother and father read books, magazines, or neither. Seeing parents reading may affect children's attitudes to reading, and parents' reading habits are also likely to be positively linked to parents' reading ability.

## Reading materials

Mothers were asked which papers, comics and magazines were regularly in the home and were thus available for the teenager to read (maternal self-completion 1986). We are able to differentiate between broadsheet and tabloid readers, local newspaper readers, weekend newspaper readers, and those who did not read newspapers. The prose style of tabloid and local newspapers (then as now) was simpler and geared towards a lower reading age and smaller vocabulary than the broadsheets. During the 1980s, newspaper readership was high, and the type of newspaper read was a strong cultural identifier.

## Reading ability

In the absence of a reading assessment for parents, we rely on a self-reported measure of reading difficulties. Mothers were asked whether they or their husband had reading difficulties, either when learning to read or currently (maternal self-completion 1986). Positive responses to these items are low, with 5% of mothers admitting to any difficulties for themselves, and 4% for their husbands. However, we know that subjective reporting of difficulties tends to be much lower than actual tested difficulties (Bynner and Parsons 2006). Item non-response (6% for mothers and 9% for husbands) and instrument non-response may also be informative, as mothers with literacy problems may have had difficulty in completing the questionnaire, or may have been embarrassed or reluctant to report their reading difficulties.

**Table 3: Home reading culture**

| | n | % |
|---|---|---|
| ***Number of days child read to per week (Age 5)*** | | |
| Missing | 1143 | 19.1 |
| None | 442 | 7.4 |
| 1 to 3 | 1304 | 21.8 |
| 4 to 6 | 920 | 15.4 |
| 7 | 2170 | 36.3 |
| | | |
| ***Father's reading (Age 16 survey)*** | | |
| Missing | 1827 | 30.6 |
| Books | 2609 | 43.6 |

| | n | % |
|---|---|---|
| Magazines | 2666 | 44.6 |
| | | |
| ***Mother's reading (Age 16 survey)*** | | |
| Missing | 1466 | 24.5 |
| Books | 3443 | 57.6 |
| Magazines | 3304 | 55.3 |
| | | |
| ***Parental reading problems (Maternal report - Age 16 survey)*** | | |
| Instrument non-response[1] | 208 | 3.5 |
| **Mother** | | |
| Item non-response[2] | 216 | 3.6 |
| Missing[3] | 1023 | 17.1 |
| Mother has reading problem | 201 | 3.4 |
| **Father** | | |
| Item non-response | 328 | 5.5 |
| Father has reading problem | 193 | 3.2 |
| | | |
| **Reading materials available in home (Age 16)** | | |
| Comics | 761 | 12.7 |
| Magazines | 2568 | 43.0 |
| Weekly paper | 1905 | 31.9 |
| Local paper | 3352 | 56.1 |
| Sunday paper | 2951 | 49.4 |
| Tabloid paper | 2806 | 46.9 |
| Broadsheet paper | 815 | 13.6 |
| Missing | 1231 | 20.6 |

## Cohort member's own reading

The 1980 self-completion pupil questionnaire includes items on reading books and going to the library. The 1986 cohort member self-completion questionnaires contained several items on reading behaviour, including items on reading books and newspapers. Book reading declines between the ages of ten and 16. Some difference may be due to the earlier variable being reported by mothers while the later variable is self-reported, but it is also likely that there was a genuine decline in reading among teenagers, perhaps partly due to a lack of availability and promotion of suitable books for this age group. For example, libraries during the 1980s typically devoted very little space to books aimed at adolescents. This decline in reading for pleasure as children get older is in line with previous research (Clark and Rumbold 2006).

[1] Where maternal interview completed but the maternal self-completion questionnaire was not completed.
[2] Where the maternal self-completion questionnaire was completed but the self-reported reading problems question was not answered.
[3] Where no maternal interview or self-completion questionnaire was completed.

**Table 4: Child's reading**

| | n | % |
|---|---|---|
| ***How often reads books (Age 10)*** | | |
| Missing | 684 | 11.4 |
| Often | 3392 | 56.7 |
| Sometimes | 1669 | 27.9 |
| Never or hardly ever | 234 | 3.9 |
| ***How often visits library (Age 10)*** | | |
| Missing | 709 | 11.9 |
| Often | 2157 | 36.1 |
| Sometimes | 2094 | 35.0 |
| Never or hardly ever | 1019 | 17.0 |
| **How often reads newspapers (Age 16)** | | |
| Missing | 476 | 8.0 |
| More than once a week | 3541 | 59.2 |
| Once a week | 936 | 15.7 |
| Less than once a week | 426 | 7.1 |
| Rarely/never | 600 | 10.0 |
| **How often reads comics or magazines (Age 16)** | | |
| Missing | 484 | 8.1 |
| More than once a week | 1271 | 21.3 |
| Once a week | 1714 | 28.7 |
| Less than once a week | 1100 | 18.4 |
| Rarely/never | 1410 | 23.6 |
| **How often reads books (Age 16)** | | |
| Missing | 487 | 8.1 |
| More than once a week | 1627 | 27.2 |
| Once a week | 778 | 13.0 |
| Less than once a week | 1180 | 19.7 |
| Rarely/never | 1907 | 31.9 |

## Cognitive tests at five and ten

The cohort members took age-appropriate tests at age five and ten. These are included in our final model, to assess cognitive progress between the ages of 10 and 16.

### Age five tests

**Copying designs**: An assessment of visual-motor co-ordination (Rutter, et al. 1970). The child copies a picture of a shape.

**English picture vocabulary** (Brimer and Dunn 1962): A test of verbal vocabulary. The child selects the picture (from four options) which corresponds to a given word.

**Human figure drawing** (draw-a-man): Intended to reflect conceptual maturity (Goodenough 1926; Harris 1963). The child draws a human figure, and this picture is scored by trained coders according to set criteria, (e.g. presence of a head, eyes, etc).

**Complete a profile**: Similar to the draw-a-man test, the child completes an outline picture of a human face in profile by filling in features (eyes, ears, etc.).

**Schonell graded reading**: The child reads a series of words from cards. Where mothers indicated that their child was unable to read this test was not administered. For the purpose of the following analyses these cases were allocated a score of 0.

For more detail see the data guide available on the CLS website (Golding 1975).

**Table 5: Age 5 test scores (for those completing at least one of the three tests at age 16).**

| | n | Min. | Max. | Mean. | Std. Deviation |
|---|---|---|---|---|---|
| **Copying designs** | 4989 | 0 | 8 | 5.0 | 1.9 |
| **English picture vocabulary** | 4683 | 0 | 60 | 38.7 | 13.0 |
| **Human figure drawing** | 4928 | 1 | 23 | 10.7 | 3.1 |
| **Complete-a-profile** | 4819 | 0 | 16 | 7.1 | 3.9 |
| **Schonell graded reading** | 4983 | 0 | 50 | 1.9 | 4.6 |

## Age ten tests

**Shortened Edinburgh Reading Test** (Godfrey Thompson Unit 1978): A test of word recognition, examining: vocabulary, syntax, sequencing, comprehension and retention.

**Pictorial language comprehension test**: Based on the English picture vocabulary test

**Friendly maths test**: A multiple choice test including arithmetic, number skills, fractions, algebra, geometry and statistics.

**Spelling:** Dictation task. This includes both real and made-up words, hence it is a test of both spelling and phonetic decoding.

**British Ability Scales** (BAS) (Elliott, et al. 1979; Hill 2005): Two verbal subscales (word definitions and word similarities) and two non-verbal subscales (digit recall and matrices).

For more detail see the guide on the CLS website (Butler, et al. 1980)

**Table 6: Age 10 test scores (for those completing at least one of the three tests at age 16).**

| | n | Min. | Max. | Mean. | Std. Deviation |
|---|---|---|---|---|---|
| **Edinburgh Reading Test** | 4506 | 0 | 64 | 40.6 | 13.5 |
| **Pictorial Language Score** | 4840 | 24 | 100 | 63.4 | 10.1 |
| **Friendly Maths Test** | 4501 | 1 | 72 | 46.7 | 11.7 |
| **Spelling score** | 4810 | 0 | 50 | 37.0 | 9.9 |
| **BAS word definitions** | 4475 | 0 | 30 | 11.0 | 5.0 |
| **BAS word similarities** | 4452 | 0 | 20 | 12.5 | 2.5 |
| **BAS digit recall score** | 4469 | 1 | 34 | 22.8 | 4.2 |
| **BAS Matrices** | 4460 | 0 | 28 | 16.5 | 5.2 |

# Results

We begin our analysis by presenting a series of General Linear Models (GLM) for each of the three separate test scores. The dependent variables are transformed into standardised Z scores, with mean=0 and standard deviation=1. These analyses use all the available cases with test score data at age 16, including cohort members who took the tests at home in the case of vocabulary and spelling. Subsequently, we present multivariate general linear models (MGLM), also known as multivariate response models, which treat the outcome variables jointly, and hence use only those cases with data for all three test scores at age 16. These analyses do not include any study members who took the tests at home, since the arithmetic test was not included in the home test booklet.

