Parents' Basic Skills and Children Cognitive Outcomes*:

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Abstract

The main aim of this paper is to assess how parents' literacy and numeracy affect the cognitive performance of their children. The data used are taken from the British Cohort Survey (BCS) 2004 where all the cohort members were assessed in their numeracy and literacy basic skills. Among those, 4,800 individuals were then randomly sampled and their children were tested in cognitive skill.

We find strong evidence that parents with higher basic skills have children who perform better in cognitive tests. This result holds for both more and less educated parents and after allowing for a wide range of factors, including family characteristics (socio-professional status and income levels of the parents), family structure (number of siblings, lone parenthood), child characteristics (gender, age, whether first born) and even parents' ability as measured at age 5, as well as parenting style.

Investigating in more detail the channels by which basic skills affect children's performance, we found that parents' literacy is more important than numeracy. We also check whether parents' basic skills are actually picking up other parental characteristics that themselves improve their children's outcome. We estimate a model where cognitive and non-cognitive outcomes of the children are simultaneously determined by their parents' basic skills (using a SUR approach). We find that parents' basic skills explain only their children's cognitive skills, and do no affect their non-cognitive outcomes.

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1. Introduction

The problems of low numeracy and literacy levels for a large proportion of the UK adult population have been documented at key points in the last two decades (e.g. the 1999 Moser Report[1], the 2003 *Skills for Life* Survey and the 2006 Leitch report). In 1999, it was documented that approximately 20% of adults in England had severe literacy difficulties, whilst around 40% had some numeracy problems. A large proportion of the population with poor literacy and numeracy is harmful both to low-skilled individuals (who face higher probability of unemployment, unstable jobs and fewer prospects for career advancement) and to firms (that increasingly needs higher skilled workforce to increase labour productivity in the knowledge economy).

This paper addresses the important question of how parents' basic skills relate to the early cognitive performance of their children. This question is particularly relevant since it has been proved that early cognitive ability is an important determinant of schooling, wages, and success in many aspect of the social and economic life (Heckman, 1995; Murnane *et al*., 1995; Feinstein and Duckworth, 2006). It seems that there are significant ability gaps across children from various socioeconomic groups and that these gaps open up at early ages before children enter school (Cunha and Heckman, 2007). Moreover, it seems that these early ability differences by family background persist and increase as children age (Carneiro and Heckman, 2004; Feinstein, 2003). Thus, understanding the inter-generational transmission of skills constitutes an important potential issue for any policy that aims at increasing the basic skills of adults. This paper therefore investigates a potential wider outcome of policies that are targeted at adults (whether parents or not).

The main novelty of this paper is to be able to distinguish the separate contribution of parents' skills when adults (at age 34) and that of skills measured at very early age before school has started (i..e. at age 5) on their children tests scores. It sheds lights on recent attempts at investigating how parents contribute to the early formation of children skills (Todd and Wolpin, 2007, Cunha and Heckman, 2007). We use the British Cohort Study data set, where incredibly rich information on parents is

[1] DfEE (1999), *Improving literacy and numeracy: a fresh start*. Great Britain Working Group on Post-School Basic Skills chaired by Sir Claus Moser, London: Department for Education and Employment.

combined with early test scores for their children. We use numeracy and literacy tests of parents at age 34 and relate them to two batteries of cognitive tests of their children, one for pre-school children aged 3 to 6 and one for school-aged children aged 6-17. We are also able to control for a vast array of family and individual characteristics, including information on parents' early years (parents have been surveyed 7 times since their birth in 1970) and their socio-economic background. As main results we find that parents basic skills in literacy and numeracy at age 34 has a distinct effect on their children tests scores, even after controlling for their own early ability at age 5.

The layout of the paper is the following: in Section 2, the recent literature is surveyed. We provide in Section 3 a discussion of the empirical challenge encountered to conduct a robust investigation of which parents skills are transferred to their children. In Section 4, we describe our data present relevant descriptive statistics. The main results are presented in Section 5. We first produce results for the whole sample (5.1), then discuss results differentiated by education level (5.2), then investigate the separate contribution of literacy and numeracy (5.3), and finally investigate non cognitive outcomes. Section 6 presents some conclusions and discusses the policy implications of our results.

2. Literature Review

Our research bridges different strands of literature. First, there is the growing body of literature assessing the impact of adults' basic skills on various economic and non-economic outcomes. As discussed below, while the bulk of this research has studied the impact of adults' literacy and numeracy on the labour market, there are almost no empirical works focusing on the impact of literacy and numeracy specifically on children's cognitive outcomes. In this sense, our analysis adds to this literature, focusing as it does on a new potential outcome from adult basic skills.

Secondly, our research could be also situated in the stream of literature analysing the intergenerational transmissions of skills and more broadly the links between parents and child outcomes. Most of the empirical works in this field have focused on the intergenerational transmission of income and of human capital (usually meant as education).

Finally, our research is also influenced by the literature on early cognitive development and on the effect of family environment on early children performance and we draw on findings from this body of work.

There is now a coherent and growing body of literature which has found a strong link between literacy and numeracy and employment outcomes, particularly earnings (Bynner *et al*., 2001 ; Dearden *et al*., 2002; De Coulon *et al.*, 2007; Grynier, 2005; McIntosh and Vignoles, 2001; Parsons and Bynner, 2006). The US literature has also found a strong wage effect from various cognitive skills, particularly mathematics (Boissiere *et al*.,1985; Ishikawa and Ryan, 2002; Murnane *et al*., 1995 ; Tyler, 2004; Zax and Rees, 2002) and some evidence that such returns to cognitive skill are rising (Murnane *et al*., 2000).

Bynner *et al.* (2001) also find that individuals with higher basic skills tend to suffer less from poor physical and mental health, are more likely to be active citizens, as shown by voting vote and expressing interest in politics, and are more liberal and less discriminatory in their attitudes.

Interestingly, they also show that people with better numeracy and literacy skills are less likely to have children experiencing difficulty at school. They use a probit model to estimate the effect of literacy and numeracy on the probability of the respondents themselves having a child with literacy or numeracy difficulties of some kind. The evidence suggests that individuals with better numeracy skills (at or above Level 1) have a 3-5 percentage point lower probability of having a child who has literacy or numeracy difficulties, although the result in the full model specification is not statistically significant.

Williams *et al.* (2003) argues that having good literacy and numeracy skills may help children with reading, writing and with maths homework. In the case of reading it is shown that there are no significant differences between parents from Entry Level 3 or above, as 95 percent of these parents do help their children. It appears that only parents with lower levels of literacy do not provide any help in reading. The same applies to help with writing. Also in the case of maths, the likelihood of a parent giving help with maths increases with numeracy ability. Those findings only describe the help provided by parents without investigating whether this help is efficient. The possible links between parents' basic skills and children outcome are also briefly investigated in Bynner and Parsons (2006). Apart from this contribution, there are no empirical works that focused on the intergenerational transfer of basics skills in numeracy and literacy.

Many empirical and theoretical works have studied the intergenerational mechanisms of transmission of education and income. Even if these works do not deal directly with basic skills, they are important to our aim since they model and discuss the impact of family background on children outcomes.

The literature agrees that economic status and education are positively correlated across generations; it repeatedly shows as well that parents with higher educational levels have children with higher educational levels. In general children growing up in more highly educated families tend to have better educational and labour market outcomes as adults than children who grow up in less educated families. However, it is not clear whether this observed intergenerational correlation comes from a selection mechanism or reflects a causal link. In the first case, the transmission mechanism works through genetic or environmental factors: more educated parents may have some unobserved characteristics that are transferred to their children which in turn will have higher education and earnings as well. This mechanism is completely different from a causal one which would imply that attaining more education bestows parents with skills that make them better parents, thus leading to their children having higher educational outcomes. In the empirical literature three main approaches and identification strategies have been used to identify a causal effect of education and distinguish it from mere correlation: identical twins, adoptees and Instrumental Variables (IV).

Behrman and Rosenzweig (2002), using data drawn from the Minnesota Twins Register, examine educational choice of children of twin pairings to eliminate the genetic/nature effect of one of the parents. Their results suggest that an increase in the schooling of women does not have beneficial effects in terms of the schooling of children. The effect of father’s education seems to be instead strong and large in magnitude. Oreopoulos *et al*. 2003 criticizes this work arguing that it is based on a small and non-representative sample.
An alternative strategy to account for genetic effects and endogeneity problems is to compare adopted and natural children. Using this strategy, Plug (2003) finds weak effects of adoptive mother's schooling on child's schooling but large effects of father's schooling.

Sacerdote (2000 and 2007) using a data set of Korean-American adoptees who were randomly assigned to families in the US, finds that being assigned to a high education family has important effects on educational outcomes for these adoptees. In particular, he finds that adoptees are 9 percent more likely to have four years of college if their mothers do and calculates that each additional year of mother's educational attainment raises the adoptee's educational attainment by .07 years. However, the effects for adoptees are modest when compared to corresponding effects for non-adoptees, indicating that the transmission of education for adoptees is much less strong than for non-adoptees. This suggests that initial endowments, the genetic factor, also play a role.

This approach is appealing because it allows separating the effect of environmental and genetic factors and it is hence impossible to ascribe the intergenerational link to a genetic inheritance; but, as noted in Carneiro *et al*, 2007, these studies do not inform directly about the causal effect of parental schooling on child outcomes.

