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Development in the early years: its importance for school performance and adult outcomes

Leon Feinstein
Kathryn Duckworth

Centre for Research on the Wider Benefits of Learning

DEVELOPMENT IN THE EARLY YEARS: ITS IMPORTANCE FOR SCHOOL PERFORMANCE AND ADULT OUTCOMES

Leon Feinstein and Kathryn Duckworth

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Executive summary

Introduction and background

The Government recognises the importance of the early years and has invested in interventions such as Sure Start in England (similar to Head Start in the US) which are designed to enhance those abilities in children (intellectual, social and physical abilities) that are the basis for their overall developmental competence. Early development of these capabilities has the potential to affect children's long-term achievement, beyond the initial introduction to the classroom, through their school lives and into adulthood. A greater understanding of the processes at work in these early years and their role in later success is therefore important to ensure that resources are appropriately targeted.

We know from other research that early cognitive attainment is strongly related to later academic success. But we are also interested in the benefit that children gain from arriving at school with particular *personal characteristics* and the relationship which these may have to cognitive development. We also seek to explore the role of development (as opposed to innate capability) in the previous pre-school years. In this study we use data from the 1970 British Cohort Study to look at the importance of early measures of children's cognitive ability and behavioural development for their subsequent school and labour market achievement.

Key findings

- Development in cognitive ability (measured by vocabulary and drawing tests) in the early years was highly predictive of subsequent achievement, showing a strong relationship with both educational success and income at age 30

- The single measure most predictive of later achievement was children's ability to accurately copy shapes and simple patterns (copying score). Copying tests evaluate visual-motor maturity and skills such as the ability to integrate information. They are frequently used to screen children for developmental delays and have been associated with language ability and various aspects of intelligence such as visual perception, manual motor ability, memory, and temporal and spatial concepts of organisation

- The link between copying score and later outcomes held across all groups in the sample, except for children who attained high copying score but who came from families of low socio-economic status (SES). This suggests a failure of family and school contexts to build on the early cognitive development of bright children from low SES groups and may be a crucial and under-recognised difference between children from disadvantaged and advantaged backgrounds and a key reason for social immobility.

- Measures of cognitive development (e.g. vocabulary and ability to draw and copy) were more predictive of later achievement than were attention or problem behaviours. However, attention and behavioural measures did have some predictive power for later achievement.

- Of the behavioural measures, skills related to attention were the most important, being statistically significant for the sample population and for all the sub-groups tested. Of the other behavioural characteristics measured, externalising behaviours (e.g. aggression) had a negative association with educational attainment of men in adulthood and internalising behaviours (e.g. withdrawal, anxiety) a positive association with age 10 reading scores for children from high socio-economic status groups. It should be noted however, that these associations held only for some measures and for particular sub-groups rather than across the outcomes for the sample as a whole.

Methodology

Data are from the UK 1970 Birth Cohort, a nationally representative longitudinal study that has attempted to follow into adulthood all the children born in Great Britain in the week of April 5 – 11, 1970. To date, five follow-up surveys have been carried out at ages 5, 10, 16, 26 and, most recently, at age 30. The achieved sample at birth was 17,196, approximately 97% of the target birth population.

This study concentrates on data collected for a sub-group of the full sample, when the cohort members were 22 and 42 months old, as these collected data are not available for the rest of the cohort. The sub-sample consists of all twins in the original cohort, the small-for-dates and post-mature births as well as a 10% random sample of the original cohort. Sensitivity analyses suggest that the sample for this analysis is representative of the whole cohort with regard to educational development. At each sweep, cohort members were given a battery of tests of intellectual, emotional and personal development. Data come from a variety of sources including mother-completed questionnaires, health visitors and other healthcare professionals and child-completed assessments carried out both during visits to the home and later the classroom.

