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Parents' Basic Skills and Children Cognitive Outcomes

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Acknowledgments

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1. Introduction

A large proportion of the UK adult population has very poor literacy and/or numeracy skills (see the 1999 Moser Report[1], the 2003 *Skills for Life* Survey and the 2006 Leitch report). In 1999, the Moser report found that approximately 20% of adults in England had severe literacy difficulties, whilst around 40% had some numeracy problems. Having a population with a large proportion of people with poor literacy and numeracy is harmful both to the low-skilled individuals themselves (who face a higher probability of being unemployed, having an unstable job and lower wages) and to firms (that increasingly need a better skilled workforce). The evidence to support the economic value of basic skills is now extensive (see section 2). There are however, potential indirect benefits from basic skills, which have been less frequently addressed in the literature.

This paper addresses the important question of how parents' basic skills relate to the early cognitive development of their children (at age 3-6). This question is important as early cognitive ability is a key determinant of subsequent schooling, wages, and other socio-economic outcomes (Heckman, 1995; Murnane *et al.*, 1995; Feinstein and Duckworth, 2006). Further, there are significant cognitive achievement gaps between children from various socioeconomic groups: these gaps emerge early i.e. before starting school (Cunha and Heckman, 2007) and increase as children age (Carneiro and Heckman, 2004; Feinstein, 2003). Understanding the inter-generational transmission of skills is therefore important from both a distributional and an efficiency perspective, and indeed a number of recent papers have investigated the contribution of parents to the early formation of their children's cognitive skill (Todd and Wolpin, 2007, Cunha and Heckman, 2007).

The novelty of this paper is that we distinguish the separate contribution of parents' literacy and numeracy skills in adulthood (at age 34) on their children's cognitive test scores, as distinct from the role of other factors including parental ability, education and socio-economic status. We use the British Cohort Study (BCS) data set, in which rich information on parents is combined with early test scores for their children. We use numeracy and literacy tests of parents at age 34 and relate them to cognitive tests of their children taken pre-school at ages 3 to 6. We are able to control for a

[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.

vast array of family and individual characteristics, including parents' early years (parents have been surveyed 7 times since their birth in 1970) and socio-economic background. We find that parents' basic skills in literacy and numeracy at age 34 have a positive significant effect on their children's test scores, over and above the positive effects of parental education and ability.

The layout of the paper is the following: in Section 2, the recent literature is surveyed. We provide a discussion of the empirical strategy in Section 3. In Section 4, we describe our data and the main results are presented in Section 5. Section 6 presents some conclusions and discusses policy implications.

2. Literature Review

Our research bridges a number of different strands of literature. It draws on the rapidly developing literature on early cognitive development and the effect of family environment. The economic framework for research on children's attainment has focused on the processes by which family inputs can affect children's educational outcomes (the *production function approach* **-** see Todd and Wolpin, 2007 and Haveman and Wolfe, 1995 for a detailed review). 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 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: *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. Cunha and Heckman (2008) operationalise a model of skill formation using the Children of the National Longitudinal Survey of Youth (CNLSY). They focus on the production of both cognitive and non-cognitive skills and investigate how family inputs affect these skills over different phases of the life-cycle. Their results reveal a strong persistence in cognitive and non cognitive skills over time, and suggest that non-cognitive skills affect the accumulation of next period cognitive skills, but not vice versa. Parental investments seem to affect both cognitive and non-cognitive skills, but mother's ability is found to affect cognitive ability only.

They also show that the early years are a particularly sensitive periods for the development of cognitive and non-cognitive skills with respect to parental investments (such as family income).