The third identification strategy to identify a causation link between parental education and children outcomes relies on the use of instrumental variables (IV). The aim is to find an instrument that is correlated with parents' education but unrelated to their children's attainments. Chevalier (2004), Black *et al.* (2005), and Oreopoulos *et al.* (2003) use the IV method based on the natural experiments of changes in compulsory schooling laws in UK, Norway and US respectively. These policy changes create a discontinuity in the years of education attained by the parental generation and therefore this method should ensure that an extra year of schooling for the treated (compared with the control) group is not correlated with the individual, family, and social characteristics of the children. Although using similar methodologies, the results of these three papers are rather different. Chevalier (2004) finds that parental education has a significant effect on their children's educational attainment: in the IV estimates the effects of a parent's education on the child of the same gender increased substantially (with respect to OLS estimates) for a sample of natural parents. This finding highlights the occurrence of substantial social returns to education for same-sex parent. Also the paper by Oreopoulos *et al.* (2003) does find a causal effect of parents' education focusing on different children outcomes. Their results in fact indicate that a one-year increase in the education of either parent significantly reduces the probability that a child repeats a grade. Indeed, it seems that education policies may have important social returns and potentially are able to reduce part of the intergenerational transmission of inequality.

Conversely, in Black *et al.* (2005) the IV estimates were consistently lower than the OLS estimates with the only statistically significant effect being a positive relationship between mother's education and son's education. They interpret this evidence by arguing that the high correlations between parents' and children’s education are due primarily to family characteristics and inherited ability and not to education spillovers.

Carneiro *et al*. (2007) use a different instrument to study the effects of maternal education on their children's outcomes, including cognitive development, behavioural problems, grade repetition, and health outcomes. They use as instruments the costs of schooling, exploiting the differential changes in the direct and opportunity costs of schooling across counties and cohorts of mothers. Their results point out that mother's education increases the child's performance in both math and reading at ages 7-8, but not at ages 12-14. They also find that maternal education reduces the incidence of behavioural problems and reduces grade repetition, but has no impact on obesity.

Overall, these works point out a strong and significant role of parental education on different children outcomes, highlighting the potential of educational policy to reduce inequality in child opportunities and performances. However, they fail to identify the channels through which parents’ higher education lead to better outcomes for their children.

Indeed another strand of the literature has directly focused on the determinants of children attainments, analysing the role of different factors, including parenting style and investments. For example, Michael (2004, 2005) shows that besides families’ resources (income, education and ability), the actual willingness of spending these resources on behalf of children is highly correlated with children’s cognitive outcomes (here measured as reading and math test scores). In other words he suggests that parent’s ‘caring’ for the child is an important mechanism affecting children performance. He exploits the rich information provided by the NCDS data to proxy such ‘family caring’ using several variables indicating parents’ behaviours during pregnancy and during the child’s early year. His results indicate that caring for children has a substantial correlation with children’s measured skills in reading and math and this relationship is separate from and additional to the advantages of family resources.

The general framework for research on children's attainment has principally focused on the processes by which family inputs can affect children's educational development and outcomes (*production function approach*). The process of child attainment is viewed as an aspect of the theory of family behaviour (see Haveman and Wolfe, 1995 for a detailed review). The family is modelled as a production unit, which employs inputs to generate utility for its member. The amount of family resources allocated to children, the nature of these resources, parents' choices regarding family structure, type of neighbourhood, type of school, etc. influence the attainments of children in the family. Cunha and Heckman (2007) have extended this approach and have built a model of skill formation with multiple stages of childhood, where inputs at different stages are complements and where there is self-productivity of investment. Two features of the model are therefore: *dynamic complementarity* which means that stock of skill acquired in period *t-1* makes investment in period *t* more productive; and *self-productivity* which implies that higher stocks of skill in one period create higher stocks of skill in the next period. While this model is theoretically appealing, it is difficult to use it in empirical research since it requires longitudinal data and repeated information on children skills.

3. The Empirical Approach

In this paper, we mean to focus on the processes by which family inputs can affect children's educational development and outcomes. Most of the analysis is performed using regression analysis where the dependent (explained) variable is the child outcomes: i.e. children's early (4 to 6) and later (6 to 16) tests scores. The dependent variable is regressed on a series of explanatory variables that the literature has shown to matter for children's scores. The main focus of our analysis is, however, on the link between parents' basic skills and their children's performance in tests scores, so we will treat all other explanatory variables other than parents' basic skills as control variables only. We will not give them any causal interpretation. More formally our estimating equation is the following:

$$S_c = \beta_0 + \beta_1 S_p + \beta_2 X_c + \beta_3 F + \beta_4 O_p + \beta_5 E_p + \beta_6 Y_p + \beta_7 A_p + \varepsilon$$

Where the subscript c = child; subscript p = parents, and S=skills, X: are the set of child characteristics (sex, age, whether first born); F are family structure (lone parents; number of siblings); O are occupation; E is education; Y is income (log household income in 2000 and 2004 and whether recipient of state benefits), finally A stands for innate ability (as measured by parents' test score at age 5). All along, we adjust the standard errors of the coefficients for the fact that some children come from the same households.

As our main interest is the link between parents' basic skills and children's tests scores, we will focus on the estimates for the coefficient β_1.

As already mentioned in the introduction, the BCS 70 data constitutes an incredibly rich source of information. The first attempt at uncovering a causal link between parents' numeracy and literacy skills and their children early tests scores is operationalised by running simple Ordinary Least Squares regression (OLS). When regressing the child tests scores on the basic skill measures for their parents, we allow for a very large array of child and parent characteristics in the regressions (see section 4). Some of those variables would be "unobserved" variables in more conventional data sets. By doing so we tend to reduce the probability that "omitted variables" might indeed bias our main coefficient of interest β_1.

Such average estimates from our OLS regressions above may hide differences in the effects of parental skill on child outcomes across different sub-groups of the population. In our attempt to uncover a causal relationship, we separate the regressions by gender[2] and qualification level of the parents to identify the specificities of the transmission mechanisms. We are particularly interested in the effects of parental skill at the bottom end of the parent basic skill distribution, as Skills for Life is targeted at individuals with low basic skills.

Given that finding an instrument proved problematic, we also explored other ways to check that we have uncovered a genuinely causal relationship between parental skill and child outcomes. In particular, we use Seemingly Unrelated Regression Estimation (SURE) to jointly estimate two

[2] The separate regressions on gender did not yield interesting results in the sense that we did not find significant differences between fathers and mothers in the extent through which their basic skills are transferred to their children. Therefore, we decided not to report these estimates in the paper. However, our results are available under request.

equations for cognitive and non-cognitive outcomes. Indeed we want to check whether parents' skills are both able to explain the performance of their children and some measure of their emotional state. By doing so, we want to check whether parents' basic skills truly translate into the performance of their children or whether there is some other mechanism that could drive this relationship. In particular, returning to the example mentioned above, we want to check whether parents with higher basic skills are actually providing their children with more emotional stability, which in turn is the key factor that then translates into higher performance in cognitive test scores.

4. Data Description

The empirical analysis relies on different sweeps of the British Court Study. Since our aim is to study the impact of parents' basic skills on their children cognitive outcomes, we restrict the sample to the cohort members included in the "Parent and Child" section of the 2004 survey.

Of the 9,665 cohort members in the core dataset, 4,792 had been randomly selected into the "Parent and Child" elements of the survey. Of these, 2,824 (59 per cent) has at least one child. In total, we have information on 5,207 own or adopted children of cohort member who are aged between 0 and 16 years and 11 months. Table 1 shows the distribution of children by age groups and sex.

Table 1: Number of children, by age group and sex

Age groups	male	female	Total
age 0-2	700	626	1,326
age 3-6	665	694	1,359
age 6-16	1,290	1,232	2,522
Total	2,655	2,552	5,207

Of the 5,207 children, only those aged between 3 and 16 are eligible for the cognitive assessment. Therefore the total number of observations in our sample is reduced to 3,881.

Of these, 1,359 (about 65 percent) are aged between 3 and 5 years and 11 months and 2,522 (about 65 percent) are aged between 6 and 16 years and 11 months.

Children have been tested using the British Ability Scale Second Edition (BAS II) which is a battery of individually administered tests of cognitive abilities and educational achievements[3]. Tests are organized in two age-specific batteries. The Early Year (EY) Battery is given to children of more than 3 and less than 6 years and it composed entirely of cognitive scales. The School Years (SY) Battery is designed for children of more than 6 and less than 17 years and comprises both cognitive and achievement scales.

Table 2 lists the different tests and gives some descriptive statistics. In particular, it displays mean, standard deviation, minimum and maximum value of ability scores[4] for each test.

Table 2: Children test scores (ability scores)

	Variable	Obs.	Mean	Std. Dev.	Min	Max
Children aged 3.0-5.11	Early Number Concepts	1226	124.39	26.47	10	185
	Naming Vocabulary	1238	99.69	19.38	10	170
Children aged 6.0-15.11	Word Reading Scale	2248	133.30	37.86	10	222
	Spelling	2248	59.91	21.91	0	100
	Number Skills	2240	107.36	31.59	10	208

Drawing on the results of these tests, we use a principal component analysis (PCA) to construct an index of 'cognitive ability' (*g-score*), using the first principal component extracted[5]. This procedure is very common in the psychometric literature in order to build an index of general ability or intelligence (See Cawley *et al*., 1996). In our case, we do not interpret this index as a measure of general intelligence or ability – which would be too ambitious for our aims – but only as an index that allow us to rank each children in terms of ability (see also Galindo-Rueda and Vignoles, 2005).