We use Ordinary Least Squares regression analysis to highlight the impact of the development of early capabilities in cognition and behaviour for later success. A key difficulty here is that innate characteristics are a major determinant of later success. Considering *development* rather than only static measures allows us to control for the effects of many of these characteristics, including any aspects of innate ability which are not subject to change over time. Thus, while we initially look only at the effect of selected (static) measures at age 5 on subsequent achievement, in later stages we use measures of change between the ages of 42 months and 5 years to control for prior levels of ability. This enables us to explore the effects of development in capability as well as other characteristics of the child and her family background. Throughout this paper, where we refer to static measures we refer to them as such, to levels of skill or to measures at age 5. Where we refer to measures of change, we refer to increase/improvement or development.

We used the following measures of school entry capabilities at age 5:

- cognitive ability assessed through a standard vocabulary test and three drawing tests – ability to copy basic designs; human figure drawing and profile drawing

- attention skills
- internalising (e.g. withdrawal, anxiety) and externalising (e.g. aggression) problem behaviours.

For most of these, we also have measures at 22 and 42 months. This allows us to control for prior attainment and consider development in these abilities rather than simply innate ability.

We use the following outcome measures:

- standardised test score in maths at age 10
- standardised test score in reading at age 10
- self-reported highest academic qualification at age 30
- self-reported hourly wage at age 30.

Findings

First and foremost, the long-term explanatory power of the copying designs test is striking and shows substantive implications for all four outcomes assessed (maths and reading attainment at age 10 and highest qualification and income at age 30). Positive development in copying ability between 42 months and 5 years is related to gains in reading and maths scores at age 10 and is strongly associated with highest educational qualifications and the measure of income at age 30. This suggests that the copying score is a very good indicator of long-term cognitive success and that improvement in the pre-school years in the abilities underlying this test score are very important in school success.

While the static measure of copying score at age 5 is highly predictive of later success, the fact that we have also used a measure of development and not just a static measure implies that any children who are supported in learning and developing these skills, and not just those with high innate levels of ability, can show lasting benefits in terms of their school attainment and subsequent labour market productivity.

We also find that the level and development of the skills involved in scoring highly in this copying test appear to be more beneficial and yield higher gains in school than the skills assessed in the age 5 vocabulary test, both for age 10 reading as well as for maths.

Our results suggest that the gains associated with the highly predictive copying score are not universal across socio-economic status (SES). Sub-group analyses reveal that low SES children with high copying scores at age 5 are not getting the same positive benefits for either the mid-childhood measures of achievement or adult success in terms of highest academic qualification by age 30. Crucially, one of the differences between low and medium/high SES families may be that children from low SES families receive insufficient support to fully develop their innate ability. This failure to scaffold, i.e. build upon earlier skills, may represent a key reason for social immobility. We do not know the extent to which this is a result of factors in the school, the home or in the interaction between the two.

Of the non-cognitive skills assessed, high levels and increases in inattention are strongly predictive of poor outcomes for both measures of achievement in mid-childhood and a measure of income at 30.

Analysis suggests that there is a degree of overlap and interaction between cognitive abilities and attention: the measures of cognitive ability at age 5 used in this study are, at the same time, also measuring skills related to attention. This result highlights the particular importance of attention as an enabling factor in cognitive development. The presence of externalising behaviour problems in early childhood is shown to be a risk factor for educational attainment in adulthood but shows no effects on either age 10 reading or maths.

Internalising behaviours (e.g. withdrawal, anxiety) demonstrate positive effects for age 10 reading for those in the high SES group, although not showing any statistically significant effect for any of the four outcome measures for the group as a whole. This result may indicate that in some contexts internalising behaviours have some protective effect supporting educational success. However, there must be doubts about the direction of causality here and equally the result may indicate that children with internalising behaviours from high SES groups are given greater levels of support than those from low SES groups or that high SES internalising children have different strategies to deal with such problems, for example retreating into a book or focusing on their studies, which have positive value for subsequent qualifications.

Conclusions and implications

We need to remember that learning is not simply a formal process which begins in the classroom, but that it involves the (often informal) acquisition of many basic cognitive, linguistic, perceptual and motor skills which develop from the earliest years. These provide the basis for subsequent successful learning.