Our analysis also relates to the literature on intergenerational transmission, most of which has focused on the intergenerational transmission of parental education specifically. Parents with higher educational levels have children with higher educational levels, although it is not clear whether this link is causal (Carneiro *et al*, 2007). Behrman and Rosenzweig (2002), using twin data, found no causal impact from maternal education on children's schooling, although the effect of father's education was large in magnitude. Comparing adopted and natural children, Plug (2003) and Sacerdote (2002 and 2007) found positive effects from parental schooling on children's schooling, albeit for fathers only in the case of Plug. Chevalier (2004), Black *et al.* (2005), and Oreopoulos *et al.* (2003) use an IV approach based on the natural experiment caused by changes in compulsory schooling laws in the UK, Norway and US respectively. Chevalier (2004) and Oreopoulos *et al.* (2003) find positive effects from parental education, whilst Black et al. (2005) find only weak effects. Carneiro *et al*. (2007) use a different instrument, namely the costs of schooling, exploiting the differential changes in the direct and opportunity costs of schooling across counties and cohorts of mothers. Their results suggest that mother's education increases the child's attainment 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. Overall, these works point to a positive effect from parental education on children's outcomes. There is virtually no evidence however, on the inter-generational effects of basic skills on child outcomes[2].

Lastly, there is a literature assessing the impact of skill on various outcomes. The US literature has found strong wage effects 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 returns to cognitive skill are rising (Murnane *et al*., 2000). There is also a UK literature which has found a strong link between literacy and numeracy specifically and labour market outcomes, particularly earnings (Bynner *et al*., 2001; Dearden *et al*., 2002; De Coulon *et al.*, 2007; McIntosh and Vignoles, 2001). There is only limited evidence on the impact of basic skills on non-economic outcomes (Bynner *et al.,* 2001). Our work contributes here by focusing on an alternative non-economic inter-generational effect from adult basic skills.

[2] One exception is Bynner *et al*. (2001) who found that parents with better basic skills were less likely to have children with self-reported literacy or numeracy difficulties at school.

3. The Empirical Approach

In this paper, we focus on the relationship between parental skill and children's cognitive development. For most of the analysis, the dependent variable is an index of child's cognitive ability, constructed from tests administered at ages 3-6 (see section 4). The model controls for a rich array of other factors, with the choice of variables informed by the literature described in the previous section. Our estimating equation is the following:

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

Where the subscript c = child; subscript p = parents, and S=skills, X: are the set of child characteristics (sex, age, whether first born); F describes family structure (lone parents; number of siblings); E is parental education; Y is household income and whether the family receives state benefits, finally A is parental ability (as measured by parents' own test scores taken from tests administered at age 5). We adjust the standard errors to allow for clustering within households and estimate the model using Ordinary Least Squares (OLS). As our main interest is the link between parents' basic skills and children's tests scores, we will focus on the coefficient β_1 .

As already mentioned, the BCS 70 data constitutes an incredibly rich source of information. When regressing the child tests scores on the basic skill measures for their parents, we allow for a large array of child and parent characteristics (see section 4). Some of these variables would be unobserved in more conventional data sets. In particular we can control for parental ability, as measured by a range of tests administered to the *parents* at the age of 5. Whilst we cannot claim that these tests fully capture parental IQ, we argue that they do measure early ability of the parent and thus make it more likely that our skills variables are identifying a distinct effect of parental literacy and numeracy on child outcomes, rather than the effect of parental ability. In general the rich range of controls we use reduces the probability that the model suffers from omitted variables bias.

Our OLS regressions may hide differences in the effects of parental skill on child outcomes across different sub-groups of the population. Further, if we are uncovering genuinely causal intergenerational transmission of skill, we might expect that literacy and numeracy would be more important for certain groups, such as very low educated parents. For more educated parents, one might expect that marginal differences in (high) levels of literacy or numeracy would be less likely to impact on child attainment. We therefore also estimated models by qualification level of the parents. We also estimated separate regressions by gender of both parent and child, to explore whether maternal or paternal skill had differing effects on boys' and girls' cognitive attainment[3].