Table 3 provides some information on the process of extracting the *g-score* for the two groups of children differentiated by age. The second and the third columns indicate the principal component order and the cumulative proportion of the overall variance explained by each principal component. It

[3] For further details on children assessment, see Bynner and Parsons (2006).

[4] Ability scores are estimates of children ability measured by an individual scale. The ability score reflects both the raw score and the difficulty of the item administered (See Bynner and Parsons, 2006, p. 81).

[5] More formally, the g-score is measured by the product of the test score vector and the eigenvector associated with the largest eigenvalue of the matrix of correlations among standardized BAS II test scores.

can be noticed that the first principal component explains about 80 percent of the variance in the case of early test scores and about 77 percent for school-year test scores. This reassures us on the validity of the choice of extracting the first component only. Columns 4 and 5 specify the correlation between each test score and the first principal component, which can be considered as an indicator of each score to the constructed *g* score.

Table 3: PCA and g-score

	Principal component rank	Cumulative variance explained	Name of original test	Correlation (g score)
Early years battery	1 (g-score)	0.836	Early Number Concepts	0.9143
	2	1.000	Naming Vocabulary	0.9143
School years battery	1 (g-score)	0.7735	Word Reading	0.9476
	2	0.9462	Spelling	0.8206
	3	1.000	Number Skills	0.8655

In order to assess parents' literacy and numeracy, two tests have been performed at age 34. The items are set at five levels of difficulty: entry level 1, entry level 2, entry level 3, level 1 and level 2, the most difficult. The literacy test is made of 20 multiple-choice questions taken from the *Skills for Life Survey* (Williams, *et al.*, 2003). Ten initial questions were introduced to screen individuals: when individuals scores lower that 6, they were asked 10 easier questions of Entry level 2 while those who scored between 6 and 10, were given harder questions: (five level 1 and then 5 level 2). The numeracy test is made of 17 multiple choice questions, asked to all individuals: five at Entry level 2, four at Entry level 3, five at level 1 and three at level 2 (for a detailed explanation of the tests' design see Parsons and Bynner, 2005).

Table 4 reports the distribution of parents' literacy and numeracy levels in 2004. This table highlights the literacy and numeracy problems faced by a large part of our sample. In literacy, almost 9 percent of individuals have skills below the minimum target of Level 1, whilst in numeracy more than 16 percent of the sample is below the national minimum target of Entry Level 3.

Table 4: Distribution of parents' literacy and numeracy

	Literacy (% of sample*)	Numeracy (% of sample*)
Below entry level 2	1.8	6.3
Entry level 2	2.3	10.4
Entry level 3 (*minimum target for numeracy*)	4.6	26.2
Level 1 (*minimum target for literacy*)	31.6	31.8
Level 2	59.6	25.3

*the sample only includes parents with children aged over 2.11 (N = 2844)

It is interesting to observe the distribution of literacy and numeracy also within each educational group. As shown in Table 5, numeracy and literacy achievements do vary also within education group. Obviously, the more educated people also have on average better basic skills. The last column shows that among those with a higher degree only 0.6 percent is below the national target for literacy and only 1.3 percent for numeracy. More interestingly, among people with no or low levels education, there is a significant variation in the basic skill assessments. This suggests that education and basic skills, although related and sometime overlapping concepts, are in fact capturing different aspects of a person's human capital. In this sense, it is important to evaluate the impact of adults' basic skills conditional on education levels.

Table 5: Distribution of numeracy and literacy by highest qualifications

	No qualifications	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Literacy						
Below entry level 2	8.6	1.8	2.0	0.9	0.3	0.0
Entry level 2	7.7	3.4	2.0	0.9	1.0	0.0
Entry level 3	8.2	6.8	6.4	3.5	1.0	0.6
Level 1	43.2	38.6	31.7	32.2	23.7	15.1
Level 2	32.3	49.4	57.9	62.6	74.0	84.4
Numeracy						
Below entry level 2	20.5	7.8	5.3	6.7	2.1	0.6
Entry level 2	19.6	15.2	12.0	7.3	4.3	1.7
Entry level 3	38.2	34.4	28.5	20.9	17.4	11.2
Level 1	15.0	30.1	30.6	36.5	37.4	33.0

Level 2	6.8	12.6	23.7	28.7	38.8	53.6

Even if the levels of literacy and numeracy presented above are instructive and have been widely used to measure adults' basic skills (see, for example, the Moser Report in DfEE, 1999 and Leitch, 2005), we prefer to use a continuous measure of the individual's basic skills, so as not to lose insightful variations. Indeed, we use PCA to create a unique index of cohort members' basic skills. As we will see below, in some regression we will also use separate measure of literacy and numeracy based on standardized test scores.

As mentioned above, we shall also include in the regressions a vast array of control variables in order to reduce the omitted-variable bias and to account for family background and characteristics. In particular, we insert child characteristics, family structure, parents' education, occupations and income, some measures of parenting style and finally parents test scores at age 5.

Indeed, first of all we control for child' age - which obviously affects the performance in the test scores – gender and whether she/he is a first born. As family characteristics, we include the number of siblings and a dummy variable describing whether the cohort member is a lone parent[6]. Then cognitive outcomes of the children may be also affected by parents' socio-economic conditions. We describe socio-economic conditions by looking at family income, at poverty status and at occupation categories. The family income variable is built as the log of the average weekly household income in 2000 and 2004. In each year, household income has been calculated as the average (mean) of net weekly earnings of the cohort member and net weekly earnings of the partner (if any). In order to control for outliers and to reduce the measurement error we have dropped the values below the lower tail (0.5 percentile) and above the upper tail (99.5 percentile). To control for the effect of poverty status in 2004 we also include a dummy variable equal to 1 if the family receive any state benefit. Parents' social class is described using the NS-SEC[7] occupationally based classification. Table 6 shows the distribution of cohort members by occupations and indicates that almost 44 percent of the sample in employed in routine or semi-routine occupations, which roughly correspond to Unskilled Occupations in the

[6] We do not control for ethnicity because the ethnic composition of our sample is not mixed enough: more than 97 percent of individuals in our sample are British and white.
[7] National Statistics Socio-Economic Classification.

SOC2000 classification[8]. Only 8.3 percent of individuals are instead employed in the most skilled occupations.

Table 6: Occupational distribution

NC-SEC classification, 2004	Freq.	Percent	Cum.
higher managerial and professional occupations	187	8.31	8.31
lower managerial and professional occupations	329	14.63	22.94
intermediate occupations	239	10.63	33.57
small employers and own account workers	229	10.18	43.75
lower supervisory and technical occupations	293	13.03	56.78
semi-routine occupations	667	29.66	86.44
routine occupations	305	13.56	100
Total	2,249	100	

In the regressions we use *intermediate occupation* as base category (the omitted one) and inserted the dummies for all other occupations. Indeed the coefficients of the different dummies should be interpreted in comparison with *intermediate occupations.* Apart from socio-economic status, we control for parents' education. If we were to exclude this variable from the analysis, then our indicators of basic skills may simply pick-up the effect of education. Instead, we want of evaluate the impact of basic skills netting out that of education so that our specification measures the marginal impact of having better basic skills conditional on a given level of education achieved. This is therefore an extremely stringent test, we are asking whether even within a given level of parental education whether having better skills improves their children's outcomes. We include a variable indicating the cohort member's highest level of education attained in 2004[9] (academic and vocational one). The distribution of this variable is described in Table 7.

[8] Further details on the classification of social classes and occupations can be found at: http://www.statistics.gov.uk/methods_quality/ns_sec

[9] We have also tried to insert the partners' level of education, but this variable never turn out to be significant and significantly reduce the number of observations. Moreover, cohort members' and partners' educational levels are highly and significantly correlated so that collinearity problems may arise if they are jointly included. Therefore we decided to omit this variable from our analysis.

Table 7: Highest parents' educational level, 2004

Highest qualification, 2004	Freq.	Percent	Cum.
No qualification	227	7.98	7.98
Level 1 (e.g. CSE, low GCSE's, etc..)	802	28.2	36.18
Level 2 (e.g. Good GCSE's, NVQ2, etc..)	614	21.59	57.77
Level 3 (e.g. A-levels, etc..)	348	12.24	70.01
Level 4 (e.g. Degree, etc..)	674	23.7	93.71
Level 5 (e.g. MSc, PhD, etc..)	179	6.29	100
Total	2,844	100	

Finally, our dataset also allow us to control for parents' 'innate' ability which we proxy using their tests scores at age 5 (Tyler, 2004). The inclusion of this variable is an attempt to control for the genetic factor in the intergenerational transmission of skills. However, the age 5 tests used in the British Cohort Study were not IQ based tests per se so some caution is needed here, in that clearly we may not have controlled for all genetic factors that influence child outcomes. Innate ability may be in fact highly correlated with parents' basic skills and can be inherited by their children. In other words, children may have inherited some of their parents' innate abilities, which can be translated later into cognitive attainments. Therefore if we do not control for this factor our results may be biased.