## General Linear Model results

### Table 6: General linear models 1-4

**Model 1**

| | **Arithmetic** | | **Spelling** | | **Vocabulary** | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Intercept** | -.400 | .000** | -.058 | .245 | -.390 | .000** |
| **Sex (Male)** | .031 | .322 | -.263 | .000** | -.007 | .784 |
| **Social Class** | | | | | | |
| **(Ref = Classes 4-7 + Not working)** | | | | | | |
| Missing | .079 | .264 | .022 | .710 | .076 | .170 |
| Classes 1-3 | .092 | .011* | .053 | .076 | .061 | .029* |
| **Parental qualifications** | | | | | | |
| **(Ref = No quals)** | | | | | | |
| Missing | -.060 | .549 | -.129 | .170 | -.045 | .604 |
| Other | .217 | .038* | .303 | .000** | .281 | .000** |
| Vocational | .175 | .000** | .052 | .196 | .173 | .000** |
| O-level etc | .281 | .000** | .220 | .000** | .354 | .000** |
| A-level etc | .320 | .000** | .241 | .000** | .456 | .000** |
| Nurse | .365 | .001** | .228 | .009** | .470 | .000** |
| Teacher | .604 | .000** | .416 | .000** | .663 | .000** |
| Degree+ | .649 | .000** | .443 | .000** | .735 | .000** |
| **Gross income per week** | | | | | | |
| **(Ref = under £100)** | | | | | | |
| Missing | -.041 | .618 | .050 | .366 | -.006 | .904 |
| Over £150 per week | .144 | .004** | .080 | .057 | .081 | .038* |
| £100-149 per week | .088 | .0.46* | .077 | .036* | .029 | .393 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Tenure** | | | | | | |
| **(Ref = Renter / Other)** | | | | | | |
| Missing | .367 | .047* | .051 | .739 | .069 | .634 |
| Homeowner | .233 | .000** | .083 | .013* | .128 | .000** |
| **Number of adults in home (Age** | | | | | | |
| **(Ref = 2)** | | | | | | |
| HH size missing | -.353 | .079 | -.167 | .315 | -.209 | .178 |
| One | .098 | .200 | -.033 | .591 | .092 | .114 |
| 3+ | -.157 | .043* | -.052 | .413 | -.030 | .605 |
| **Number of younger siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.073 | .073 | -.042 | .207 | -.146 | .000** |
| 2+ | -.084 | .147 | -.038 | .422 | -.222 | .000** |
| **Elder siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.084 | .046* | -.174 | .000** | -.235 | .000** |
| 2+ | -.237 | .000** | -.175 | .000** | -.297 | .000** |
| **Completed tests at home** | | | .008 | .776 | .537 | .000** |
| **N** | 3,676 | | 5,649 | | 5,756 | |
| **$R^2$** | 0.112 | | 0.066 | | 0.183 | |

**Model 2**

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Intercept** | -.644 | .000** | -.307 | .000** | -.712 | .000** |
| **Sex (Male)** | .046 | .139 | -.249 | .000** | .010 | .661 |
| **Social Class** | | | | | | |
| **(Ref = Classes 4-7 + Not working)** | | | | | | |
| Missing | .077 | .270 | .021 | .722 | .062 | .256 |
| Classes 1-3 | .062 | .083 | .034 | .246 | .030 | .271 |
| **Parental quals** | | | | | | |
| **(Ref = No quals)** | | | | | | |
| Missing | -.076 | .470 | -.025 | .795 | .005 | .953 |
| Other | .160 | .124 | .293 | .001** | .241 | .002** |
| Vocational | .152 | .002** | .018 | .645 | .138 | .000** |
| O-level etc | .223 | .000** | .158 | .000** | .268 | .000** |
| A-level etc | .241 | .000** | .174 | .001** | .339 | .000** |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| Nurse | .270 | .014* | .137 | .117 | .344 | .000** |
| Teacher | .479 | .000** | .322 | .000** | .484 | .000** |
| Degree+ | .511 | .000** | .357 | .000** | .543 | .000** |
| **Gross income per week** | | | | | | |
| **(Ref = under £100)** | | | | | | |
| Missing | .048 | .476 | .056 | .309 | .005 | .915 |
| Over £150 per week | .114 | .024* | .055 | .186 | .044 | .248 |
| £100-149 per week | .086 | .050 | .069 | .059 | .029 | .390 |
| **Tenure** | | | | | | |
| **(Ref = Renter / Other)** | | | | | | |
| Missing | .294 | .110 | .056 | .715 | .035 | .807 |
| Homeowner | .218 | .000** | .072 | .029* | .098 | .001** |
| **Number of adults in home (Age 10)** | | | | | | |
| **(Ref = 2)** | | | | | | |
| HH size missing | -.283 | .156 | -.175 | .285 | -.191 | .209 |
| One | .121 | .121 | -.030 | .633 | .106 | .073 |
| 3+ | -.167 | .030* | -.047 | .459 | -.030 | .601 |
| **Number of younger siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.042 | .303 | -.022 | .504 | -.105 | .001** |
| 2+ | -.040 | .486 | .004 | .940 | -.160 | .000** |
| **Elder siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.059 | .157 | -.154 | .000** | -.200 | .000** |
| 2+ | -.196 | .000** | -.135 | .001** | -.247 | .000** |
| **Completed tests at home** | | | -.002 | .933 | .509 | .000** |
| **Number of days child read to at 5** | | | | | | |
| **(Ref = 0)** | | | | | | |
| Missing | .249 | .000** | .064 | .269 | .165 | .002** |
| 1 to 3 | .184 | .006** | .124 | .025* | .085 | .095 |
| 4 to 6 | .197 | .005** | .122 | .036* | .230 | .000** |
| 7 | .280 | .000** | .214 | .000** | .316 | .000** |
| **Father's reading** | | | | | | |
| Missing | -.012 | .873 | .050 | .389 | .109 | .041* |
| Books | .026 | .549 | .021 | .542 | .142 | .000** |
| Magazines | -.007 | .881 | .010 | .779 | .022 | .506 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Mother's reading** | | | | | | |
| Missing | .028 | .776 | .091 | .263 | .046 | .537 |
| Books | .068 | .144 | .086 | .019* | .063 | .064 |
| Magazines | .094 | .045* | -.003 | .930 | .028 | .412 |
| **Parental reading problems** | | | | | | |
| Instrument non-response | -.047 | .695 | .024 | .822 | -.080 | .413 |
| Mother - item non-response | -.398 | .001** | -.376 | .000** | -.263 | .002** |
| Missing | -.010 | .920 | -.056 | .518 | -.014 | .863 |
| Mum has reading problem | -.083 | .405 | -.183 | .019* | -.121 | .093 |
| Father - item non-response | -.080 | .415 | -.078 | .310 | -.075 | .284 |
| Dad has reading problem | -.290 | .005** | -.274 | .000** | -.180 | .014* |
| **Reading material in home at 16** | | | | | | |
| Comics | -.050 | .318 | .074 | .065 | -.068 | .065 |
| Magazines | .004 | .918 | .015 | .639 | .087 | .003** |
| Weekend papers | .008 | .833 | -.056 | .063 | -.036 | .187 |
| Local papers | .004 | .929 | .024 | .477 | .020 | .529 |
| Sunday papers | .073 | .076 | .114 | .000** | .091 | .002** |
| Tabloids | -.111 | .004** | .023 | .464 | -.087 | .002** |
| Broadsheets | .148 | .006** | .085 | .040* | .160 | .000* |
| **N** | 3,676 | | 5,649 | | 5,756 | |
| **$R^2$** | 0.140 | | 0.091 | | 0.218 | |