We have argued that the richness of the data gives some credibility to the argument that we can control for many factors that are usually unobservable. For example, we have data on parents' attitudes to education, information on parental ability and measures of parental mental health. However, it remains a possibility that any positive relationship between parental literacy and numeracy and child cognitive attainment is due to unobservable factors correlated with both parent and child skill. One approach to uncover causality would be to find an instrumental variable: it proved problematic to identify a credible instrument. We therefore explored other ways of assessing whether we have uncovered a genuinely causal relationship. In particular, we hypothesized that if the relationship is causal then parental basic skills are likely to impact most on children's cognitive skills via a number of important transmission mechanisms such as reading with the child[4]. Basic skills in literacy and numeracy (as opposed to other parental attributes such as social class or education) would appear less likely to have a causal impact on children's non-cognitive development. If, on the other hand, it is simply the case that parents with better basic skills also have other unobserved qualities that help their children develop better cognitive skills (e.g. encouraging their children to achieve), then parental basic skill would also show a positive effect on children's non-cognitive skill. We use Seemingly Unrelated Regression Estimation (SURE) to jointly estimate two equations for child cognitive and non-cognitive outcomes to determine whether literacy and numeracy is impacting more on children's cognitive attainment. The identification of these equations is discussed in section 5.

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[3] The separate regressions by gender did not indicate significant differences in the relationship between father's and mother's basic skills and children's cognitive attainment. Therefore, we do not report these estimates but results are available on request.

[4] Of course it may be that reading impacts on other non-cognitive outcomes, such as confidence (Cunha and Heckman, 2003). Given we have measures of the extent the parent reads to the child and data on children's cognitive and non-cognitive outcomes, we are able to test this issue empirically.

In the absence of an experiment, we cannot claim definitively to have uncovered a causal inter-generational relationship. However, we would argue that our empirical strategy is strong enough to be highly suggestive of a causal link.

4. Data Description

The empirical analysis relies on different sweeps of the BCS 70. Since our aim is to study the impact of parents' basic skills on their children's 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 in 2004, 4,792 had been randomly selected into the "Parent and Child" sub-study. Of these, 2,824 (59 per cent) had at least one child. In total, we have information on 5,207 own or adopted children of cohort members 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 undertook cognitive assessment. Of these, 1,359 (about 65 percent) are aged between 3 and 5 years and 11 months. We focus on the pre-school years, guided by the literature which suggests investments made early have greater impact (Cunha *et al*., 2005). Also, although the role of schooling in determining cognitive achievement may not be as important as the inputs of parents (Cunha *et al*. 2005), we do not have good data on the nature of the children's schooling and for older children we have no measures of their early cognitive ability. We therefore do not present the results for the school age child sample. However, results for school age children are qualitatively similar[5].

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[6]. 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 (see Table 2 for descriptive statistics[7]).

Table 2: Child cognitive test 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

We use a principal component analysis (PCA) to construct an index of child cognitive skill, using the first principal component extracted[8]. We interpret this index as a measure of cognitive skill that allows us to rank each child in terms of their cognitive ability.

Table 3 provides information on the process of extracting the first principal component. The second and the third columns indicate the principal component order and the cumulative proportion of the overall variance explained by each principal component. The first principal component explains about 80 percent of the variance. This reassures us of 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, as an indication of the contribution of each score to the constructed index.

[5] These results are available on request.
[6] For further details on these children's assessments, see Bynner and Parsons (2006).
[7] Test scores are estimates of children's cognitive skills measured by an individual scale. The score reflects both the raw score and the difficulty of the item administered (See Bynner and Parsons, 2006, p. 81).
[8] This procedure is very common in the psychometric literature in order to build an index of general ability (Cawley *et al*., 1996). The index is constructed from the product of the test score vector and the eigenvector associated with the largest eigenvalue of the matrix of correlations among standardized test scores.