The next table summarizes all the variables used in the analysis and give some descriptive statistics.

Table 8: Variables in the analysis

Variable Description	Obs.	Mean	Std. Dev.	Min	Max
g-score for younger children	1226	0.00	1.29	-5.91	3.98
g-score for older children	2240	0.00	1.52	-5.25	3.94
child age	5207	5.86	4.16	0	16
whether child is female	5207	0.49	0.50	0	1
whether CM is female	5207	0.63	0.48	0	1
CM standardized literacy scores	5113	0.00	1.00	-5.37	1.24
CM standardized numeracy scores	5141	0.00	1.00	-3.56	1.26
principal component on CM literacy and numeracy scores	5141	-0.09	1.31	-6.67	1.30
whether child is first born	5207	0.55	0.50	0	1
CM's age at first birth	5207	25.69	4.31	16.25	34.67
whether CM is lone parent	5207	0.10	0.30	0	1
social class; NS-SEC classification	3913	3.60	1.93	1	7
whether CM receives state benefits	5207	0.09	0.29	0	1
highest qualification in 2004	5197	2.58	1.09	1	5
Average value of household income in 2000 and 2004	3759	439	229	18	2331
Principal component on parents cognitive test scores at age 5 (1975)	3367	0.00	1.26	-3.89	3.57
Life satisfaction scale (0 to 10)	5170	7.59	1.80	0	10
Frequency of which parents read to the child. Young child	1256	4.43	0.79	1	5
Frequency of which parents read to the child. School age child	1308	3.92	0.97	1	5
Standardized scores on “Strengths and Difficulties” scale (Goodman). Young children	1259	0.00	1.00	-7.03	5.17
Standardized scores on “Strengths and Difficulties” scale (Goodman). School age children	1259	0.00	1.00	-7.03	5.17

5. Results

Throughout the empirical analysis, we use as dependent variable the child test g-scores calculated using PCA on the tests scores of children. As explained in the Descriptive Statistics Section, for younger children, the principal components are extracted from two tests (Early Number Concepts and Naming Vocabulary) and for older children three tests (Word Reading Scale, Spelling, and Number Skills).

As the main explanatory variable, we use the g-scores of parents' basic skill (aged 34) in literacy and numeracy. In most Tables, we follow an approach where in the first few columns from the left, only parsimonious regressions are performed where few variables of control are introduced. As we move to the right of the Tables, more variables of control are introduced, each of which have been shown to affect children tests scores in previous research (quoted in the literature review). We will comment only briefly on these coefficients (when they first appear), and will not put strong emphasis on their value as their main role is to control for factors that may otherwise confound the relationship between parents' basic skills and their children's tests scores.

5.1: Results for young and school-aged children (whole samples)

This Section provides two sets of OLS regressions for young children aged 3 to 5 and 11 months (Table 9) and older children of age 6 to 16 and 11 months (Table 10). In column 1 of Table 9, we first regress young children's g-scores on their parents' g-scores from literacy and numeracy tests. The coefficient is positive and highly significant. This coefficient provides essentially the raw correlation between parental skill and child cognitive skill, controlling only for child age and gender. As one might expect, this coefficient is positive and highly significant.

The child's age is positive and highly significant. The gender variable is not significant, meaning test scores do no vary according to gender at this early age. This first regression therefore suggests that parents with better basic skills have children who also have higher levels of cognitive skill. However, a number of other factors may explain this relationship, not least parental socio-economic background. In column (2) to (8), we therefore progressively introduce more variables of control, starting with some family demographic features. The number of sibling is only significant in column (3) and its significance disappears once more variables are introduced (col. 4 to 8). First born children tend to perform better and the effect is significantly positive and strong in all specifications where it is introduced. We then introduce parents' characteristics. As mentioned above, we are particularly fortunate in that respect as the BCS provides invaluable information on the early and later lives of parents. One question of importance is to determine whether being a lone parent, may impact on the transfer of skills. The coefficient for whether the parent is a lone parent is however never significant, suggesting this factor is not in and of itself an important determinant of child cognitive development. Also the effect of parents' income and whether they receive state benefits is never significant. On the other hand parental occupation does influence child cognitive skills, namely if the parent performs semi-skilled work, the child has lower cognitive skills. The coefficient is always significant and strongly negative. The highest education level of parents is also introduced but it never turns out to be significant. On the other hand, the coefficients on the variables measuring parents' own ability at age 5 are highly significant. Those early tests scores are supposed to proxy IQ (Tyler, 2004). Those tests capture probably that part of the children performance that comes from their parents higher IQ. Indeed when they are introduced, the coefficient for parents' literacy and numeracy decrease substantially.

The main result to take from this first Table is that the coefficient for the literacy and numeracy is high and remains high and significant when we introduce our large array of control variables[10]. In particular, the effect is robust to the inclusion of the parental qualification levels and parental ability measures. This means that parents' basic skills have a positive impact within each educational group, and conditional on parental IQ (as best we can measure it).

[10] Other control variables we have tried to include are related to home environment, parents' behaviours and parent-child interactions which are shown to affect child development and cognitive outcomes (see for example Michael, 2005 and Feinstein *et al,* 2004). In order to capture parenting style, we tried to insert in the model measures of *warmth* and of *conflict* in the parent and child relationship, by extracting the first and second principal component respectively from the *Child-Parent Relationship Scale* (Pianta: Short Form). However these variables are never significant and reduce our sample size so that we have decided not to report these results.

Table 9: Young children

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Literacy/ Numeracy (pc)	0.189***	0.183***	0.179***	0.148***	0.147***	0.144***	0.119***	0.0998**
	(0.024)	(0.024)	(0.023)	(0.027)	(0.027)	(0.030)	(0.031)	(0.044)
Child's age	1.059***	1.056***	1.063***	1.044***	1.047***	1.064***	1.062***	1.076***
	(0.032)	(0.032)	(0.032)	(0.035)	(0.036)	(0.040)	(0.040)	(0.050)
Child is female	0.0780	0.0786	0.0796	0.0551	0.0541	0.0554	0.0575	0.00552
	(0.051)	(0.051)	(0.051)	(0.056)	(0.056)	(0.063)	(0.062)	(0.084)
Whether first-born		0.270***	0.206***	0.198***	0.198***	0.202***	0.200***	0.212**
		(0.052)	(0.059)	(0.067)	(0.067)	(0.074)	(0.073)	(0.095)
Number of siblings			-0.0699*	-0.0396	-0.0452	-0.0480	-0.0457	-0.0550
			(0.037)	(0.050)	(0.051)	(0.059)	(0.058)	(0.073)
Whether lone parent			-0.0602	-0.135	-0.171	-0.272*	-0.243	-0.316
			(0.11)	(0.12)	(0.12)	(0.16)	(0.16)	(0.20)
Higher managerial and professional occupations				-0.0363	-0.0410	-0.0132	-0.0870	0.0612
				(0.13)	(0.13)	(0.14)	(0.14)	(0.19)
Lower managerial and professional occupations				0.122	0.119	0.143	0.0901	0.0746
				(0.10)	(0.11)	(0.11)	(0.11)	(0.15)
Lower supervisory and technical occupations				-0.0918	-0.0974	-0.0782	-0.0529	-0.147
				(0.13)	(0.13)	(0.14)	(0.14)	(0.18)
Small employers and own account workers				-0.0828	-0.0898	-0.0399	-0.0606	-0.149
				(0.11)	(0.11)	(0.16)	(0.16)	(0.19)
Semi-routine occupations				0.0766	0.0723	0.0760	0.0992	0.121
				(0.13)	(0.13)	(0.14)	(0.14)	(0.17)
Routine occupations				-0.382**	- 0.405***	-0.408**	-0.360**	-0.441**
				(0.15)	(0.15)	(0.16)	(0.17)	(0.21)
Receipt State benefits					0.314*	0.394*	0.469**	0.169
					(0.17)	(0.20)	(0.22)	(0.28)
Mean log hh income (2000-2004)						0.0963	0.0839	-0.0772
						(0.079)	(0.078)	(0.094)
Level 1							0.0124	-0.267
							(0.17)	(0.20)
Level 2							0.231	-0.0344
							(0.18)	(0.20)
Level 3							0.123	-0.178
							(0.19)	(0.22)
Level 4							0.267	-0.0316
							(0.18)	(0.22)
Level 5							0.310	-0.0081
							(0.21)	(0.26)
Parents' ability at age 5								0.119***
								(0.041)
Observations	1219	1219	1219	934	934	758	758	481
R-squared	0.50	0.51	0.51	0.51	0.51	0.52	0.53	0.53

Note: dependent variable: young children (aged 3-6) overall g score (pc on standardized ability scores)
Standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 10: School-age children