Our results suggest that, of the various measures which we have used in this study, the most powerful predictor of later academic and labour market success is the ability of children to copy basic designs, and their development of this ability during the pre-school period. There are several possible explanations for this. It may be, for example, that the elements assessed within it provide the foundations upon which reading and maths skills are subsequently built. However, this does not mean that “teaching to the test” per se will result in gains for all, but rather that such a test might provide a very good indicator for the early identification of basic skill difficulties.

Given the failure of children from low SES groups who have high early measures of cognitive ability to achieve successful outcomes in later life, the copying designs test may also provide a tool to identify children showing high cognitive ability who are at risk of not developing to their full potential. The use of such diagnostic tools would allow early intervention to ensure that children receive appropriate support to maintain their rate of development.

This is why we believe that the copying score merits further consideration, to assess in more detail why it has such predictive power, what features of the developing cognitive capability of the child it measures and how these might be enhanced by teaching practices in pre-schools and/or in the home for all children.

We do not ignore the importance of behavioural factors in achieving academic and labour market success and we would highlight the importance of attentional skills in this respect as having a direct contribution to make to subsequent achievement. With regard to other behavioural attributes, we also suggest that problem behaviours are related to academic underachievement not only directly, but also through their association with attentional skills and difficulties. Further analysis of these data would be required to explore the possible mediating role of attention problems.

The results also clearly show that early development of both cognitive and behavioural factors have a role in subsequent achievement. In this respect, we believe that the findings presented here add to the debate on the appropriate balance between cognitive and non-cognitive skills at different ages and for different groups of children. In particular, failure to place sufficient emphasis on cognitive development may run counter to the interests of children from low SES groups. We believe that pedagogy should continue to address ways in which cognitive and non-cognitive abilities can support one another and how the interactions between these different groups of skills can best be harnessed for different groups of children.

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1. Introduction

The purpose of this report is to assess the relative importance of a range of different features of child development for later academic achievement and adult success. We assess the impacts of early development in different cognitive abilities, socio-emotional skills and behaviours in predicting educational attainment in mid-childhood measured at age 10 as well as measures of human capital in adulthood, at age 30.

The relationships between these diverse features of early child development and later academic and adult success can be thought of as occurring within-domain, i.e. in terms of the relationship of early cognitive attainments to later cognitive achievement, or cross-domain, i.e. as in the relationship between early behavioural indicators and later cognitive achievement. While we expect greater continuity in measures of cognitive achievement, theoretically, the cross-domain capabilities should also matter: genuinely poor behaviour in class may lead to poor relationships with peers and teachers, lower concentration and task persistence and a potential risk of exclusion from the best learning opportunities. Poor behaviour may also proxy for underlying affective responses to the learning environment that may indicate difficulties in participation in learning that could be hypothesised to lead to lower actual school attainment. However, some authors find relatively low continuity in problem behaviours (La Paro and Pianta, 2000) and so it is feasible that early behaviour issues are developmentally normative and, if not persistent, routinely dealt with in classrooms such that there need be few long-term repercussions on subsequent academic achievement.

While the finding of continuity in cognitive attainments is well established (Kowleski-Jones and Duncan, 1999; McCall, Applebaum, and Hogarty, 1973; Wilson 1983), the (dis)continuity in socio-emotional skills and problem behaviours such as inattention, internalising and externalising behaviours and the relationship between these features of the developing child and their later achievement is less clear. The key question here is the relative importance of children's early capabilities for subsequent school and labour market achievement. In this report we have a range of different within- and cross-domain tests at age 5 years including drawing and copying tasks – reliable measures of emerging IQ and general intelligence – as well as mother-reported (in)attention skills and internalising and externalising problem behaviours. Under the assumptions of our estimation model, associations can be thought of as effects that provide clues about how powerful each of these features of early development is in supporting positive pathways for children. These have implications for the curriculum and pedagogy of early years' learning, for assessments and for the development of interventions.