Table 3: Principal Component Analysis of child test scores

	Principal component rank	Cumulative variance explained	Name of original test	Correlation
Early years battery	1 (g-score)	0.836	Early Number Concepts	0.9143
	2	1.000	Naming Vocabulary	0.9143

Two tests were administered at age 34 to assess parents' literacy and numeracy. 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 were lower they were then asked easier questions. The numeracy test is made of 17 multiple choice questions, asked to all individuals (for a detailed explanation of the tests' design see Parsons and Bynner, 2005). It is interesting to observe the distribution of parental literacy and numeracy within each educational group, where education is given in levels ranging from no qualifications through to having a postgraduate qualification at level 5. High school graduation is equivalent to level 3, whilst a college graduate would be classified as level 4. As shown in Table 4, numeracy and literacy achievements do vary within education group. Obviously, more educated parents also have on average better basic skills. However, among parents with no or low levels education, there is nonetheless a significant variation in their basic skills level. 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 4: Distribution of parental numeracy and literacy by highest parent qualification level*

	No qualifications	Level 1	Level 2	Level 3	Level 4	Level 5
Literacy						
Quintile 1	58.5	32.5	23.2	13.5	8.2	4.5
Quintile 2	20.6	24.6	17.7	26.8	11.6	5.6
Quintile 3	16.0	30.6	33.3	36.2	34.6	25.7
Quintile 4	2.7	7.5	18.2	13.5	23.3	24.0
Quintile 5	2.3	4.9	7.6	10.0	22.2	40.2
Numeracy						
Quintile 1	59.6	34.1	26.0	18.8	11.6	4.5
Quintile 2	18.2	24.3	16.9	15.1	11.2	8.4
Quintile 3	13.6	21.2	23.0	24.6	21.5	16.2
Quintile 4	7.7	16.2	24.5	27.8	37.1	40.8
Quintile 5	0.9	4.1	9.5	13.6	18.6	30.2

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

We constructed a continuous measure of the individual's basic skills based on these two tests of literacy and numeracy, using PCA.

As mentioned above, we 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 include child characteristics, family structure, parents' education and income, some measures of parenting style and finally parents' ability as measured by test scores at age 5.

In terms of child characteristics, we control for child's age, gender and whether she/he is a first born. For family characteristics, we include the number of siblings and a dummy variable describing whether the cohort member is a lone parent[9]. We control for the family's socio-economic circumstances by controlling for family income, poverty status of the household and parental socio-economic status. The family income variable is the log of the average weekly household income in 2000 and 2004[10]. To control for the effect of poverty status in 2004, we include a dummy variable equal to 1 if the family was in receipt of any state benefit. Parents' socio-economic status is described using the NS-SEC (National Statistics Socio-Economic Classification) occupationally based classification[11]. We also control separately for parents' education to evaluate the impact of basic skills netting out the effect from parental education more broadly. This is therefore an extremely stringent specification. We are asking whether, even within a given level of parental education, having better skills improves children's cognitive outcomes. We therefore include a variable indicating the cohort member's highest level of education attained in 2004[12]. The distribution of this variable is described in

Table **5.**

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[9] 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.

[10] In both years, 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).

[11] According to this classification occupations are grouped in 7 categories: higher managerial and professional occupations; lower managerial and professional occupations; intermediate occupations; small employers and own account workers; lower supervisory and technical occupations; semi-routine occupations; routine occupations. Almost 44 percent of our sample of parents was employed in routine or semi-routine occupations, which roughly correspond to Unskilled Occupations in the SOC2000 classification. Only 8.3 percent of individuals were employed in the most skilled occupations. Further details on the classification of social classes and occupations can be found at: http://www.statistics.gov.uk/methods_quality/ns_sec .

[12] We also tried to control for CM partners' level of education. This variable was insignificant and due to missing values, significantly reduced the number of observations in the sample. Cohort members' and partners' educational levels are also highly correlated so that collinearity problems may arise if they are jointly included.

As discussed, our dataset also allow us to control for parents' early ability using their test scores obtained from assessments taken at age 5. The inclusion of this variable is an attempt to control for the genetic factor in the intergenerational transmission of skill, although we recognise that the genetic versus environment debate has moved on from a simple dichotomous perspective (Cunha et al. 2005). The age 5 tests administered to the parents in our sample were not IQ tests per se so some caution is needed here, in that we may not have controlled for all genetic factors that influence child outcomes. Appendix A provides some descriptive statistics of the variables included in the analysis.