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Literacy/ Numeracy (pc)	0.219***	0.210***	0.207***	0.162***	0.162***	0.164***	0.144***	0.113***
	(0.023)	(0.023)	(0.022)	(0.028)	(0.028)	(0.034)	(0.034)	(0.040)
Child's age	0.358***	0.350***	0.354***	0.355***	0.355***	0.354***	0.358***	0.361***
	(0.0099)	(0.010)	(0.011)	(0.013)	(0.013)	(0.015)	(0.015)	(0.017)
Child is female	0.185***	0.191***	0.191***	0.192***	0.192***	0.256***	0.263***	0.208***
	(0.050)	(0.050)	(0.050)	(0.058)	(0.058)	(0.065)	(0.065)	(0.074)
Whether first-born		0.220***	0.188***	0.176***	0.176***	0.206***	0.196***	0.198**
		(0.054)	(0.057)	(0.066)	(0.066)	(0.075)	(0.076)	(0.093)
Number of siblings			-0.0406	-0.0169	-0.0171	-0.0129	-0.0157	-0.0171
			(0.035)	(0.043)	(0.043)	(0.049)	(0.051)	(0.061)
Whether lone parent			-0.133	-0.126	-0.128	-0.159	-0.193	-0.157
			(0.083)	(0.11)	(0.11)	(0.14)	(0.14)	(0.15)
Higher managerial and professional occupations				0.0120	0.0122	-0.0176	-0.0434	-0.0709
				(0.13)	(0.14)	(0.14)	(0.15)	(0.19)
Lower managerial and professional occupations				-0.0421	-0.0421	-0.0202	-0.0311	0.00517
				(0.089)	(0.089)	(0.096)	(0.098)	(0.11)
Lower supervisory and technical occupations				-0.125	-0.125	-0.155	-0.148	-0.0902
				(0.12)	(0.12)	(0.13)	(0.13)	(0.14)
Small employers and own account workers				-0.158	-0.158	-0.134	-0.137	-0.217
				(0.12)	(0.11)	(0.17)	(0.17)	(0.19)
Semi-routine occupations				-0.176*	-0.177*	-0.145	-0.130	-0.162
				(0.099)	(0.099)	(0.11)	(0.11)	(0.12)
Routine occupations				-0.261**	-0.262**	-0.285**	-0.290**	-0.257
				(0.12)	(0.12)	(0.13)	(0.14)	(0.17)
Receipt State benefits					0.0123	-0.0672	-0.0460	0.0902
					(0.20)	(0.20)	(0.20)	(0.21)
Mean log hh income (2000-2004)						0.0743	0.0548	0.109
						(0.076)	(0.078)	(0.094)
Level 1							0.303**	0.179
							(0.14)	(0.14)
Level 2							0.229	0.0126
							(0.15)	(0.16)
Level 3							0.274*	0.0830
							(0.17)	(0.17)
Level 4							0.240	0.0280
							(0.16)	(0.17)
Level 5							0.664***	0.576**
							(0.22)	(0.26)
Parents' ability at age 5								0.0438
								(0.033)
Observations	2228	2228	2228	1649	1649	1310	1309	881
R-squared	0.42	0.42	0.43	0.43	0.43	0.42	0.42	0.46

Note: dependent variable: school age children (aged 6-16) overall g score (pc on standardized ability scores). Standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Table 10, similar regressions are performed for children aged 6 to 16 and 11 months. Results are very similar to those for younger children. In particular the age variable is highly significant and positive, and the same applies for first-born children. One noticeable difference is that child gender is now significant. Girls are performing better, so it is when children are older and in the school environment that this advantage appears. But again, the main result to take from this second table is that the coefficient for parents' basic skills in numeracy and literacy remains positive and highly significant despite our best effort to find confounding variables.

For the interpretation of the size effect, we use the value of the coefficients for our fully controlled regressions (col. 8 in Table 9 and 10). An increase in one standard deviation of parents' basic skills index (1.3) would lead to an increase in their young children's cognitive skill index by 10 per cent of a standard deviation.

Otherwise expressed, the parents whose basic skills situated them at the 25th percentile have children who perform 10.1 per cent better than those parents situated at the 10th percentile (the difference between the 25th and the 10th percentiles is within one standard deviation).

For older children, the same gaps in parents basic skills explains a 9.7 per cent difference in their children's cognitive skill.

Overall, these results suggest a great impact from adults' basic skills on child cognitive development, conditional on a large set of other control variables. This result holds even after inclusion of parents' education and ability. The coefficient of parents' basic skills – although decreasing in magnitude as we add more controls – remains always strongly significant. The decreasing value of our coefficient of interest is due to the fact that we are adding more controls that mediate the impact of parents' literacy and numeracy and not to the different sample size of each regression. Appendix A reports the previous tables using the same sample size for all the regressions.

The next section will test whether the impact of basic skills is higher for those with low and high qualification taken separately.

5.2 Results differentiated by parental qualification level

The main aim of *Skills for Life* is to address the lack of basic skills of large proportions of the UK adult population, i.e. to help people who did not gain sufficient basic skills during their school years. It is therefore of great interest to check whether the results obtained here on the role of parental basic skill still apply with samples restricted to low educated parents. It is also interesting to check with a sample restricted to high-qualified individuals for comparison purpose. Therefore, we split the sample in two groups: parents with less than Level 3 (A-level equivalent) and parents with higher qualifications (Level 3, 4, and 5). We do this decomposition first for young children (Table 11 and Table 12) and then for older children (Table 13 and Table 14). In all those tables, we focus on the relationship of main interest, namely the association between parental basic skill and child outcomes, and therefore only indicate which variables of control are introduced without providing their coefficients.

5.2.1: Young children (3 to 5 and 11 months)

In Table 11 results for low-educated parents are presented. As it can be seen from the first row, the link between parents' basic skills and their children early test scores remain strong and significant across the full range of regressions (1) to (5). The coefficient on parental basic skill in the full specification allowing for the widest range of control variables is 0.13, which is very similar to the corresponding one for the full sample in Table 9 (0.11). The range of variation from a parsimonious to a fully controlled regression is reduced, the coefficients moved down from 0.17 to 0.13 (from col. 1 to 5).

Table 11: young children- low educated parents

	(1)	(2)	(3)	(4)	(5)
Parents skills	0.168***	0.162***	0.139***	0.137***	0.128**
	(0.028)	(0.027)	(0.032)	(0.035)	(0.053)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√
Family structure (n. of siblings; lone parent)		√	√	√	√
Socio-economic occupation			√	√	√
Household (log) Income and poverty status				√	√
Parents' ability at age 5					√
Observations	691	691	501	394	252
R-squared	0.52	0.53	0.54	0.55	0.54

Note: dependent variable: young children (aged 3-6) overall g score (pc on standardized ability scores)
Robust standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

These results contrast sharply when compared to results for the sample restricted to the children of parents with at least an A-level (e.g. with qualification of level 3 to 5). For the high-educated sample, the intergenerational link is not robust to the inclusion of more control variables. Interestingly, this not caused only by increasing standard errors which lead to non significant coefficients in the fully controlled regression (col. 5). It is rather caused by the sharp decrease in the magnitude of the basic skill coefficient, dropping from 0.14 to 0.05 when one adds more control variables. This is an important result as we would have expected a sharper increase in the standard errors due to the reduced size of the sample in the column to the right of the table. The decrease in the value of the coefficient is large when the household income and poverty status are introduced (in col. 4) and then even greater when parents' early ability tests scores at 5 are introduced (in col. 5).

Table 12: young children- medium and high educated parents

	(1)	(2)	(3)	(4)	(5)
Parents skills	0.142***	0.142***	0.129**	0.0975	0.0465
	(0.053)	(0.052)	(0.058)	(0.062)	(0.083)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√
Family structure (n. of siblings; lone parent)		√	√	√	√
Socio-economic occupation			√	√	√
Household (log) Income and poverty status				√	√
Parents' ability at age 5					√
Observations	528	528	433	364	229
R-squared	0.49	0.49	0.50	0.51	0.52

Note: dependent variable: young children (aged 3-6) overall g score (pc on standardized ability scores)
Robust standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Overall, these results indicate rather clearly that for younger children, the impact of parents' basic skills is higher for those at the bottom of the educational distribution. This result does not imply that parents with higher level of qualification do not transfer any skills to their young children. Rather that at higher levels of basic skill (due to selecting a sample with higher levels of education), the role of parental basic skill does not appear so important in determining child cognitive outcomes. In fact, we rather think that this result may be due to the design of the parents' basic skill tests. Indeed, the main aim of the basic skill tests is to discriminate skills level at the bottom of the distribution. This will lead to a distribution where a large proportion of parents with higher qualifications will get the maximum score. There is consequently low variation in the dependent variable for parents of younger children when one introduces more variables in the regressions. These results are compatible with a story where the types of skills measured by our parental basic skill tests (low levels of numeracy and literacy) do not affect significantly the cognitive tests score of the children of parents with more than A-level. For parents with low qualification levels, the opposite conclusion can be drawn. The type of skills measured by our tests makes a great deal of difference to children of parents with low qualification. This provides some support for policy that aims at increasing the basic skills of parents at the bottom of the qualification distribution only.

We now turn to the results for older children aged 6 to 16 and 11 months.