**Model 3**

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Intercept** | -1.361 | .000** | -.972 | .000** | -1.335 | .000** |
| **Sex (Male)** | .145 | .000** | -.164 | .000** | .134 | .000** |
| **Social Class** | | | | | | |
| **(Ref = Classes 4-7 + Not working)** | | | | | | |
| Missing | .068 | .313 | .004 | .943 | .060 | .236 |
| Classes 1-3 | .053 | .122 | .023 | .400 | .015 | .551 |
| **Parental quals** | | | | | | |
| **(Ref = No quals)** | | | | | | |
| Missing | -.071 | .483 | -.033 | .714 | -.033 | .686 |
| Other | .131 | .190 | .270 | .000** | .175 | .016* |
| Vocational | .147 | .002** | .026 | .483 | .138 | .000** |
| O-level etc | .188 | .000** | .135 | .000** | .217 | .000** |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| A-level etc | .215 | .000** | .129 | .006** | .286 | .000** |
| Nurse | .270 | .010* | .128 | .111 | .304 | .000** |
| Teacher | .410 | .000** | .208 | .008** | .375 | .000** |
| Degree+ | .441 | .000** | .275 | .000** | .463 | .000** |
| **Gross income per week** | | | | | | |
| **(Ref = under £100)** | | | | | | |
| Missing | .032 | .613 | .031 | .533 | -.015 | .758 |
| Over £150 per week | .117 | .016* | .066 | .085 | .048 | .179 |
| £100-149 per week | .085 | .043* | .077 | .022* | .046 | .143 |
| **Tenure** | | | | | | |
| **(Ref = Renter / Other)** | | | | | | |
| Missing | .359 | .043* | .023 | .868 | .061 | .645 |
| Homeowner | .210 | .000** | .055 | .072 | .083 | .003** |
| **Number of adults in home (Age 10)** | | | | | | |
| **(Ref = 2)** | | | | | | |
| HH size missing | -.066 | .775 | .217 | .252 | .030 | .867 |
| One | .162 | .031* | .035 | .546 | .136 | .013* |
| 3+ | -.153 | .038* | -.026 | .655 | -.033 | .539 |
| **Number of younger siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.040 | .306 | -.002 | .947 | -.090 | .001** |
| 2+ | -.038 | .493 | .012 | .775 | -.157 | .000** |
| **Elder siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.025 | .534 | -.074 | .019* | -.112 | .000** |
| 2+ | -.163 | .001** | -.075 | .044* | -.181 | .000** |
| **Completed tests at home** | | | -.009 | .713 | .473 | .000** |
| **Number of days child read to at 5** | | | | | | |
| **(Ref = 0)** | | | | | | |
| Missing | .175 | .009** | .028 | .589 | .117 | .018* |
| 1 to 3 | .138 | .031* | .082 | .107 | .057 | .224 |
| 4 to 6 | .142 | .037* | .083 | .122 | .188 | .000** |
| 7 | .186 | .003** | .136 | .006** | .232 | .000** |
| **Father's reading** | | | | | | |
| Missing | -.014 | .844 | .036 | .500 | .092 | .065 |
| Books | .003 | .950 | -.007 | .833 | .103 | .000** |
| Magazines | | | | | | |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Mother's reading** | | | | | | |
| Missing | -.002 | .954 | -.016 | .632 | .021 | .504 |
| Books | .049 | .278 | .071 | .034* | .043 | .177 |
| Magazines | .063 | .157 | -.024 | .484 | -.006 | .848 |
| **Parental reading problems** | | | | | | |
| Instrument non-response | -.077 | .510 | -.067 | .493 | -.105 | .249 |
| Mother - item non-response | -.379 | .001** | -.329 | .000** | -.254 | .001** |
| Missing | -.030 | .767 | -.089 | .264 | -.029 | .698 |
| Mum has reading problem | -.073 | .441 | -.151 | .035* | -.109 | .105 |
| Father - item non-response | -.075 | .424 | -.073 | .293 | -.051 | .439 |
| Dad has reading problem | -.246 | .012* | -.203 | .005** | -.128 | .060 |
| **Reading material in home at 16** | | | | | | |
| Comics | -.029 | .545 | .063 | .090 | -.062 | .074 |
| Magazines | -.002 | .967 | .008 | .774 | .078 | .004** |
| Weekend papers | .009 | .815 | -.057 | .039* | -.037 | .145 |
| Local papers | -.009 | .824 | .003 | .927 | .011 | .712 |
| Sunday papers | .042 | .288 | .082 | .006** | .063 | .022* |
| Tabloids | -.136 | .000** | -.005 | .865 | -.098 | .000** |
| Broadsheets | .103 | .046* | .074 | .051 | .117 | .001** |
| **CM Book reading Age 10** | | | | | | |
| **(Ref = Never or hardly ever)** | | | | | | |
| Missing | .521 | .013* | .382 | .035* | .424 | .010** |
| Often | .470 | .000** | .552 | .000** | .467 | .000** |
| Sometimes | .301 | .000** | .317 | .000** | .154 | .011* |
| **CM Library visits Age 10** | | | | | | |
| **(Ref = Never or hardly ever)** | | | | | | |
| Missing | -.330 | .048* | -.169 | .225 | -.237 | .064 |
| Often | .172 | .000** | .095 | .010* | .062 | .074 |
| Sometimes | .026 | .551 | .040 | .259 | .010 | .771 |
| **CM reads newspapers Age 16** | | | | | | |
| **(Ref = Rarely / Never)** | | | | | | |
| Missing | -.222 | .071 | -.532 | .000** | -.175 | .062 |
| More than once a week | .412 | .000** | .291 | .000** | .263 | .000** |
| Once a week | .258 | .000** | .206 | .000** | .112 | .012* |
| Less than once a week | .182 | .012* | .132 | .021* | .061 | .250 |
| **CM reads comics or mags Age 16** | | | | | | |
| **(Ref = Rarely / Never)** | | | | | | |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| Missing | .032 | .779 | -.403 | .000** | -.172 | .044* |
| More than once a week | -.181 | .000** | -.013 | .727 | -.078 | .025* |
| Once a week | .032 | .467 | .090 | .008** | .066 | .041* |
| Less than once a week | .010 | .841 | .080 | .031* | .071 | .040* |
| **CM reads books Age 16** | | | | | | |
| **(Ref = Rarely / Never)** | | | | | | |
| Missing | .171 | .139 | -.313 | .000** | -.105 | .212 |
| More than once a week | .229 | .000** | .166 | .000** | .425 | .000** |
| Once a week | .100 | .047* | .020 | .609 | .196 | .000** |
| Less than once a week | .157 | .000** | .087 | .011* | .156 | .000** |
| **N** | 3,676 | | 5,649 | | 5,756 | |
| **$R^2$** | 0.216 | | 0.243 | | 0.330 | |