1.1 Early years' resources and provision of services

In recent years, the resources for early years' programmes have greatly increased in the UK. In England, this began in 1998 with the targeting of resources through the nationwide Sure Start program on the most deprived areas of the country. Alongside the wide-ranging parenting and child support services provided through Sure Start there has been a major increase in national resources for education and health and ongoing reorganisation of the provision of services for children. Similar Sure Start initiatives have also been developed for the other nations of the UK.

Key recent features have included: (i) the integration of education and social work services set out in the UK's Every Child Matters Green Paper (HM Government, 2003); (ii) reform of the regulations, standards and training for those working with children, set out in the Children's Workforce Strategy (HM Government, 2004); (iii) a 5 Year Plan for the provision of education (Department for Education and Skills, 2004); (iv) a Children's Act (2004) leading to the creation of a Children's Commissioner and greater integration of services; and (v) a 10 year strategy for childcare (HM Treasury, 2004) outlining the long-term goal of universalising the benefits of the Sure Start programme with nationally rolled out Children's Centres, with the aim of providing, by 2010, 20 hours a week of free high quality care for 38 weeks for all 3 and 4 year olds and an out of school childcare place for all children aged 3-14 between the hours of 8am to 6pm each weekday.

The Government recognises the importance of the early years and has started building the foundations for improving these outcomes by expanding early years' education and investing in interventions. For example, programmes such as Sure Start in England (and Head Start in the US) are designed to enhance children's intellectual, social and physical abilities on the grounds that each domain contributes to a child's overall developmental competence and their readiness for school. But, given the major increases in investment for children and young people that have accompanied this reform, particularly in resources for pre-school children, it is important to ensure that resources are spent efficiently and effectively. This requires a consideration of the key features of development towards which resources should be targeted. A more complete understanding of which features of early development are more powerful for enhancing the positive trajectories of children also has implications for a broader definition of human capital and related capabilities, as well as skill valuation in the workplace. Moreover, if school entry abilities carry meaningful signals for later achievement and life chances in middle childhood, adolescence and adulthood then intervention in the earliest years might help realise the goals of the Government's Every Child Matters agenda.

1.2 Relations between early skills and mid-childhood academic achievement

Academic achievement is a cumulative process beginning with the understanding of many basic cognitive, linguistic, perceptual and motor processes which provide the basis for subsequent successful learning. Early abilities are built on over time in hierarchical ways; existing skills are adapted and improved upon making way for new skills to be gradually mastered (Entwisle and Alexander, 1990; Pungello, Kuperschmidt, Burchinal and Patterson, 1996; Whitehurst and Lonigan, 1998). As such, the acquisition of early skills are best conceptualised as part of a developmental continuum, with origins that precede formal schooling, rather than an all-or-none phenomenon that begins when children enter the classroom.
A growing body of research demonstrates the importance of both specific academic skills as well as more general cognitive ability in early childhood as important for the

development of more complex understanding in reading and maths-related knowledge as children grow older. For example, oral language abilities conceptualised broadly rather than as vocabulary skills alone serve as a better foundation for both early reading skills and reading achievement in mid-childhood. Moreover, these broader features of language ability become increasingly important as they provide more than a foundation for reading per se; rather, they offer a foundation for "learning to learn" (NICHD Early Child Care Research Network, 2005a; see also Scarborough, 2001; Snow et al, 1998; Storch and Whitehurst, 2002).

Similarly, Whitehurst and Lonigan (1998) note that a child can be aware of elements of language structures (e.g. that propositions are formed of words) without being aware of other aspects of linguistic organisation (e.g. that words are made up from a finite set of phonemes). However, although knowledge of the alphabet at entry to school is one of the strongest single predictors of short- and long-term literacy success (Stevenson and Newman, 1986), interventions that specifically teach children letter names do not seem to produce large effects on reading acquisition (Adams, 1990). Thus, while communication- and language-rich homes will foster and build general language skills as well as supplement vocabulary and metalinguistic skills, simply targeting the latter would not be sufficient to reinforce general language development. Teaching letter names, for example, may increase surface letter knowledge, but may not affect other underlying processes.