5.2.2: School age children (aged 6 to 16 and 11 months)

Results for older children differ compared to young children. The transfer of basic skills to the children is highly significant both for low and highly qualified parents. The coefficients in col. 5 of both Table 13 and Table 14 are strongly significant and positive. The sample of parents with older children differs substantially from the sample of parents with young children, not least in the sense that the former had their children 'early', indeed below the age of 28 years for cohort members[11]. In general parents who have their children younger are less educated and skilled and many become qualified as they raise their children. We think this could explain why the impact of parental basic skill on child cognitive development appears to be significant for both more and less qualified early parents. In other words, parents who have their children early may have poorer skills during the early years of their children's childhood, even if they go on to achieve higher levels of skill and education later on. If it is the early years (0-5) that matter most in terms of a child's cognitive development, as suggested by a number of influential academics (Heckman, 2007), it may be that we need to measure actual parental skill during these formative years rather than much later when the children have passed through this formative phase. One policy conclusion to draw from this, could be that the transfer of basic skills is important for early parents whether qualified (or rather in the process of become qualified) or not qualified.

[11] See Appendix B for a table reporting the distribution of education levels and the average basic skills g-score for parents of younger and older children separately. The table highlights that among higher educated parents those with older children have on average lower basic skills (and higher variance) than those with younger children. Moreover even in the 'high qualified' category, they are concentrated in the lower levels of qualification if compared with parents of younger children.

Table 13: school age children- low educated parents

	(1)	(2)	(3)	(4)	(5)
Parents skills	0.187***	0.184***	0.137***	0.138***	0.100**
	(0.026)	(0.026)	(0.032)	(0.039)	(0.044)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√
Family structure (n. of siblings; lone parent)		√	√	√	√
Socio-economic occupation			√	√	√
Household (log) Income and poverty status				√	√
Parents' ability at age 5					√
Observations	1575	1575	1119	872	609
R-squared	0.41	0.41	0.40	0.40	0.43

Notes: dependent variable: school age children (aged 6-16) overall g scores (pc on standardized ability scores). Robust standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 14: school age children- medium and high educated parents

	(1)	(2)	(3)	(4)	(5)
Parents skills	0.267***	0.264***	0.263***	0.245***	0.251***
	(0.048)	(0.048)	(0.055)	(0.072)	(0.087)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√
Family structure (n. of siblings; lone parent)		√	√	√	√
Socio-economic occupation			√	√	√
Household (log) Income and poverty status				√	√
Parents' ability at age 5					√
Observations	653	653	530	438	272
R-squared	0.47	0.48	0.51	0.50	0.55

Notes: dependent variable: school age children (aged 6-16) overall g scores (pc on standardized ability scores). Robust standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Results so far rely on Ordinary Least Squares (OLS) regressions with a rich set of control variables. They show that parents' basic skills are important determinants of the cognitive outcomes of their children. This result is robust to different specifications and to the inclusion of a large set of controls. The next section will explore in more details the channels of transmissions of parents' basic skills by looking at the relative contribution of literacy and numeracy separately.

5.3: Impact of Literacy and Numeracy considered separately

Up until now, we have always considered the common components of parents basic skills measured from two different tests (i.e. a literacy and a numeracy test). Using a unique composite index derived from a principal components analysis, relies on the assumption that a lot of the skills measured in the two tests are highly positively correlated[12]. The tests are designed to differentiate very low levels of basic skills, so that for example someone who can not read properly will also score very low in the numeracy test. For policy purpose, however, it may be interesting to try to relax this assumption and investigate whether it is possible to observe separate effects of parents' literacy and numeracy on their children tests scores.

In Table 15we present such regressions. We show the results using only our preferred specification with all controls. We observe in columns (1) and (4), standardised tests scores for literacy when entered in isolation. Both coefficients are highly significant and positive hinting at a strong effect of literacy on tests scores both for pre- and school aged children. The effect of numeracy in isolation is only significant for school aged children. So there is some support for a story where the effects observed previously comes mainly from parents' literacy skills. This is confirmed in col. (3) where both tests are entered separately in the same regressions. Obviously the high correlation between numeracy and literacy takes away a bit of the significance of the literacy scores. Also numeracy is not significant in both the pre- and school aged children. But we do not take the view that numeracy is not affecting children tests scores, rather we think that there is a combined effect of both literacy and numeracy. And we argue that the best way to measure this combined effect is to use our previously computed predictions from the first components derived a principal components analysis.

Table 15: Impact of literacy and numeracy separately

	(1)	(2)	(3)	(4)	(5)	(6)
	Younger children			**Older Children**		
Parents Literacy score	0.142**		0.136*	0.194***		0.174***
	(0.066)		(0.080)	(0.057)		(0.064)
Parents Numeracy score		0.0818	0.0127		0.114**	0.0343
		(0.058)	(0.069)		(0.050)	(0.057)
All controls	٧	٧	٧	٧	٧	٧
Observations	481	481	481	880	881	880
R-squared	0.53	0.52	0.53	0.46	0.46	0.46

[12] Indeed, the correlation between the two tests is as high as 0.66 and highly significant

While the previous table suggests that parents' literacy matters more than numeracy for child's cognitive outcomes, we still do not know whether this relationship is linear or not.

In the following table, we use as variable of interest the *levels* of literacy and numeracy achieved by parents (as defined in the new *Skills for Life* standards) instead of using a continuous measure. In this way we should be able to indentify possible discontinuities in the relationship between parents' basic skills and child performance. Indeed, Table 16 show the estimates outcomes for both younger (col. 1, 2) and older (col. 3, 4) children. As usual, the regressions are run using the full set of controls, even if they are not reported in the table.

Focusing on the younger children, the results reveal a significant cut-off between parents at Entry Level 3 literacy and higher levels. Children in families with parents at Level 1 or 2 in literacy assessment perform significantly better than children of parents at the very lowest literacy level (Below Entry Level 2). In the case of numeracy the cut-off appears to be between parents at Entry Level 3 and higher levels. It seems that having reached the literacy and numeracy levels set as minimum target by the government (Level 1 and Entry Level 3 respectively) significantly affects the performance of young children.

For older children, the picture is rather different in that the impact of literacy seems to be more continuous. Each level of literacy above the lowest one leads to better performance of children. As showed also in before, numeracy has a lower impact, and only children of parents with numeracy Level 2 are significantly advantaged with respect to the others.

Table 16: Impact of parents' literacy and numeracy levels

	(1)	(2)	(3)	(4)
	Younger children		**School-aged children**	
	Literacy Levels	*Numeracy Levels*	*Literacy Levels*	*Numeracy Levels*
Entry Level 2	0.286	0.448	0.785***	0.0830
	(0.56)	(0.28)	(0.24)	(0.22)
Entry Level 3	0.0664	0.470*	0.787***	0.161
	(0.48)	(0.24)	(0.20)	(0.20)
Level 1	0.638**	0.565**	1.003***	0.139
	(0.32)	(0.24)	(0.18)	(0.21)
Level 2	0.732**	0.588**	1.048***	0.408*
	(0.32)	(0.23)	(0.18)	(0.21)
All controls	√	√	√	√
Observations	481	481	881	881

R-squared	0.53	0.53	0.46	0.46

5.4: Analysing cognitive and non-cognitive outcomes

Our results have revealed that the higher the parents' literacy and numeracy scores, the better is the cognitive performance of their children. From a theoretical point of view, we might expect parents' basic skills to have a positive impact on cognitive outcomes only. Better basic skills might enable parents to read to their children and help them with their homework, etc. However, it is not clear that the basic skills of parents would necessarily impact on other outcomes, such as behaviour. In fact if we find similar effects from parental basic skill (conditional on parental education and occupation) on non-cognitive outcomes of children, we might suspect that our apparent impact from parental basic skills is actually picking up other aspects of parents behaviour, such as attitude or aspirations. To explore this issue further, we estimate a model where cognitive and non-cognitive outcomes are simultaneously determined.

The cognitive outcomes are described using the g-score extracted from different test scores as in previous regressions. In order to capture the non-cognitive outcomes we use the "***Strength and Difficulties scale***" (SDQ or Goodman) included in the *Parent and Child Questionnaire*. The four sub-scales of the SDQ constitute an index of general "emotional behavioural problems". Appendix C gives the full list of questions used to construct the index. The final scale is negative so that a low score indicates fewer emotional and behavioural problems.

We use a Seemingly Unrelated Regression (SUR; see Zellner, 1962) method jointly testing two equations: one for cognitive outcomes and one for non-cognitive ones.

Formally, the estimating equations are the following:

$$\begin{cases} S_c^C = \alpha^C + \beta_1^C S_p + \beta_2^C read + \beta_k^C \sum_k X_k + \varepsilon^C \\ S_c^{NC} = \alpha^{NC} + \beta_1^{NC} S_p + \beta_2^{NC} pwb + \beta_k^{NC} \sum_k X_k + \varepsilon^{NC} \end{cases} \qquad (2)$$

where the subscript c refers to children, the subscript p to parents; S^c and S^{nc} are children's cognitive and non-cognitive outcomes respectively. As explained before, cognitive outcomes are expressed using BAS tests scores, while non-cognitive outcome are proxied by the SDQ scale. S^p is the parents' combined literacy and numeracy scores, while X_k is the full set of control variable described in equation (1). As in the previous regressions, we shall control for child characteristics, family structure, parents' occupation, education, income and 'innate' ability. Because we have two equations, we need to find variables that predict one outcome but not the other. We therefore add a variable that is exclusive to the cognitive equation, namely the variable *read* which is a variable describing how often the parent read to the child. The hypothesis is that reading to a child could be an important mechanism linking parents' basic skills and cognitive outcomes but should not have a direct impact on their children's non-cognitive outcomes. We also have a variable exclusive to the non-cognitive skill equation, namely a measure of parental well being proxied by their assessment about their life satisfaction[13]. The hypothesis here is that parental well being is likely to impact on children's emotional development but not necessarily their cognitive skills directly.