**Model 4**

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Intercept** | -.667 | .000** | -.614 | .000** | -.846 | .000** |
| **Sex (Male)** | .081 | .004** | -.161 | .000** | .069 | .002** |
| **Social Class** | | | | | | |
| **(Ref = Classes 4-7 + Not working)** | | | | | | |
| Missing | .059 | .302 | -.011 | .827 | .035 | .449 |
| Classes 1-3 | .028 | .344 | .002 | .925 | -.012 | .618 |
| **Parental quals** | | | | | | |
| **(Ref = No quals)** | | | | | | |
| Missing | -.122 | .161 | -.079 | .352 | -.107 | .161 |
| Other | .067 | .430 | .225 | .002** | .097 | .147 |
| Vocational | .105 | .008** | .009 | .794 | .092 | .004** |
| O-level etc | .066 | .092 | .061 | .078 | .100 | .001** |
| A-level etc | .085 | .087 | .039 | .384 | .154 | .000** |
| Nurse | .173 | .054 | .073 | .336 | .184 | .008** |
| Teacher | .147 | .082 | .054 | .469 | .141 | .035* |
| Degree+ | .164 | .002** | .120 | .010** | .226 | .000** |
| **Gross income per week** | | | | | | |
| **(Ref = under £100)** | | | | | | |
| Missing | -.009 | .870 | .004 | .934 | -.065 | .137 |
| Over £150 per week | .031 | .449 | .031 | .396 | .004 | .910 |
| £100-149 per week | .021 | .564 | .042 | .190 | -.003 | .927 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| **Tenure** | | | | | | |
| **(Ref = Renter / Other)** | | | | | | |
| Missing | .182 | .227 | -.011 | .934 | .044 | .720 |
| Homeowner | .092 | .004** | .003 | .912 | .017 | .522 |
| **Number of adults in home (Age 10)** | | | | | | |
| **(Ref = 2)** | | | | | | |
| HH size missing | -.026 | .896 | .165 | .360 | .002 | .988 |
| One | .124 | .053 | -.002 | .973 | .087 | .086 |
| 3+ | -.165 | .009** | -.008 | .891 | -.014 | .776 |
| **Number of younger siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | .025 | .453 | .019 | .504 | -.048 | .068 |
| 2+ | .040 | .396 | .054 | .191 | -.058 | .116 |
| **Elder siblings in home** | | | | | | |
| **(Ref = 0)** | | | | | | |
| 1 | -.030 | .389 | -.045 | .137 | -.065 | .016* |
| 2+ | -.132 | .001** | -.026 | .459 | -.099 | .002** |
| **Completed tests at home** | | | -.023 | .344 | .458 | .000** |
| **Number of days child read to at 5** | | | | | | |
| **(Ref = 0)** | | | | | | |
| Missing | -.008 | .928 | -.011 | .884 | -.011 | .875 |
| 1 to 3 | .076 | .163 | .051 | .294 | -.012 | .784 |
| 4 to 6 | .020 | .726 | .032 | .535 | .071 | .126 |
| 7 | .061 | .255 | .067 | .161 | .092 | .031* |
| **Father's reading** | | | | | | |
| Missing | -.081 | .173 | .000 | .993 | .039 | .399 |
| Books | -.021 | .555 | -.021 | .469 | .070 | .009** |
| Magazines | -.018 | .636 | -.011 | .734 | .014 | .632 |
| **Mother's reading** | | | | | | |
| Missing | -.017 | .836 | .090 | .205 | .043 | .504 |
| Books | .020 | .594 | .046 | .148 | .010 | .724 |
| Magazines | .073 | .056 | -.004 | .893 | .003 | .915 |
| **Parental reading problems** | | | | | | |
| Instrument non-response | -.023 | .814 | -.033 | .720 | -.078 | .348 |
| Mother - item non-response | -.231 | .014* | -.248 | .002** | -.151 | .036* |
| Missing | .070 | .411 | -.054 | .480 | .012 | .859 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| Mum has reading problem | -.053 | .517 | -.137 | .043* | -.076 | .220 |
| Father - item non-response | .042 | .599 | .027 | .684 | .048 | .424 |
| Dad has reading problem | -.118 | .158 | -.131 | .054 | -.078 | .210 |
| **Reading material in home at 16** | | | | | | |
| Comics | .004 | .916 | .085 | .015* | -.033 | .294 |
| Magazines | .012 | .706 | .001 | .984 | .059 | .018* |
| Weekend papers | .003 | .917 | -.045 | .086 | -.025 | .292 |
| Local papers | -.038 | .278 | -.016 | .591 | .004 | .870 |
| Sunday papers | .027 | .419 | .073 | .009** | .061 | .017* |
| Tabloids | -.090 | .005** | .032 | .247 | -.044 | .076 |
| Broadsheets | .062 | .159 | .066 | .071 | .094 | .004** |
| **CM Book reading Age 10** | | | | | | |
| **(Ref = Never or hardly ever)** | | | | | | |
| Missing | .299 | .094 | .240 | .165 | .252 | .096 |
| Often | .166 | .012* | .327 | .000** | .222 | .000** |
| Sometimes | .178 | .006** | .234 | .000** | .069 | .217 |
| **CM Library visits Age 10** | | | | | | |
| **(Ref = Never or hardly ever)** | | | | | | |
| Missing | -.250 | .078 | -.133 | .315 | -.211 | .074 |
| Often | .112 | .005** | .059 | .094 | .023 | .479 |
| Sometimes | .003 | .927 | .024 | .481 | -.005 | .861 |
| **CM reads newspapers Age 16** | | | | | | |
| **(Ref = Rarely / Never)** | | | | | | |
| Missing | -.287 | .006** | -.548 | .000** | -.192 | .027* |
| More than once a week | .240 | .000** | .200 | .000** | .173 | .000** |
| Once a week | .182 | .000** | .175 | .000** | .100 | .016* |
| Less than once a week | .070 | .253 | .089 | .101 | .024 | .632 |
| **CM reads comics or mags Age 16** | | | | | | |
| **(Ref = Rarely / Never)** | | | | | | |
| Missing | .017 | .859 | -.425 | .000** | -.170 | .031* |
| More than once a week | -.121 | .003** | 2.760 E-05 | .999 | -.060 | .061 |
| Once a week | .014 | .718 | .075 | .021* | .052 | .077 |
| Less than once a week | -.019 | .637 | .058 | .099 | .043 | .176 |
| **CM reads books Age 16** | | | | | | |
| **(Ref = Rarely / Never)** | | | | | | |
| Missing | .225 | .022* | -.324 | .000** | -.123 | .113 |
| More than once a week | .133 | .000** | .106 | .001** | .329 | .000** |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **Sig.** | **B** | **Sig.** | **B** | **Sig.** |
| Once a week | .072 | .090 | -.012 | .746 | .148 | .000** |
| Less than once a week | .096 | .010** | .051 | .115 | .107 | .000** |
| **Test scores** | | | | | | |
| **Age 5** | | | | | | |
| Copying designs | .131 | .000** | .081 | .000** | .045 | .001** |
| Pictorial vocabulary | .041 | .016* | .001 | .972 | .078 | .000** |
| Human figure drawing | .019 | .234 | .007 | .593 | .023 | .068 |
| Profile test score | -.031 | .036* | -.005 | .724 | -.003 | .819 |
| Reading test | .024 | .084 | .050 | .000** | .037 | .000** |
| **Age 10** | | | | | | |
| Edinburgh Reading Test | .019 | .464 | .082 | .000** | .090 | .000** |
| Friendly Maths Test | .368 | .000** | .056 | .011* | .043 | .030* |
| Pictorial Language | -.019 | .353 | .019 | .286 | .061 | .000** |
| Spelling | .160 | .000** | .242 | .000** | .154 | .000** |
| BAS matrices | .094 | .000** | -.006 | .722 | -.023 | .149 |
| BAS word definitions | -.009 | .686 | -.003 | .870 | .119 | .000** |
| BAS word similarities | -.016 | .453 | -.009 | .633 | .040 | .019* |
| BAS digit recall | .041 | .014* | -.028 | .053 | -.005 | .710 |
| **Missing scores** | | | | | | |
| **Age 5** | | | | | | |
| Copying designs | .138 | .523 | -.056 | .771 | -.093 | .588 |
| Pictorial vocabulary | -.094 | .096 | .026 | .607 | .069 | .130 |
| Human Figure Drawing | -.088 | .489 | -.260 | .027* | -.151 | .149 |
| Profile test score | .000 | .995 | .109 | .122 | -.010 | .880 |
| Reading test | .127 | .424 | .200 | .142 | .255 | .037* |
| **Age 10** | | | | | | |
| Edinburgh Reading Test | .575 | .010* | .261 | .202 | .239 | .205 |
| Friendly Maths Test | -.284 | .208 | -.303 | .136 | -.102 | .590 |
| Pictorial Language | .009 | .926 | .087 | .304 | -.028 | .706 |
| Spelling | -.114 | .213 | -.062 | .454 | -.019 | .797 |
| BAS matrices | -.343 | .053 | -.031 | .840 | -.041 | .773 |
| BAS word definitions | .273 | .264 | -.477 | .040* | -.144 | .491 |
| BAS word similarities | -.101 | .667 | .108 | .642 | -.195 | .345 |
| BAS digit recall | -.034 | .865 | .438 | .010* | .323 | .034* |
| **N** | 3,676 | | 5,649 | | 5,756 | |
| **$R^2$** | 0.442 | | 0.322 | | 0.437 | |

Table 6 shows the linear regression results. In Model 1 we control only for sex, family background and (in the case of spelling and vocabulary) whether the tests were completed at home. Model 1 shows no link between gender and maths or vocabulary scores, but a significant negative coefficient for males on the spelling score. Parents' qualifications are significantly linked to all three test scores in this model, with the children of more highly educated parents achieving higher scores, particularly in vocabulary. There are some significant effects of parents' social class, income and housing tenure but these coefficients are smaller than those for parental education. Older siblings are negative for all three test outcomes, but the coefficients are larger for vocabulary, and in the case of vocabulary, younger siblings are also significantly negative. These findings suggest that the presence of both older and younger siblings is particularly negative for the development of children's vocabularies, which could be explained by children with more siblings tending to spend less time in individual conversation with their parents.

Having completed the vocabulary test at home rather than at school is significantly positive for vocabulary, but not for spelling. This is surprising, given that the same mode of cheating (using a dictionary) would have been equally effective for both tests.

In model 2, we introduce variables related to the home reading climate. How often the child was read to at age five is significant across the three test scores. The father reading books is significant for vocabulary scores, and the mother reading books is significant for spelling. As noted earlier, few mothers acknowledged reading problems. The coefficient for this parameter was negative, but only statistically significant in the case of spelling. Item non-response on this variable was however significantly negative across all three scores, confirming our hypothesis that mothers who left this item blank may have been relatively likely to have reading problems. In the case of fathers, the response that the father had a reading problem is significantly negative across the three scores, while the non-response parameter is non-significant. This disparity may be due to the fact that it was the mother who completed the questionnaire.

Turning to newspapers and magazines in the home, we can see that neither comics, weekend papers, nor local papers were significant for any of the test score outcomes. There were some positive coefficients for magazines, Sunday papers and broadsheets, but tabloid newspapers were significantly linked to lower test scores in both maths and vocabulary.

In this model, the social class and income coefficients, which were already weak, are rendered broadly non-significant, but housing tenure remains significant. Parents' education remains significant, though the coefficients are reduced.