Table 5: Highest parents' educational level, 2004

Highest qualification, 2004	**Years of school**	**Freq.**	**Percent**	**Cum.**
No qualification	9	227	7.98	7.98
Level 1 (e.g. CSE, low GCSE's, etc.)	10	802	28.2	36.18
Level 2 (e.g. Good GCSE's, NVQ2, etc.)	11	614	21.59	57.77
Level 3 (e.g. A-levels/ high school)	13	348	12.24	70.01
Level 4 (e.g. university degree)	16	674	23.7	93.71
Level 5 (e.g. postgraduate qualification)	17.5	179	6.29	100
Total		2,844	100	

5. Results

This section presents a set of OLS regressions where the dependent variable is the child's cognitive test scores determined using PCA. Our focus of interest is the main explanatory variable, namely parents' basic skills (aged 34) in literacy and numeracy. The left hand column of Table 6 controls only child characteristics (child age, gender and whether she is first born). As one moves from left to right across the table additional controls are added.

In column 1, the coefficient on our measure of parental basic skill is positive and highly significant. This coefficient provides the 'raw' correlation between parental literacy and numeracy skill and their children's early cognitive skill, controlling only for child age and gender. 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 apparent relationship between parental literacy and numeracy and child cognitive development, not least parental socio-economic background and family circumstances. In column (2) to (7), we therefore progressively introduce more controls, starting with some family demographic features.

The coefficient on the literacy and numeracy variable remains large and significant when we introduce our large array of control variables[13]. In particular, this result is robust to the inclusion of parental qualification levels and parental ability measures[14]. This means that parents' basic skills have a positive association with children's cognitive test scores within each parental educational group, and conditional on parental ability. The specification in col. 8 suggests that even allowing for parental education and ability, an increase of one standard deviation in parents' basic skills on the index constructed (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, parents whose basic skills situated them at the 25th percentile have children who perform 10.1 per cent better on cognitive tests than parents situated at the 10th percentile (the difference between the 25th and the 10th percentiles is within one standard deviation).

Table 6: The relationship between parental basic skill and child cognitive outcomes full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Parents test score (pc)	0.183***	0.179***	0.148***	0.147***	0.134***	0.125***	0.0944**
	(0.024)	(0.023)	(0.027)	(0.027)	(0.028)	(0.030)	(0.042)
Child characteristics (age, gender, whether first born)	√	√	√	√	√	√	√
Family structure (nber of siblings, lone parents)		√	√	√	√	√	√
Socio-economic occupation			√	√	√	√	√
Receipt of state benefit				√	√	√	√
Parents education (by levels in 2004)					√	√	√
Log household income						√	√
Parents ability age 5 (pc)							√
R-squared	0.51	0.51	0.51	0.52	0.53	0.53	0.53
N	1219	1219	934	934	934	758	481

Note: dependent variable: overall cognitive index score (pc on standardized ability scores)
Standard errors (clustered by family) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[13] Other control variables we tested for inclusion 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, included measures of *warmth* and of *conflict* in the parent and child relationship as measured by the first and second principal component respectively from the *Child-Parent Relationship Scale* (Pianta: Short Form). However these variables were never significant and reduce our sample size so are not included in the specification shown.

[14] As we include additional controls the sample size decreases; we also run the same set of regressions keeping the sample size constant and the results are very similar (See the results in Appendix B)

Results differentiated by parental qualification level

UK policy, as in many countries, has focused on improving the basic skills of those who leave the education system with no qualifications. This is because having no qualifications is an easily observable indicator of having potentially poor literacy or numeracy. It is therefore of great interest to determine the relationship between parental basic skill and child cognitive development for unqualified parents. We split the sample in two groups: parents with less than Level 3 (A-level or high school graduation equivalent) and parents with higher qualifications (high school graduates or above). The estimates are reported in Table . The first two columns refer to low-educated parents, while results for parents who have A levels or above are shown in columns 3 and 4. Columns 1 and 3 present the result for the basic specification, which only includes child characteristics and col. 2 and 4 show the fully controlled specification.