Equivalent processes occur in the development of maths and numeracy skills with children learning many mathematically related skills without fully understanding their conceptual basis (Briars and Siegler, 1984; Fuson, 1988). Children first engage in immature strategies, such as self-invented counting, which then form the basis of more mature knowledge, including understanding simple number combinations and basic arithmetic principles. Some of these mathematical concepts are acquired through incidental learning during everyday interactions, but more complex computational skills are primarily learned through formal teaching (Baroody, 2003; see also Aunola, Leskinen, Lerkkanen, and Nurmi, 2004; Ginsburg, Klein and Starkey, 1998; Entwisle and Alexander, 1996; Case, 1975).

A variety of problem behaviours have been linked to low academic achievement. Aggression and other forms of antisocial behaviour for example, have displayed consistent inverse relationships with achievement (Williams and McGee, 1994) with peer rejection as a particular risk factor for low- or under-achievement (Ollendick et al., 1992). Features of internalising problem behaviours such as anxiety and negativism, for example, have been identified as key personality traits associated with academic problems (Stevens and Pihl, 1987). Moreover, a subjective sense of belonging and interpersonal support has been associated with higher achievement motivation and educational plans (Cotterell, 1992; Goodenow, 1993).

Consistent evidence has also documented associations between children's attention-related classroom behaviour and their school performance. Attentive behaviour and related skills such as concentration and restlessness are expected to increase the time children can sustain engagement and participate in academic activities. For example, Alexander, Entwisle and Dauber (1993) found that features of the child such as interest and active participation in classroom activities as well as sufficient attention span predict later achievement test scores (Alexander, Entwisle, and Dauber, 1993; see also Brown and Saks, 1986; Raver, Smith-Donald, Hayes, and Jones, 2005). Moreover, these authors suggest that children who are engaged and interested and who pay attention not only spend more time on tasks, but also that this time is greater in quality.

Attention skills are conceptually distinct from and can be measured separately from other types of problem behaviours (e.g. Barriga et al., 2002). Moreover, attention and related features of the child are associated with later academic achievement, independent of initial cognitive ability (McClelland, Morrison, and Holmes, 2000; Yen, Konold, and McDermott, 2004). There may also be differences in how attention skills relate to different domains of later ability; reading and maths involve comparable yet disparate abilities that may be differentially affected by attention problems (Pungello et al., 1996). For example, in maths, there are qualitative distinctions between the topics taught over time and each requires different types of computational skills. Reading, however, involves quantitative differences in learning over time; after the initial skill of reading has been learnt, the reading material merely becomes more complicated and advanced, not in and of itself different. Pungello et al. (1996) suggest that theoretically, learning material that is qualitatively different from prior knowledge requires more attention than that which is quantitatively different.

Furthermore, research on children's behaviour problems is made more problematic because of the high level of co-morbidity among problem behaviours (e.g. Jensen, Martin and Cantwell, 1997; McConaughy and Achenbach, 1994). Studies looking at the relationships across different problem behaviours have highlighted the importance of distinguishing between attentional skills and externalising problems. Frick et al. (1991) for example, found that aggressive behaviours in childhood are related to low academic achievement primarily because of their associations with attention problems. Other research has further clarified their separate roles with respect to achievement and suggests that attention is more predictive of later achievement than more general problem behaviours (Barriga et al., 2002; Hinshaw, 1992; Konold and Pianta, 2005; Ladd, et al., 1999; Normandeau, 1998; Trzesniewski, Moffitt, Caspi, Taylor, and Maughan, 2006).