Model 3 introduces the child's own reading behaviour. Book reading at 10 and 16 and newspaper reading at 16 are particularly significant. Interestingly, gender becomes significant for maths and vocabulary in this model, with positive coefficients for boys (the male coefficient on spelling remains negative). This suggests that, while boys' absolute performance was not different from girls' in maths and vocabulary, boys performed at higher levels than girls for any given level of recreational reading – in other words, boys performed

as well as girls, despite not reading as much as girls. The influence of variables reflecting the parents' reading culture is reduced but still significant in this model.

Model four introduces the cohort member's test scores at the ages of five and ten. We treat each score as a standardised Z score, with missing values set to the mean, and a missing dummy included to account for this. The inclusion of the age five and ten test scores in the model means that it becomes a model of how far the predictions of model 3 had already been established by age ten, and how far they continued to be reflected in changes in the child's test scores between age ten and age 16. Essentially it is a model of progress, with the proviso that the tests taken at ages five and ten were not the same as those taken at 16, although vocabulary was measured at both 5 and 10, and both maths and spelling were also measured at age 10. Coefficients in this model could be biased if measurement error in the cognitive tests at ages 5 and 10 are linked to other variables of interest (Jerrim and Vignoles 2013 in press). Therefore, we have minimised the risk of spurious results due to measurement error in any given test by including a full set of individual test scores at both ages in our analysis.

Overall, the age five and ten tests are highly predictive of scores in the age 16 tests, as one would expect. Also as expected, tests in a given domain tended to be most strongly predictive of tests in the same domain, e.g. age ten spelling was highly predictive of spelling at 16, and age ten maths was highly predictive of maths at 16.

Many variables that were significant in model 3 become non-significant or marginally significant in model 4 because they are linked to absolute attainment in the test scores at age 16, but not to progress between ten and 16. Parents' education remains significant, but the coefficient is much reduced in size. The link with parents' education remains strongest in the case of the vocabulary test. All the economic indicators are insignificant in this model, with the exception of the link between home ownership and maths test scores. The negative influence of elder siblings remains significant for maths and vocabulary.

The mother's non-response regarding reading difficulties remains significant across all three test scores. Newspapers in the home also remain significant, with a negative link to tabloids for maths and a positive link to broadsheets and Sunday papers for spelling and vocabulary.

Importantly, the cohort member's own reading behaviour, including reading books and newspapers, remains highly significant in model 4. This suggests that it is not just the case that academically able children read more, but that leisure reading is linked to greater cognitive progress during adolescence.

## Multivariate general linear models

The multivariate general linear models (MGLM) use only the subsample of cohort members who took all three tests. This analysis broadly confirms the results from the regressions shown above, although the samples for spelling and vocabulary are reduced (see table 7). This is reassuring as a robustness check on the home test data, as including or excluding these scores does not substantially affect the results.

## Table 7: Multivariate general linear models 1-4 (n=3,424)

**Model 1**

| | **Arithmetic** | | **Spelling** | | **Vocabulary** | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Intercept | -.370 | .000** | -.081 | .099 | -.442 | .000** |
| **Sex (Male)** | .049 | .128 | -.296 | .000** | .023 | .398 |
| **Social Class (ref 4-7 + not working)** | | | | | | |
| Missing | .074 | .308 | .030 | .604 | .092 | .138 |
| Classes 1-3 | .074 | .045* | .052 | .073 | .059 | .060 |
| **Parental quals (ref=none)** | | | | | | |
| Missing | -.016 | .881 | -.131 | .112 | -.081 | .365 |
| Other | .212 | .048* | .225 | .008** | .224 | .015* |
| Vocational | .191 | .000** | .103 | .009** | .162 | .000** |
| O-level etc | .285 | .000** | .250 | .000** | .345 | .000** |
| A-level etc | .331 | .000** | .222 | .000** | .429 | .000** |
| Nurse | .357 | .001** | .228 | .011* | .442 | .000** |
| Teacher | .633 | .000** | .307 | .000** | .686 | .000** |
| Degree+ | .651 | .000** | .447 | .000** | .787 | .000** |
| **Gross income per week (ref=<£100)** | | | | | | |
| Missing | .066 | .341 | .016 | .768 | .025 | .672 |
| Over £150 per week | .126 | .014* | .063 | .121 | .120 | .007** |
| £100-149 per week | .089 | .048* | .081 | .024* | .059 | .129 |
| **Housing tenure (Ref = Renter / Other)** | | | | | | |
| Missing | .317 | .108 | .184 | .239 | .108 | .521 |
| Home owner | .211 | .000** | .098 | .002** | .131 | .000** |
| **Number of adults in home (ref=2)** | | | | | | |
| HH size missing | -.320 | .131 | -.184 | .275 | -.105 | .564 |
| One | .100 | .193 | .040 | .512 | .094 | .155 |
| 3+ | -.131 | .098 | .006 | .923 | .004 | .953 |
| **Younger siblings (ref=0)** | | | | | | |
| 1 | -.067 | .106 | -.023 | .483 | -.135 | .000** |
| 2+ | -.053 | .364 | -.014 | .772 | -.196 | .000** |
| **Older siblings (ref=0)** | | | | | | |
| 1 | -.085 | .046* | -.126 | .000** | -.232 | .000** |
| 2+ | -.195 | .000** | -.198 | .000** | -.286 | .000** |
| **Adjusted R squared** | .099 | | .105 | | .151 | |

**Model 2**

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Intercept | -.498 | .000** | -.212 | .032* | -.689 | .000** |
| **Sex (Male)** | .065 | .041* | -.282 | .000** | .041 | .128 |
| **Social Class (ref 4-7 + not working)** | | | | | | |
| Missing | .071 | .323 | .038 | .497 | .077 | .200 |
| Classes 1-3 | .045 | .214 | .034 | .241 | .030 | .336 |
| **Parental quals (ref=none)** | | | | | | |
| Missing | -.034 | .756 | -.105 | .222 | -.045 | .621 |
| Other | .151 | .157 | .193 | .022* | .159 | .077 |
| Vocational | .168 | .001** | .079 | .044* | .135 | .001** |
| O-level etc | .227 | .000** | .196 | .000** | .265 | .000** |
| A-level etc | .252 | .000** | .157 | .001** | .323 | .000** |
| Nurse | .256 | .021* | .155 | .079 | .320 | .001** |
| Teacher | .511 | .000** | .223 | .006** | .518 | .000** |
| Degree+ | .512 | .000** | .362 | .000** | .593 | .000** |
| **Gross income per week (ref=<£100)** | | | | | | |
| Missing | .071 | .299 | .030 | .577 | .033 | .565 |
| Over £150 per week | .098 | .056 | .042 | .301 | .079 | .067 |
| £100-149 per week | .087 | .051 | .077 | .030* | .057 | .134 |
| **Housing tenure (Ref = Renter / Other)** | | | | | | |
| Missing | .254 | .194 | .159 | .305 | .034 | .836 |
| Home owner | .199 | .000** | .086 | .007* | .103 | .003** |
| **Number of adults in home (ref=2)** | | | | | | |
| HH size missing | -.263 | .211 | -.154 | .357 | -.039 | .825 |
| One | .111 | .154 | .076 | .221 | .098 | .138 |
| 3+ | -.147 | .062 | .010 | .878 | -.012 | .854 |
| **Younger siblings (ref=0)** | | | | | | |
| 1 | -.035 | .399 | -.001 | .983 | -.090 | .010* |
| 2+ | -.012 | .843 | .032 | .492 | -.130 | .009** |
| **Older siblings (ref=0)** | | | | | | |
| 1 | -.060 | .158 | -.104 | .002** | -.193 | .000** |
| 2+ | -.154 | .002** | -.151 | .000** | -.230 | .000** |
| **Number of days child read to at 5 (ref=0)** | | | | | | |
| Missing | .235 | .001** | .227 | .000** | .255 | .000** |
| 1 to 3 | .149 | .0318 | .200 | .000** | .198 | .001** |
| 4 to 6 | .157 | .032* | .242 | .000** | .274 | .000** |
| 7 | .254 | .000** | .300 | .000** | .380 | .000** |
| **Father's reading** | | | | | | |
| Missing | .029 | .698 | -.051 | .388 | .155 | .013* |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Books | .031 | .475 | -.001 | .981 | .134 | .000** |
| Magazines | -.013 | .774 | -.016 | .664 | .011 | .767 |
| **Mother's reading** | | | | | | |
| Missing | -.013 | .901 | .055 | .498 | -.013 | .876 |
| Books | .067 | .154 | .060 | .110 | .057 | .154 |
| Magazines | .077 | .106 | .042 | .268 | .058 | .149 |
| **Parental reading problems** | | | | | | |
| Instrument non-response | -.052 | .671 | .033 | .734 | -.137 | .189 |
| Mother - item non-response | -.369 | .002** | -.179 | .055 | -.152 | .125 |
| Missing | -.025 | .813 | -.021 | .806 | -.082 | .359 |
| Mum has reading problem | -.101 | .318 | -.169 | .035* | -.106 | .213 |
| Dad- item non-response | -.123 | .219 | -.160 | .043* | -.160 | .059 |
| Dad has reading problem | -.304 | .004** | -.321 | .000** | -.303 | .001** |
| **Reading material in home at 16** | | | | | | |
| Comics | -.034 | .506 | .029 | .477 | -.087 | .043* |
| Magazines | .010 | .813 | .055 | .083 | .109 | .001** |
| Weekly papers | -.004 | .922 | -.067 | .028* | -.041 | .206 |
| Local papers | .010 | .809 | -.001 | .976 | -.014 | .706 |
| Sunday papers | .074 | .074 | .067 | .042* | .062 | .079 |
| Tabloids | -.110 | .005** | .013 | .668 | -.105 | .002** |
| Broadsheets | .138 | .010* | .049 | .249 | .184 | .000** |
| **Adjusted R squared** | .122 | | .132 | | .197 | |