The estimates' outcomes are reported in the next two tables. Table 17 refers to pre-school children, while Table 18 to school- age children. Columns 1, 3, 5, 7, 9 and 11 in each table show the coefficients for cognitive outcomes, while the even columns refer to non-cognitive outcomes.

[13] The scale goes from 0 (the lowest level of life satisfaction) to 10 (the highest one).

Table 17: SURE regressions on cognitive and non cognitive outcomes. Young children

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Cognitive	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*
Parents skills	0.170***	-0.278***	0.168***	-0.281***	0.133***	-0.182*	0.117***	-0.145	0.126***	-0.154	0.0863**	-0.101
	(0.023)	(0.080)	(0.024)	(0.080)	(0.029)	(0.10)	(0.030)	(0.10)	(0.032)	(0.11)	(0.042)	(0.14)
Reading to child	0.127***		0.124***		0.121***		0.114***		0.134***		0.140**	
	(0.033)		(0.034)		(0.036)		(0.037)		(0.042)		(0.054)	
Parents life satisfaction		-0.205***		-0.210***		-0.144**		-0.142**		-0.110		-0.0521
		(0.054)		(0.055)		(0.066)		(0.066)		(0.071)		(0.089)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√	√	√	√	√	√	√	√
Family structure (n. of siblings; lone parent)			√	√	√	√	√	√	√	√	√	√
Socio-economic occupation					√	√	√	√	√	√	√	√
Education							√	√	√	√	√	√
Household (log) Income and poverty status									√	√	√	√
Parents' ability at age 5											√	√
Observations	1166	1166	1166	1166	892	892	892	892	727	727	466	466
R-squared	0.51	0.04	0.51	0.04	0.51	0.04	0.52	0.04	0.52	0.05	0.52	0.08

Table 18: SURE regressions on cognitive and non cognitive outcomes. Older children

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Cognitive	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*	*Cognitive*	*Non-cognitive*
Parents skills	0.206***	-0.332***	0.203***	-0.329***	0.176***	-0.256**	0.152***	-0.198*	0.170***	-0.280**	0.140***	-0.216
	(0.026)	(0.091)	(0.026)	(0.091)	(0.033)	(0.11)	(0.034)	(0.12)	(0.039)	(0.13)	(0.050)	(0.18)
Reading to child	-0.0750**		-0.0745**		-0.101***		-0.113***		-0.114**		-0.151***	
	(0.035)		(0.035)		(0.039)		(0.040)		(0.045)		(0.051)	
Parents life satisfaction		-0.537***		-0.522***		-0.535***		-0.532***		-0.575***		-0.505***
		(0.061)		(0.062)		(0.075)		(0.075)		(0.086)		(0.11)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√	√	√	√	√	√	√	√
Family structure (n. of siblings; lone parent)			√	√	√	√	√	√	√	√	√	√
Socio-economic occupation					√	√	√	√	√	√	√	√
Education							√	√	√	√	√	√
Household (log) Income and poverty status									√	√	√	√
Parents' ability at age 5											√	√
Observations	1225	1225	1225	1225	930	930	929	929	757	757	502	502
R-squared	0.31	0.09	0.31	0.09	0.32	0.08	0.33	0.09	0.32	0.09	0.36	0.09

Consistent with our previous results, we can note that parents' basic skills have a strong, positive and significant impact on cognitive outcomes for both younger and older children. As far as non-cognitive outcomes are concerned, columns 2, 4 and 6 in Table 17 and Table 18 show a significant negative impact of parents' basic skills on children behavioural problems (this means that the higher the literacy and numeracy of parents, the better the behavioural outcomes of children). However, when we control for occupation, education and ability, it turns out that parents' basic skills have a statistically positive significant impact only on cognitive outcomes, both for younger children and for school age ones.

Looking at the other variables, the results show that as expected parents' well being significantly affect children's behavioural and emotional problems (the negative sign means that the higher the parents' life satisfaction the less behavioural and emotional problems for their children). This effect is greater for older than for younger children, suggesting that the sensitivity of children to parents' mental state may increase with age. The identifying variable for the cognitive equation (how often do the parents read to the children) is positive and significant only for younger children. For older ones, it turns out to be negative. This finding could be surprising at the first sight, but can be easily interpreted if we consider the likely endogeneity of this variable for school-age children. For younger children being read to by a parent may be useful and may stimulate their curiosity, logical capacities and vocabulary abilities. For older children, instead, the fact that they are still being read to by parents instead of doing that alone may be a signal of some cognitive problems. Therefore, in this case there may be a problem of reverse causality.

However, the main result we derived from these tables is that parents' basic skills have indeed a direct impact only on children's cognitive outcomes, once the effects of other aspect of family background are netted out. This also reassures us on the validity of our specification in the sense that it seems that we are in fact identifying the specific effects of parents' literacy and numeracy, without capturing other aspects of parents' behaviour, such as attitude or aspirations.

7. Conclusion

The main aim of this paper was to assess how basic skills in literacy and numeracy of parents affect the cognitive performance of their children. The data used for our analysis are taken from the British Cohort Survey (BCS). This dataset covers a sample of 18.000 babies born in a week in 1970 who have been interviewed and tested at regular intervals. In 2004, all the cohort members' have been assessed in their basic numeracy and literacy. Amongst those, 4,800 individuals have been randomly selected and their children have also been tested. This paper investigates how the children's performances in those tests are affected by their parents' basic numeracy and literacy skills. In particular, we address the question of whether parents' basic skills influence their children's cognitive performance in early (3 to 6 years) and later (6 to 17) childhood.

As our main result, we found strong evidence that parents with higher basic skills have children who perform better in tests scores. This main result remains true within each educational group, and controlling for a wide range of variables: socio-professional status of the parents, income levels of parent, gender of the child, whether first born, number of siblings, single parenthood, parents' ability measured at age 5 and parenting style.

When splitting the sample in to two groups according to the highest level of education attained by parents, we found that the transfer of basic skills is always significant for parents with low levels of qualifications. This lends support for skills enhancing policies targeted at adults with low-level qualifications. For parents with high levels of qualifications, having higher basic skills is associated with higher test scores for school-aged children only (aged from 6 to 17 years).

Investigating in more details the channels by which basic skills affect children performance, it appears that parents' literacy could be more important than numeracy.

As main policy conclusions, these results suggest that policy aimed at increasing parents' basic skills may have potentially large inter-generational effects on the cognitive performance of children. There is particular scope for policies targeted at low qualified adults and young parents, for which our results show the inter-generational transfer is especially strong.

Appendix A

OLS estimates using the same sample size for all the regressions

Table 19: Younger children

	(1)	(2)	(3)	(4)	(5)	(6)
Parents skills	0.175***	0.176***	0.152***	0.153***	0.137***	0.0998**
	(0.041)	(0.040)	(0.039)	(0.040)	(0.042)	(0.044)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√	√
Family structure (n. of siblings; lone parent)		√	√	√	√	√
Socio-economic occupation			√	√	√	√
Household (log) Income and poverty status				√	√	√
Education					√	√
Parents' ability at age 5						√
Observations	481	481	481	481	481	481
R-squared	0.49	0.49	0.51	0.51	0.52	0.53

Table 20: Older children

	(1)	(2)	(3)	(4)	(5)	(6)
Parents skills	0.175***	0.173***	0.146***	0.138***	0.127***	0.113***
	(0.034)	(0.034)	(0.037)	(0.038)	(0.039)	(0.040)
Child Characteristics (age, gender, whether first born)	√	√	√	√	√	√
Family structure (n. of siblings; lone parent)		√	√	√	√	√
Socio-economic occupation			√	√	√	√
Household (log) Income and poverty status				√	√	√
Education					√	√
Parents' ability at age 5						√
Observations	881	881	881	881	881	881
R-squared	0.44	0.44	0.45	0.45	0.46	0.46

Appendix B

Table 21: Different characteristics between parents of younger and older children

		Parents of young children	Parents of older children
Whole sample			
Qualification	No qualification	4.0	11.3
	Level 1	24.9	33.1
	Level 2	21.7	23.3
	Level 3	12.8	11.7
	Level 4	27.3	17.6
	Level 5	9.3	3.0
Literacy and Numeracy scores	mean	0.14	-0.24
	std	(1.12)	(1.35)
Low qualified only (less than level 2)			
Qualification	No qualification	7.9	16.7
	Level 1	49.2	48.9
	Level 2	42.9	34.5
Literacy and Numeracy scores	mean	-0.24	-0.49
	std	(1.22)	(1.41)
High qualified only (more or equal to level 2)			
Qualification	Level 3	25.9	36.1
	Level 4	55.3	54.5
	Level 5	18.8	9.4
Literacy and Numeracy scores	mean	0.51	0.27
	std	(0.75)	(1.03)

Appendix C

Strength and Difficulties Scale

Questions:
Restless, overactive and not able to sit still for long
Often complaining of headaches, stomach-aches or sickness
Has often had temper tantrums or hot tempers
Rather solitary, tending to play alone
Many worries, often seeming worried
Constantly fidgeting and squirming
Has often had fights with other children or bullied them
Often unhappy, downhearted or tearful
Generally liked by other children
Easily distracted, concentration wandered
Nervous or clingy in new situations, easily loses confidence
Picked on or bullied by other children
Getting on better with adults than with other children
Many fears, easily scared

References

Angrist, J. and Krueger, A., (1999), ‘‘Empirical Strategies in Labor Economics’’, in O. Ashenfelter and D. Card (eds), Handbook of Labor Economics, Vol. 3A, ch. 23. Amsterdam: Elsevier.