1.3 Relations between early skills and adult labour market success

The predictive capability of cognitive performance at different ages is well established with respect to economic outcomes (see Carneiro and Heckman, 2003; Card, 1999; Jencks et al. 1979), but there is a growing literature highlighting the importance of "softer", non-cognitive skills in labour-market outcomes (again, see Carneiro and Heckman for a review, 2003). This literature suggests, for example, that measures of aggression and withdrawal (Osborne, 1999), individual motivation (Goldsmith, Veum and Darity, 2000), behavioural problems in high school (Cawley, Heckman and Vytlacil, 2001), and locus of control (Coleman and DeLeire, 2000; Goldsmithh, Veum and Darity, 1997; Osborne, 1999) each have predictive power with respect to wages. Follow-up studies of children with attention-related problems found that as adults they have lower levels of educational attainment, occupational rank, job performance and self-esteem (Mannuzza and Klein, 1999).

Early empirical sociological work by Jencks et al. (1979) separates the effects of academic ability and non-cognitive traits on occupational and earnings attainment. They find that academic ability and non-cognitive traits such as leadership, study habits, industriousness, and perseverance in high school are positively correlated and that, even conditioning on social class background, both predict higher occupational attainment and earnings in adulthood. For occupational attainment, non-cognitive skills are as important as cognitive ones; both have standardized coefficients of 0.31. For earnings, while both non-cognitive traits and academic skills retain their individual significance, non-cognitive traits show the larger effect.

Similarly, Rosenbaum (2001) measures the extent to which students' non-cognitive behaviours, cognitive skills, and grade-point average in high school predict their later earnings and finds that all three are significant predictors of earnings 10 years after high school graduation, highlighting in particular the importance of leadership skills.

Other early influential work Bowles and Gintis (1976) also suggests that non-cognitive behaviours are more important than cognitive skills in the determination of labour-market outcomes. They posit that most of the effect of schooling on occupational and earnings attainment is due, not to the effect of schooling on cognitive skills as measured by test scores, but to the correlation between schooling and various non-cognitive traits of workers.

Bowles and Gintis (*op cit*) also suggest that the non-cognitive traits rewarded by employers are the same ones that are rewarded by teachers. This position has been supported more recently by Farkas (2003) who notes that irrespective of whether the individual being studied is a parent, teacher, or employer, essentially similar skills and habits are desired (and rewarded) in children, students, or workers. In parallel, both UK and US employer surveys suggest that employers ascribe greater importance to non-cognitive behaviours such as attitude and communication skills than academic performance or years of schooling (for example, see Green, Machin and Wilkinson, 1998 for the UK; Bureau of Census, 1998; Heckman, Hsee, and Rubinstein, 1999; Cameron and Heckman, 1993 for comparable U.S. findings).

Therefore, although there is acknowledgement in both the economic and developmental psychology literatures (as well as from sociology, anthropology and criminology) on the long-term importance of "non-cognitive" skills, there is little consensus on whether they are more important than cognitive skills in predicting labour-market outcomes.

1.4 The current study

In sum, while the evidence for continuity in cognitive attainments is well established, the roles played by socio-emotional skills and problem behaviours in relation to later achievement are less clear. The focus of this report is to estimate the relative importance of children's early capabilities and of increments in those skills on later school and labour market success. We use a range of early measures of cognitive ability and emerging IQ, as well as measures of mother-reported inattention, internalising- and externalising-problem behaviours, controlling for prior levels of those skills where possible, to elucidate the antecedents of subsequent achievement.

We hypothesise that our measures of cognitive ability will prove more predictive in relation to subsequent measures of achievement than those of attention or problem behaviours. Of these socio-emotional capabilities, we predict a particularly strong role for skills related to attention. Moreover, we hypothesise that elements of the three socio-emotional behaviours assessed here will be contained within the measures of cognitive ability and so excluding these "harder" ability measures from the model will increase the estimated effects of the "softer" measures, again particularly for attention.

2. Methods

2.1 Data

Data are from the UK 1970 Birth Cohort, a nationally representative longitudinal study that has attempted to follow into adulthood all the children born in Great Britain in the week of April 5 – 11, 1970. To date, five follow-up surveys have been carried out at ages 5, 10, 16, 26 and, most recently, at age 30. The achieved sample at birth was 17,196, approximately 97% of the target birth population. Attrition has reduced the sample to 11, 200 at the last survey. Representativeness of the original birth cohort has been maintained with only slight biases in the currently participating sample towards women and towards the more educated (Ferri et al., 2003). However, missing data at the item response level (again maintaining broadly the representativeness of the original cohort) reduces the effective data set for most analyses to between 9,000 and 10,000 cases.