**Model 3**

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Intercept | -1.334 | .000** | -1.083 | .000** | -1.585 | .000** |
| **Sex (Male)** | .151 | .000** | -.181 | .000** | .179 | .000** |
| **Social Class (ref 4-7 + not working)** | | | | | | |
| Missing | .064 | .355 | .025 | .646 | .082 | .141 |
| Classes 1-3 | .038 | .282 | .024 | .369 | .019 | .504 |
| **Parental quals (ref=none)** | | | | | | |
| Missing | -.028 | .787 | -.096 | .239 | -.047 | .579 |
| Other | .135 | .188 | .185 | .020* | .119 | .149 |
| Vocational | .161 | .001** | .077 | .037* | .131 | .001** |
| O-level etc | .195 | .000** | .173 | .000** | .223 | .000** |
| A-level etc | .222 | .000** | .139 | .003** | .276 | .000** |
| Nurse | .263 | .014* | .157 | .060 | .332 | .000** |
| Teacher | .445 | .000** | .155 | .046* | .423 | .000** |
| Degree+ | .441 | .000** | .298 | .000** | .496 | .000** |
| **Gross income per week (ref=<£100)** | | | | | | |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Missing | .050 | .451 | .002 | .972 | -.002 | .966 |
| Over £150 per week | .105 | .033 | .051 | .186 | .090 | .023* |
| £100-149 per week | .083 | .053 | .079 | .018* | .066 | .055 |
| **Housing tenure (Ref = Renter / Other)** | | | | | | |
| Missing | .347 | .065 | .192 | .189 | .101 | .503 |
| Home owner | .207 | .000** | .085 | .005** | .103 | .001** |
| **Number of adults in home (ref=2)** | | | | | | |
| HH size missing | -.069 | .780 | -.020 | .918 | .031 | .877 |
| One | .160 | .034* | .130 | .026* | .152 | .012* |
| 3+ | -.146 | .053 | .023 | .696 | -.011 | .851 |
| **Younger siblings (ref=0)** | | | | | | |
| 1 | -.026 | .515 | .005 | .874 | -.082 | .010* |
| 2+ | -.005 | .928 | .033 | .459 | -.133 | .003** |
| **Older siblings (ref=0)** | | | | | | |
| 1 | -.019 | .651 | -.050 | .119 | -.112 | .001** |
| 2+ | -.117 | .017* | -.106 | .006** | -.164 | .000** |
| **Number of days child read to at 5 (ref=0)** | | | | | | |
| Missing | .160 | .020* | .162 | .003** | .173 | .002** |
| 1 to 3 | .105 | .115 | .158 | .002** | .151 | .005** |
| 4 to 6 | .100 | .153 | .197 | .000** | .221 | .000** |
| 7 | .166 | .011* | .219 | .000** | .282 | .000** |
| **Father's reading** | | | | | | |
| Missing | .018 | .796 | -.059 | .290 | .138 | .016* |
| Books | .007 | .870 | -.029 | .372 | .088 | .009** |
| Magazines | -.007 | .879 | -.014 | .678 | .018 | .609 |
| **Mother's reading** | | | | | | |
| Missing | -.051 | .600 | .020 | .791 | -.065 | .406 |
| Books | .047 | .302 | .042 | .235 | .030 | .417 |
| Magazines | .048 | .296 | .013 | .724 | .022 | .547 |
| **Parental reading problems** | | | | | | |
| Instrument non-response | -.070 | .556 | .001 | .988 | -.141 | .142 |
| Mother - item non-response | -.367 | .001** | -.174 | .048* | -.166 | .067 |
| Missing | -.028 | .784 | -.032 | .689 | -.078 | .347 |
| Mum has reading problem | -.092 | .344 | -.156 | .039* | -.101 | .197 |
| Dad- item non-response | -.106 | .270 | -.158 | .034* | -.140 | .071 |
| Dad has reading problem | -.259 | .010* | -.261 | .001** | -.227 | .005** |
| **Reading material in home at 16** | | | | | | |
| Comics | -.019 | .693 | .025 | .516 | -.073 | .065 |
| Magazines | .009 | .824 | .042 | .165 | .093 | .003** |
| Weekly papers | .004 | .916 | -.055 | .055 | -.031 | .301 |
| Local papers | -.005 | .909 | -.015 | .634 | -.026 | .428 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Sunday papers | .050 | .210 | .044 | .158 | .041 | .197 |
| Tabloids | -.141 | .000** | -.009 | .759 | -.124 | .000** |
| Broadsheets | .097 | .061 | .017 | .669 | .120 | .004** |
| **Book reading age 10 (ref=never)** | | | | | | |
| Missing | .383 | .081 | .624 | .000** | .529 | .003** |
| Often | .485 | .000** | .616 | .000** | .580 | .000** |
| Sometimes | .318 | .000** | .334 | .000** | .251 | .000** |
| **CM Library visits Age 10 (ref=never or hardly ever)** | | | | | | |
| Missing | -.176 | .307 | -.232 | .084 | -.155 | .262 |
| Often | .161 | .001** | .051 | .171 | .061 | .114 |
| Sometimes | .002 | .958 | .020 | .572 | -.009 | .796 |
| **CM reads newspapers Age 16 (ref= rarely/ never)** | | | | | | |
| Missing | -.215 | .086 | -.043 | .656 | -.051 | .610 |
| More than once a week | .393 | .000** | .309 | .000** | .317 | .000** |
| Once a week | .243 | .000** | .245 | .000** | .184 | .000** |
| Less than once a week | .149 | .040* | .144 | .011* | .086 | .140 |
| **CM reads comics or mags Age 16 (ref rarely/ never)** | | | | | | |
| Missing | .104 | .361 | -.074 | .404 | .008 | .929 |
| More than once a week | -.179 | .000** | .000 | .992 | -.092 | .015* |
| Once a week | .036 | .414 | .076 | .026* | .005 | .878 |
| Less than once a week | .018 | .703 | .102 | .006** | .081 | .035* |
| **CM reads books Age 16 (ref= rarely/ never)** | | | | | | |
| Missing | .209 | .075 | .007 | .941 | .082 | .385 |
| More than once a week | .225 | .000** | .175 | .000** | .472 | .000** |
| Once a week | .103 | .040* | .012 | .764 | .205 | .000** |
| Less than once a week | .175 | .000** | .082 | .015* | .173 | .000** |
| **Adjusted R squared** | 0.190 | | 0.231 | | 0.332 | |