Table 7: Separate regressions by parents' qualifications

	(1)	(2)	(3)	(4)
	Low educated parents		*High educated parents*	
Parents skills	0.168***	0.128**	0.142***	0.0465
	(0.028)	(0.053)	(0.053)	(0.083)
Child Characteristics (age, gender, whether first born)	√	√	√	√
All other controls		√		√
Observations	691	252	528	229
R-squared	0.52	0.54	0.49	0.52

For the low educated sample, the relationship between parents' basic skills and their children's early test scores remain positive and significant across the specifications in columns (1) and (2). 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 6 (0.1). Instead, for the high-educated parent sample the intergenerational link between parental basic skill and child cognitive test score is not robust to the inclusion of more control variables. Interestingly, this is not only because of the increasing standard errors caused by small sample size. It is also 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.

Some caution is required of course, since there are fewer highly educated parents with extremely poor basic skills. Additionally the parental literacy test is somewhat right censored (this is not the case for the numeracy test see Parsons and Bynner, 2005). The results are robust to a non linear specification however and suggest that the relationship between parental basic skill and child cognitive outcomes is stronger for parents at the bottom of the educational distribution. Of course, this result does not imply that parents with higher levels of qualification do not transfer any skills to their young children. Rather for more educated parents, *basic* skills in literacy and numeracy do not appear so important in determining child cognitive outcomes. By contrast, for parents with low qualification levels, having good basic skills in literacy and numeracy is strongly associated with better child cognitive outcomes. If one interprets this evidence as causal (on which more later), this provides some support for policy aimed specifically at increasing the basic skills of the least educated parents.

Analysing children's cognitive and non-cognitive outcomes

Our results have revealed that higher parents' literacy and numeracy scores are associated with better cognitive performance of their children. We might expect parents' basic skills in literacy and numeracy to have a greater positive impact on children's cognitive outcomes. For example, better basic skills might enable parents to read to their children and help them with their homework. However, conditional on other measures of family background (particularly parental education, parental socio-economic status and family income), it is not clear that the basic skills of parents would necessarily have an additional impact on other non-cognitive outcomes, such as behaviour. In fact if we find similar effects from parental basic skill on the non-cognitive outcomes of children, we might suspect that our apparent impact from parental basic skills on children's cognitive skill may actually picking up other aspects of parents behaviour, such as attitude or aspirations[15]. To explore this issue further, we estimate a model where cognitive and non-cognitive outcomes are simultaneously determined.

The cognitive outcomes are those used earlier in the paper based on child test scores. Our measure of children's non-cognitive outcomes is taken from the "***Strength and Difficulties scale***" (SDQ or Goodman) instrument used in the 2004 survey. The four sub-scales of the SDQ constitute an index

[15] We have more direct measures of parental attitude, including data on their attitude towards their child's schooling. The results reported are robust to inclusion of such direct measures.

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 that the child is observed (by the parent) to have 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 outcomes.

Formally, the estimating equations are the following:

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

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. S^p is the index of parents’ combined literacy and numeracy test scores described earlier in the paper. X_k is the full set of child and family control variables. As in the previous regressions, we control for child characteristics, family structure and parents’ occupation, education, income and ability. 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 measures how often the parent reads 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 (again conditional on other measures of parental inputs, such as socio-economic status and attitudes). We also have a variable exclusive to the non-cognitive skill equation, namely parental well being as measured by their self assessed life satisfaction[16]. The hypothesis here is that parental well being is likely to impact on children’s emotional development but not necessarily on their cognitive skills directly.

The estimates from the model are reported in   Columns 1, 3, 5, 7, 9 and 11 in each table show the coefficients for cognitive outcomes, while the even columns relate to non-cognitive outcomes.