2.2 Sample

Of particular value are the data collected for two sub-groups of the full sample, when the cohort members were 22 and 42 months old, as these collected data are not available for the rest of the cohort. The aims of the sub-sample data collection were to assess obstetric services and quality of life in the first week of life, as well as to attempt to identify foetal malnutrition and investigate its effects on brain cell proliferation and subsequent development. The sub-samples consisted of all twins in the original cohort, the small-for-dates and post-mature births as well as a 10% random sample of the original cohort.

Inference about the general population using the non-random components of the sub-sample are likely to be biased if foetal malnutrition is indeed linked both to the development of brain activity and so to performance in development tests, particularly since foetal malnutrition is also linked to unobserved aspects of family background. To deal with this possibility, sensitivity analysis was undertaken by conducting the analyses on the control group (i.e. the 10% random sample included in the sub-sample) separately to test whether results varied from those for the whole sub-sample. The results do not change substantively when the analyses are run only for this control group, suggesting that the risk of foetal malnutrition for the sub-sample did not lead to selection biases in relation to the research questions being considered here, namely the predictive power of age 5 measures for age 30 or age 10 outcomes. The results, therefore, can be considered to be representative of the educational development of the wider population of children.

Selection of the sub-sample groups was also subject to the important restriction that all the children in these early sub-samples were from two-parent families. This may limit the representativeness of these results, particularly for those concerned with family breakdown. Nonetheless, bearing this exclusion in mind, analysis of these data still sheds light on the question of the relative explanatory power of early abilities and behaviours.

Table 1 shows summary statistics of key demographic features of the family for each of the four sub-samples. These descriptive statistics show that those in the small-for-dates sub-sample are slightly more disadvantaged, having, on average, lower SES and levels of parental education and younger parents (summary statistics are based categorical scales, see Appendix Table 1 for more detail here). However, these differences are small and we emphasise the results presented throughout this report do not differ across the sub-samples considered.

Table 1: Summary statistics for key distal features of the family, by sub-group

	Full sample			10% control group sub sample			Twins sub sample			Post-mature sub sample			Small-for-date sub sample		
	Obs	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
Variable															
Mother's occupational status at CM birth	15689	4.07	(2.25)	1170	4.14	(2.28)	230	4.35	(2.27)	733	4.07	(2.23)	573	3.96	(2.09)
Father's occupational status at CM birth	16289	3.88	(1.32)	1266	3.82	(1.26)	253	3.88	(1.21)	804	3.94	(1.24)	623	4.11	(1.21)
Mother's age at CM birth	17544	2.58	(0.73)	1272	2.64	(0.69)	253	2.77	(0.67)	809	2.54	(0.70)	627	2.53	(0.73)
Father's age at CM birth	12292	2.90	(0.68)	1000	2.95	(0.66)	205	3.09	(0.69)	658	2.86	(0.64)	476	2.85	(0.69)
Mother's highest educational qualifications	12606	0.58	(0.75)	1020	0.58	(0.74)	206	0.52	(0.75)	664	0.57	(0.75)	487	0.47	(0.65)
Father's highest educational qualifications	12420	0.84	(1.05)	1001	0.82	(1.05)	199	0.67	(0.97)	654	0.82	(1.05)	482	0.66	(0.92)

At each sweep, cohort members were given a battery of tests of intellectual, emotional and personal development. Data come from a variety of sources including mother-completed questionnaires, health visitors and other healthcare professionals and child-completed assessments carried out both during visits to the home and later the classroom. The means and standard deviations of key dependent and independent variables are presented in Table 2.