**Model 4**

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Intercept | -.552 | .000** | -.648 | .000** | -.828 | .000** |
| **Sex (Male)** | .087 | .002** | -.174 | .000** | .099 | .000** |
| **Social Class (ref 4-7 + not working)** | | | | | | |
| Missing | .056 | .333 | .019 | .689 | .072 | .124 |
| Classes 1-3 | .010 | .732 | .007 | .780 | -.012 | .613 |
| **Parental quals (ref=none)** | | | | | | |
| Missing | -.093 | .298 | -.110 | .137 | -.110 | .125 |
| Other | .068 | .431 | .182 | .011* | .076 | .279 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Vocational | .120 | .003** | .056 | .092 | .087 | .007** |
| O-level etc | .075 | .058 | .107 | .001** | .112 | .000** |
| A-level etc | .085 | .090 | .057 | .174 | .135 | .001** |
| Nurse | .173 | .056 | .137 | .069 | .222 | .002** |
| Teacher | .163 | .053 | -.013 | .851 | .148 | .029* |
| Degree+ | .161 | .003** | .138 | .002** | .255 | .000** |
| **Gross income per week (ref=<£100)** | | | | | | |
| Missing | .005 | .923 | -.019 | .686 | -.062 | .167 |
| Over £150 per week | .028 | .507 | .019 | .586 | .020 | .542 |
| £100-149 per week | .022 | .538 | .042 | .165 | .006 | .832 |
| **Housing tenure (Ref = Renter / Other)** | | | | | | |
| Missing | .213 | .180 | .163 | .218 | .058 | .652 |
| Home owner | .097 | .003** | .028 | .313 | .014 | .606 |
| **Number of adults in home (ref=2)** | | | | | | |
| HH size missing | -.047 | .823 | -.069 | .691 | -.005 | .977 |
| One | .124 | .051 | .083 | .118 | .081 | .115 |
| 3+ | -.162 | .011* | .027 | .608 | -.006 | .901 |
| **Younger siblings (ref=0)** | | | | | | |
| 1 | .029 | .387 | .031 | .266 | -.024 | .374 |
| 2+ | .057 | .238 | .066 | .101 | -.023 | .544 |
| **Older siblings (ref=0)** | | | | | | |
| 1 | -.030 | .393 | -.042 | .153 | -.084 | .003** |
| 2+ | -.100 | .017* | -.064 | .067 | -.083 | .014* |
| **Number of days child read to at 5 (ref=0)** | | | | | | |
| Missing | -.004 | .968 | .065 | .376 | -.059 | .408 |
| 1 to 3 | .042 | .459 | .121 | .010** | .083 | .066 |
| 4 to 6 | -.019 | .750 | .131 | .008** | .088 | .065 |
| 7 | .031 | .575 | .131 | .004** | .115 | .010* |
| **Father's reading** | | | | | | |
| Missing | -.065 | .281 | -.084 | .091 | .073 | .129 |
| Books | -.020 | .576 | -.037 | .212 | .055 | .050 |
| Magazines | -.022 | .560 | -.010 | .735 | .011 | .710 |
| **Mother's reading** | | | | | | |
| Missing | -.036 | .659 | .022 | .753 | -.054 | .415 |
| Books | .022 | .565 | .017 | .588 | -.009 | .768 |
| Magazines | .072 | .061 | .039 | .228 | .031 | .312 |
| **Parental reading problems** | | | | | | |
| Instrument non-response | -.009 | .930 | .052 | .533 | -.101 | .213 |
| Mother - item non-response | -.219 | .022* | -.061 | .440 | -.013 | .868 |
| Missing | .071 | .411 | .018 | .804 | .001 | .990 |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| Mum has reading problem | -.077 | .348 | -.138 | .044* | -.070 | .292 |
| Dad- item non-response | .012 | .886 | -.085 | .209 | -.071 | .278 |
| Dad has reading problem | -.106 | .212 | -.162 | .022* | -.140 | .041* |
| **Reading material in home at 16** | | | | | | |
| Comics | .011 | .794 | .049 | .156 | -.042 | .208 |
| Magazines | .019 | .572 | .041 | .133 | .076 | .004** |
| Weekly papers | .001 | .963 | -.051 | .049* | -.029 | .254 |
| Local papers | -.037 | .288 | -.032 | .273 | -.032 | .250 |
| Sunday papers | .035 | .300 | .033 | .234 | .033 | .223 |
| Tabloids | -.090 | .006** | .017 | .531 | -.079 | .003** |
| Broadsheets | .058 | .184 | -.004 | .911 | .081 | .022* |
| **Book reading age 10 (ref=never)** | | | | | | |
| Missing | .124 | .502 | .456 | .003** | .334 | .025* |
| Often | .162 | .016* | .381 | .000** | .313 | .000** |
| Sometimes | .176 | .008** | .247 | .000** | .176 | .001** |
| **CM Library visits Age 10 (ref=never or hardly ever)** | | | | | | |
| Missing | -.097 | .504 | -.182 | .133 | -.071 | .541 |
| Often | .102 | .011* | .009 | .788 | .009 | .791 |
| Sometimes | -.016 | .678 | .002 | .960 | -.034 | .262 |
| **CM reads newspapers Age 16 (ref= rarely/ never)** | | | | | | |
| Missing | -.277 | .009** | -.095 | .280 | -.088 | .299 |
| More than once a week | .218 | .000** | .192 | .000** | .183 | .000** |
| Once a week | .164 | .001** | .192 | .000** | .152 | .000** |
| Less than once a week | .026 | .668 | .081 | .111 | .009 | .847 |
| **CM reads comics or mags Age 16 (ref rarely/ never)** | | | | | | |
| Missing | .083 | .391 | -.076 | .346 | .016 | .836 |
| More than once a week | -.122 | .002** | .009 | .794 | -.074 | .021* |
| Once a week | .011 | .772 | .060 | .051 | -.026 | .376 |
| Less than once a week | -.015 | .716 | .080 | .016* | .049 | .126 |
| **CM reads books Age 16 (ref= rarely/ never)** | | | | | | |
| Missing | .257 | .009** | .015 | .860 | .058 | .469 |
| More than once a week | .126 | .001** | .116 | .000** | .353 | .000** |
| Once a week | .079 | .060 | -.005 | .893 | .161 | .000** |
| Less than once a week | .102 | .006** | .041 | .179 | .105 | .000** |
| **Age 5 tests** | | | | | | |
| Copying designs | .123 | .000** | .083 | .000** | .072 | .000** |
| Pictorial vocabulary | .036 | .040* | .004 | .766 | .091 | .000** |
| Human figure drawing | .026 | .110 | .005 | .706 | -.001 | .949 |
| Profile test score | -.029 | .050 | .012 | .348 | -.004 | .756 |
| Reading test | .021 | .124 | .043 | .000** | .039 | .000** |

| | Arithmetic | | Spelling | | Vocabulary | |
|---|---|---|---|---|---|---|
| | **B** | **p** | **B** | **p** | **B** | **p** |
| **Age 10 tests** | | | | | | |
| Edinburgh Reading Test | .014 | .603 | .090 | .000** | .117 | .000** |
| Friendly Maths Test | .368 | .000** | .089 | .000** | .050 | .013* |
| Pictorial Language | -.008 | .710 | -.003 | .869 | .076 | .000** |
| Spelling | .168 | .000** | .251 | .000** | .177 | .000** |
| BAS matrices | .101 | .000** | -.007 | .660 | -.013 | .439 |
| BAS word definitions | -.011 | .637 | -.019 | .301 | .134 | .000** |
| BAS word similarities | -.016 | .445 | -.015 | .398 | .019 | .272 |
| BAS digit recall | .043 | .011* | -.015 | .275 | -.008 | .570 |
| **Adjusted R squared** | 0.430 | | 0.377 | | 0.526 | |

We can use this analysis to compare model fit across the three outcomes, and to look at differences in the predictors across the three outcomes.

In model 1, we see that the model fit is strongest in the case of vocabulary ($R^2$ = 0.151) and weaker in the case of arithmetic (0.099) and spelling (0.105), suggesting that ascribed social characteristics are more important determinants of vocabulary than of the other two scores. In particular, parents' education and income were weaker predictors of spelling than of the other two scores. Parents' education was a much more powerful predictor than social class (only significant for arithmetic), income and housing tenure across all three scores. Being male is negative only for spelling, with no significant gender difference on the other two scores. Younger siblings are only negative for vocabulary and older siblings are negative across the board and particularly negative for vocabulary.

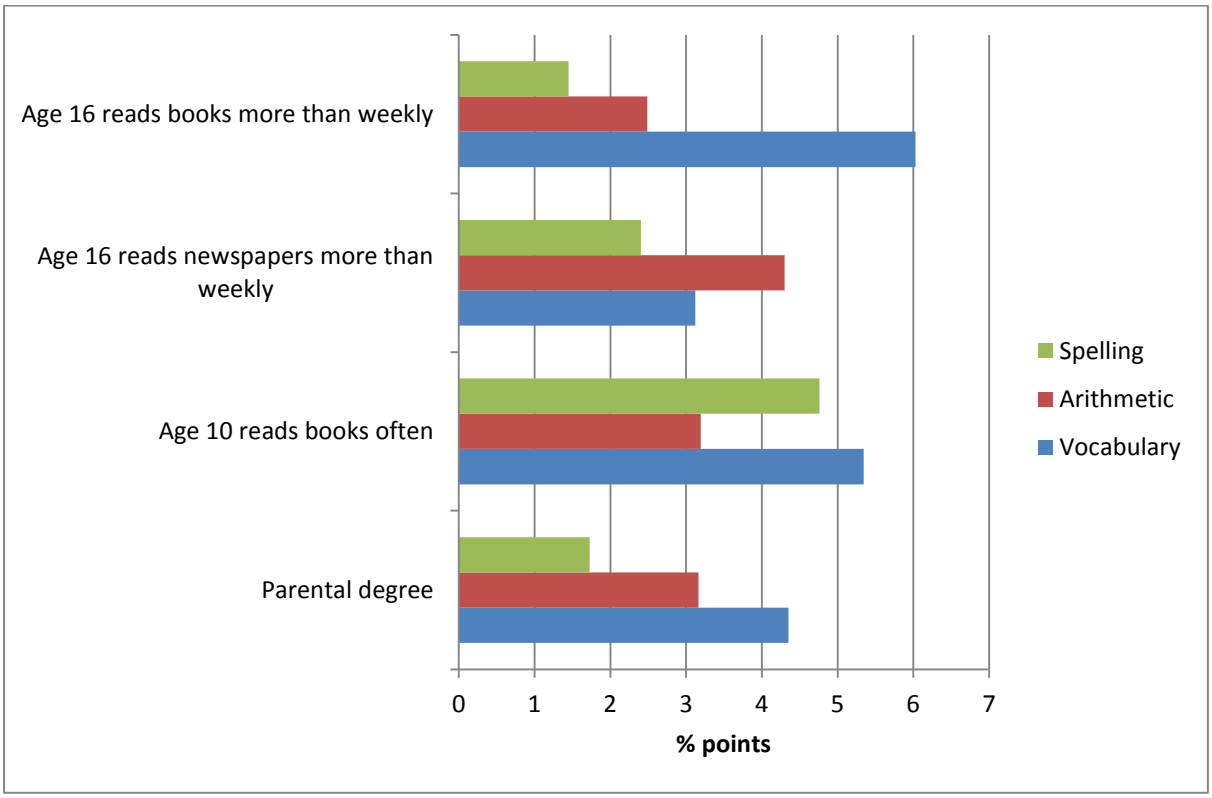
In model 2, the improvement in model fit is greatest for vocabulary, suggesting that the home reading climate is more important for vocabulary than for maths or spelling. In particular, fathers' reading of books and having broadsheets in the home were significantly positive only for vocabulary. The influence of parents' education is somewhat mediated in this model.