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

Consistent with our previous results, parents' basic skills have a strong, positive and significant impact on cognitive outcomes for pre-school children. The results also suggest that in the full specification, which controls for parental occupation, education and ability, parents' basic skills have no statistically significant effect on children's non-cognitive outcomes. For completeness, this main model is re-estimated on the sample of school age children, and a qualitatively similar result is found although the magnitude of the coefficient is somewhat larger in the school age sample[17] (as shown in Appendix D).

As expected, parents' well being significantly affects children's non-cognitive outcomes. The negative sign means that the greater parents' life satisfaction, the fewer behavioural and emotional problems their children exhibit.

Parents' basic skills therefore appear to have a direct impact only on children's cognitive outcomes, once the effects of other aspects of family background are netted out. This may reassure us on the validity of our contention that we are uncovering a distinct causal impact from parental basic skill on children's cognitive outcomes, rather than simply capturing other aspects of parents' behaviour, such as their attitude towards or aspirations for their children.

6. Conclusion

This paper investigated the impact of parents' basic skills in literacy and numeracy on the cognitive performance of their children in early (3 to 6 years) childhood.

We found strong evidence that parents with higher basic skills have children who perform better in cognitive tests. This result holds within each parental educational group, and controlling for a wide range of variables including, 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.

[17] Of course age of child is not random, with more educated mothers in particular tending to have their children later. Thus the pre-school sample tends to have more educated mothers and come from households with higher income levels. The results are therefore not necessarily generalisable. Details of the different samples are also given in Appendix D.

Table 8: 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

We also found that the impact of parental basic skill on children's cognitive skills was larger for low educated parents i.e. parents with GCSE qualifications or below. This lends support for the notion of designing policies aimed specifically at enhancing the basic skills of adults with low-level qualifications.

Our results also indicate that parental basic skill impacts on children's cognitive skill but not on children's non-cognitive skills. We argue this lends further support to the proposition that we are uncovering a causal link between parental literacy and numeracy and their children's cognitive development.

In policy terms, our results if interpreted as causal would suggest that policies aimed at increasing parents' basic skills may not only impact on parents' earnings and economic well being but also on their children's cognitive performance. In particular, the results suggest that policies targeted at low qualified adults may be particularly effective.

Appendix A

Variable Description	Obs.	Mean	Std. Dev.	Min	Max
Cognitive index for younger children	1226	0.00	1.29	-5.91	3.98
Cognitive index 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 parent is female	5207	0.63	0.48	0	1
parent standardized literacy scores age 34	5113	0.00	1.00	-5.37	1.24
parent standardized numeracy scores age 34	5141	0.00	1.00	-3.56	1.26
principal component from parent 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
Parent's age at first birth	5207	25.69	4.31	16.25	34.67
whether lone parent	5207	0.10	0.30	0	1
social class of parent; NS-SEC classification	3913	3.60	1.93	1	7
whether family receives state benefits	5207	0.09	0.29	0	1
Average value of household income in 2000 and 2004	3759	439	229	18	2331
Parental education (years of school)	5204	12.25	2.75	9	17.5
Principal component on parents' cognitive test scores at age 5 (1975)	3367	0.00	1.26	-3.89	3.57
Parental life satisfaction scale (0 to 10)	5170	7.59	1.80	0	10
Frequency with which parents read to the child. Young child	1256	4.43	0.79	1	5
Frequency with which parents read to the child. School age child	1308	3.92	0.97	1	5
Standardized child test score on "Strengths and Difficulties" scale (Goodman). Young children	1259	0.00	1.00	-7.03	5.17
Standardized child test score on "Strengths and Difficulties" scale (Goodman). School age children	1259	0.00	1.00	-7.03	5.17

Appendix B

OLS estimates using the same sample size for all the regressions

	(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

Appendix C

Strength and Difficulties Scale

Items:

- 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

Appendix D

SURE regressions of cognitive and non cognitive outcomes for school age 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

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)

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