Behrman J.R. and Rosenzweig, M., (2002) “Does Increasing Women’s Schooling Raise the Schooling of the Next Generation?” *American Economic Review*, Vol. 92:1, pp. 323-334.

Black, S., Devereux, P. and Salvanes, K., (2005), "Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital," American Economic Review, vol. 95(1), pages 437-449.

Boissiere, M., Knight, J.B. and Sabot, R.H., (1985), "Earnings, Schooling, Ability, and Cognitive Skills," *American Economic Review* 75, no. 5, 1016-1030.

Bound J, Jaeger D, Baker R., (1995), “Problems with Instrumental Variables Estimation When the Correlation between the Instruments and the Endogenous Explanatory Variable Is Weak”, *Journal of the American Medical Association,* **90**(430):443–50.

Bynner, J., Dearden, H., McIntosh, S., Reed, J., Van Reenen, J. and Vignoles, A., (2001), “Improving Adult Basic Skills: Benefits to the Individual and to Society”, DfEE Research Brief No. 251.

Bynner, J. and Parsons, S., (2006), “New Light on Literacy and Numeracy: Results of the Literacy and Numeracy Assessment in the Age 34 Follow-up of the 1970 Cohort Study (BCS70)”, NRDC main report.

Carneiro, P. and Heckman, J., (2004): “Human Capital Policy”, in Heckman, J.J and A.B. Krueger, “*Inequality in America: What Role for Human Capital Policies?”* Cambridge, MA, MIT Press**:** pp. 370.

Carneiro, P., Meghir, C. and Parey, M., (2007), "Maternal Education, Home Environments and the Development of Children and Adolescents," *IZA Discussion Papers* N. 3072, Institute for the Study of Labor (IZA), Bonn.

Cawley, J., Conneely, K., Heckman, J. and Vytlacil, E., (1996), “Measuring the effects of cognitive ability", *NBER Working Paper* No. 5645, National Bureau of Economic Research: Cambridge, Ma.

Chevalier, A., (2004), “Parental Education and Child's Education: A Natural Experiment”, *IZA Discussion Paper* no. 1153, IZA, Bonn.

Chevalier, A., Harmon, C., O'Sullivan, V. and Walker, I., (2005), "The Impact of Parental Income and Education on the Schooling of Their Children", *IZA Working Paper* No. 1496, IZA, Bonn.

Cunha, F. and Heckman, J., (2007), "The Technology of Skill Formation." American Economic Review **97**(2): 31-47.

Dearden, L., McIntosh, S., Myck, M. and Vignoles, A., (2002), 'The Returns to Academic, Vocational and Basic Skills in Britain', *Bulletin of Economic Research*, vol 54, no. 3, pp. 249-274.

De Coulon, A., Marcenaro-Gutierrez, O. and Vignoles, A., (2007), "The Value of Basic Skills in the British Labour Market", Centre for Economic Performance, London School of Economics.

Department for Education and Employment (DfEE), (1999), *Improving literacy and numeracy: a fresh start*. Great Britain Working Group on Post-School Basic Skills chaired by Sir Claus Moser, London: Department for Education and Employment.

Feinstein, L., (2003), "Inequality in the Early Cognitive Development of British Children in the 1970 Cohort," *Economica* **70**(277): 73-97.

Feinstein, L. Duckworth, K., and Sabates, R., (2004), "A model of the intergenerational transmission of educational success", *Wider Benefits of Learning Research Report*, No. 10, Institute of education, London.

Feinstein, L. and Duckworth, K., (2006), "Development in the early years: its importance for school performance and adult outcomes", *Wider Benefits of Learning Research Report No 20,* Institute of education, London.

Friedman, M., (1957), A Theory of the Consumption Function, Princeton University Press, Princeton, NJ, USA

Galindo-Rueda, F., (2003), "The Intergenerational Effect of Parental Schooling: Evidence from the British 1947 School Leaving Age Reform." Centre for Economic Performance, London School of Economics, mimeo.

Galindo-Rueda, F. and Vignoles, A., (2005), "The Declining Relative Importance of Ability in Predicting Educational Attainment", *Journal of Human Resources,* **40**(2), pp. 335-353.

Grinyer, J., (2005), Literacy, Numeracy and the labour market: Further analysis of the Skills for Life survey, Department for Education and Skills report (DfES)**.** Research Report No 712.

Haveman, R. and Wolfe, B., (1995). "The Determinants of Children's Attainments: A Review of Methods and Findings." *Journal of Economic Literature*, **33**(4): 1829-1878.

Heckman, J., (1995), "Lessons from the Bell Curve," *The Journal of Political Economy,* **103**(5): 1091-1120.

Ishikawa, M., Ryan, D., (2002), "Schooling, Basic Skills, and Economic Outcomes." *Economics of Education Review,* **21**(3), 231-243.

Koenker, R.W. and Bassett, G.J., (1978), "Regression Quantiles," *Econometrica*, Vol. **46**(1), pp. 33-50.

Koenker, R.W and Hallock, K.F., (2001), "Quantile Regression," *Journal of Economic Perspectives*, Vol. **15**(4), pp. 143-156,

Leitch Review of Skills, (2006), Prosperity for all in the global economy- world class skills, Final Report, December, HMSO.

Masten, A.S. and Coatsworth, J.D., (1998), "The development of competence in favourable and unfavourable environments: Lessons from Research on successful children'. *American Psychologist,* **53**(2), 205-220.

McIntosh, S. and Vignoles, A., (2001), "Measuring and assessing the impact of basic skills on labour market outcomes", *Oxford Economic Papers*, **53**(3), pp.453-481

Michael, R., (2004), Family Influences on Children's Verbal Ability. Family Investments in Children: Resources and Behaviors that Promote Success. A. Kalil and T. DeLeire. Mahwah, NJ, L. Erlbaum Assoc. Inc 49-84.

Michael, R., (2005), "Children Reading and Math Skills: the Family's Two Constraints", *Harris School Working Paper Series* No 05.11, University of Chicago.

Murnane, R.J. Willett, J.B. and Levy, F., (1995), "The growing importance of cognitive skills in wage determination", *Review of Economics and Statistics* **77**(2), 251–266

Murnane, R., Willett, J., Duhaldeborde, Y., and Tyler, T., (2000), "How important are the cognitive skills of teenagers in predicting subsequent earnings?" *Journal of Policy Analysis and Management* 19(4): 547-568.

Oreopoulos, P., Page, M.E. and Stevens, A.H., (2003), "Does Human Capital Transfer from Parent to Child? The Intergenerational Effects of Compulsory Schooling", *NBER Working Papers* N.10164, National Bureau of Economic Research, Cambridge, MA.

Parsons, S., (2006), "Guide to Child Paper Questionnaires", available at http://www.cls.ioe.ac.uk

Parsons, S. and Bynner, J., (2005), “Measuring Basic Skills for Longitudinal Study: the design and development of instruments for use with cohort members in the age 34 follow-up of the 1970 British Cohort Study (BCS70)”, NRDC Report. http://www.nrdc.org.uk/content.asp?CategoryID=424

Plug, E., (2003), “Schooling, Family Background, and Adoption: Is it Nature or is it Nurture? *Journal of Political Economy*, **111**, pp. 611-641

Pryor, F. and Schaffer, D., (1999), *Who's not working and why: Employment, cognitive skills, wages, and the changing U.S. Labor market*. (Cambridge: Cambridge University Press).

Sacerdote, B., (2000), "The Nature and Nurture of Economic Outcomes," *NBER Working Paper* No. 7949, National Bureau of Economic Research, Cambridge, MA.

Sacerdote B., (2002), “The Nature and Nurture of Economic Outcomes,” *American Economic Review*, **92**, pp. 344-348

Sacerdote, B., (2007), “How Large Are the Effects from Changes in Family Environment? A Study of Korean American Adoptees”, *Quarterly Journal of Economics,* **122**: pp. 1-119

Todd, P., Wolpin, K., (2007), The Production of Cognitive Achievement in Children: Home, School, and Racial Test Score Gaps, *Journal of Human Capital*, 1(1), 91-136.

Tyler, J., (2004), “Basic Skills and the Earnings of Dropouts”, *Economics of Education Review*, 23(3), 221-35.

Williams, J., Clemens, S., Oleinikova, K. and Tarvin, K., (2003), “The Skills for Life survey: A national needs and impact survey of literacy, numeracy and ICT skills”. DfES Research Report 490. Department for Education and Skills. Crown copyright.

Zax, J., Rees, D., (2002), “IQ, Academic Performance, Environment, and Earnings”, *Review of Economics and Statistics*, **84**(4), 600-616.

Zellner, A., (1962), "An efficient method of estimating seemingly unrelated regression equations and tests for aggregation bias", *Journal of the American Statistical Association*, 57, 348–368.