Model 3 also shows a substantially improved model fit for vocabulary, with smaller improvements for maths and spelling, suggesting that the child's own reading is most important for vocabulary development. In particular, the cohort member's reading at age 16 was more strongly linked to vocabulary than to the other scores. The influence of parental education is only slightly mediated in this model. Young people's leisure reading is important in its own right, but cannot largely explain social differentials in the test score outcomes we examine here.

In model 4, economic resources are no longer significant, with the exception of housing tenure in the case of maths. Parents' education is still highly significant, though much reduced, with the coefficients for a degree cut roughly in half. The ongoing influence of parents' education is strongest and most consistent in the case of vocabulary. The child's own reading remains powerfully significant in this model.

To put the effect sizes in context, the coefficients for a parental degree and for the key childhood reading variables are converted into percentage point equivalents in figure 1. Taking the three key variables reflecting childhood reading together, they add up to a gain of 14.54 percentage points in vocabulary, 10.0 percentage points in maths and 8.6 percentage points in spelling. This compares to a difference associated with a parental degree of 4.4 percentage points for vocabulary, 3.2 percentage points for maths and 1.7 percentage points for spelling. In other words, the influence of reading on cognitive growth is substantial.

**Figure 1: Selected coefficients from model 4 expressed as percentage point equivalents**




Finally, in supplementary analysis (available on request) we examined the question of whether the benefit of reading varied according to the educational level of the parent. We found that in the case of vocabulary, the children of graduates gained a more substantial advantage from reading (i.e. there was a significant positive interaction term between degree status and reading). But this was not the case for spelling or mathematics, where the interaction term proved insignificant.

## Conclusions

We found that differentials in test scores at age 16 due to parental social background varied across the three domains of mathematics, spelling and vocabulary. In line with our hypothesis, parental education, but not parental material resources, was more strongly linked to vocabulary than to maths and spelling scores. We also found that parental material resources were less strongly linked to all three test scores than was the case for parental education. These findings broadly support Bourdieu's emphasis on cultural resources, confirming that they matter more than material resources, at least for cognitive outcomes. Our findings also support the view that linguistic fluency is more dependent on parental cultural resources than other academic skills, such as maths performance. We also found that siblings were most detrimental to performance on the vocabulary test, suggesting that interaction with parents is particularly important for the development of linguistic fluency.

We found that the home reading culture, including reading to the child, reading books and newspapers, and having problems with reading, was significantly linked to children's test scores, and that this had a relatively strong role in mediating the influence of parents' education, and a smaller role in mediating parents' material resources. In order to interpret the influence of the home reading culture on children's outcomes, it is important to acknowledge that the variables relating to home reading are likely to be strongly related to one another. For example, a mother who struggles with reading is likely to struggle to read to her child, and unlikely to read in her leisure time. We found that the children of mothers who did not answer a question on reading problems (although they did return the questionnaire) scored significantly less well than children whose mothers reported no reading problems. This result remained significant even when controlling for earlier test scores and the child's own reading behaviour. This suggests that parental illiteracy presents ongoing problems for children's learning throughout childhood, and also highlights the problem that parental difficulties with literacy may well be hidden due to stigma. Given the prevalence of adult illiteracy in Britain, with functional illiteracy estimated at 15% (National Audit Office 2008) this could be an important policy lever for improving children's outcomes.

Children's own reading behaviour was strongly linked to test scores in maths, spelling and vocabulary, and this somewhat mediated the influence of parents' reading. Our findings support other work suggesting that children's leisure reading is important for educational attainment and social mobility (Taylor 2011), and suggest that the mechanism for this is increased cognitive development. Once we controlled for the child's test scores at age five and ten, the influence of the child's own reading remained highly significant, suggesting that the positive link between leisure reading and cognitive outcomes is not purely due to more able children being more likely to read a lot, but that reading is actually linked to increased cognitive progress over time. From a policy perspective, this strongly supports the need to support and encourage children's reading in their leisure time, especially given that the available evidence on trends over time suggests that children's reading for pleasure has declined in recent years (Clark and Rumbold 2006). In light of the decline in leisure reading between the ages of ten and 16, our findings suggest the particular need to support teenagers' reading.

In future work, we intend to assess the role of cognition in determining educational attainment and future life chances, including the question of whether vocabulary has a particularly strong role in determining educational attainment, and whether children from advantaged social backgrounds achieve higher educational qualifications than would be suggested by their cognitive scores.

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## Appendix Table A1:
## Odds ratios of logit response models for BCS70 1986 tests

| | All tests | | Any test | |
|---|---|---|---|---|
| **Gender (reference: Men)** | | | | |
| Women | 1.37*** | (0.057) | 1.73*** | (0.061) |
| ***Marital status (reference: Single)*** | | | | |
| Married | 1.90*** | (0.265) | 1.93*** | (0.214) |
| **Mother lives in London in 1970 (reference: not in London)** | | | | |
| In London | 0.60*** | (0.043) | 0.54*** | (0.031) |
| **Parity (reference: 0)** | | | | |
| 1 | 0.83*** | (0.042) | 0.83*** | (0.036) |
| 2 | 0.75*** | (0.050) | 0.69*** | (0.039) |
| 3+ | 0.55*** | (0.045) | 0.52*** | (0.036) |
| **Lactation (reference: attempted)** | | | | |
| Not attempted | 0.94 | (0.042) | 0.85*** | (0.032) |
| **Mother's age at Delivery (reference: less than 20)** | | | | |
| [20-24] | 1.25* | (0.107) | 1.39*** | (0.100) |
| [25-29] | 1.35*** | (0.122) | 1.52*** | (0.116) |
| [30-34] | 1.61*** | (0.163) | 1.75*** | (0.150) |
| 35 or more | 1.51*** | (0.187) | 1.95*** | (0.203) |
| **Mother's age at completion of education (reference: 14 or less)** | | | | |
| 15 | 1.20 | (0.133) | 1.18 | (0.106) |
| 16 | 1.38** | (0.162) | 1.43*** | (0.139) |
| 17 | 1.27 | (0.166) | 1.33** | (0.145) |
| 18 or more | 1.29 | (0.166) | 1.39** | (0.149) |
| **Father's social class (reference: SC 1)** | | | | |
| SC2 | 1.00 | (0.104) | 0.89 | (0.082) |
| SC3 non-manual | 1.00 | (0.108) | 0.95 | (0.090) |
| SC3 manual | 0.84 | (0.086) | 0.78** | (0.071) |
| SC4 | 0.76* | (0.087) | 0.74** | (0.074) |
| SC5 | 0.55*** | (0.079) | 0.57*** | (0.067) |
| Other | 0.82 | (0.116) | 0.71** | (0.087) |
| **Father's age at completion of education (reference: 14 or less)** | | | | |
| 15 | 0.99 | (0.095) | 1.08 | (0.087) |
| 16 | 1.04 | (0.112) | 1.25* | (0.113) |
| 17 | 1.31* | (0.160) | 1.57*** | (0.165) |
| 18 or more | 1.02 | (0.116) | 1.18 | (0.115) |
| *N* | 15270 | | 15270 | |
| pseudo $R^2$ | 0.024 | | 0.045 | |

Exponentiated coefficients; Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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