Table 2: Descriptive statistics for measures of adult outcomes, achievement, attention skills and socio-emotional behaviours

Variable	Mean	Standard deviation
Age 30 adult outcomes		
Highest academic qualification by age 30	1.80	(1.42)
Log wage at age 30	2.04	(0.49)
Age 10 achievement outcomes		
Reading test score	0.00	(1.00)
Maths test score	0.00	(1.00)
Age 5 achievement scores		
Human figure drawing	0.00	(1.00)
English picture vocabulary test	0.00	(1.00)
Profile drawing	0.00	(1.00)
Copying designs	0.00	(1.00)
Age 5 mother report of attentional skills		
Inattention	0.00	(1.00)
Age 5: Mother report of socioemotional behaviours		
Internalising problem behaviour	0.00	(1.00)
Externalising problem behaviour	0.00	(1.00)

2.3 Measures

2.3.1 Outcome measures

Age 10 mid-childhood achievement outcome measures

Age 10 maths achievement was measured by the “Friendly Maths Test” developed by the University of Bristol. It was piloted in two halves in Bristol primary schools on

400 children. It consisted of a total of 72 multiple choice questions and covered the rules of arithmetic, number skills, fractions, measures in a variety of forms, algebra, geometry, and statistics and has a reported reliability of .93.

Reading achievement was measured by the 67 item Shortened Edinburgh Reading Test which examined vocabulary, syntax, sequencing, comprehension, and retention. Items were carefully selected to cover a wide age range of ability from 7 to 13 years in a form suitable to straddle the age 10 cohort. Particular attention was paid to the lower limit to allow a score to be allocated for very poor readers.

Age 30 adult measures

Academic achievement was defined as the cohort member's self reported highest educational qualifications at age 30. This variable reports the academic level achieved on a 0-4 scale where 0 denotes no qualifications and 4 denotes a university degree or higher. Since the measure is not fully continuous we undertook all regression analysis for this outcome using the ordered probit method (Greene, 1990) as well as ordinary least squares but the results are not sensitive to this methodological concern. Therefore we have reported results using Ordinary Least Squares regression. The wage measure is the log of the cohort member's self-reported hourly wage at age 30.

2.3.2 Key independent variables

Cognitive achievement and language development at age 5

In the full sample sweep at age 5, cognitive ability was assessed by a standard test of vocabulary as well as through three drawing tasks; copying designs, human figure drawing, and profile drawing. Vocabulary was examined using the English Picture Vocabulary Test (EPVT). Similar to the Peabody Picture Vocabulary Test (PPVT), the EPVT is a measure of general verbal ability, assessing receptive (i.e. aural) vocabulary. Children are asked to identify one of four pictures which best matches the stimulus word's meaning. The test is made up of 56 items, arranged in ascending order of difficulty (a full list of the words used can be found in Appendix A). Testing is stopped after the child makes five consecutive errors. See WBL Research Report 19 for more detail on measures of verbal ability.

In the copying designs test, children were asked to copy eight basic designs (see Appendix B for full details) as carefully as possible. They were given two attempts at each design but no help by the instructor. Previous studies have used the copying designs test as a means of assessing visual and fine motor control, such as the ability to carefully control a pencil, so as to identify children with marked visual motor difficulties which can sometimes be associated with certain problems of cognitive functioning, particularly in clinical populations (Davie, Butler and Goldstein, 1972; Rutter, Tizard and Whitmore, 1970). For the Human Figure Drawing test, the child was asked to draw the best picture he/she can of a whole person, not just a face or head. Instructors were not permitted to help the child in any way or make suggestions. However, once the child had finished, instructors were allowed to clarify aspects of the drawing. For the Profile Drawing test, the child was asked to complete the profile of a basic head shape given in the test booklet. Again, instructors were not able to provide any assistance. Harris (1963) and Koppitz (1968) show these tests also have good properties of discrimination and reliability.

Attention and problem behaviours at age 5

Attentiveness and problem behaviours were also assessed at age 5 using mother's ratings on the Rutter Behaviour Problem Scales (Rutter, Tizard and Whitemore, 1970). The scale is comprised of three subscales: (in)attention, internalising and externalising problem behaviours. These are ratings of children's attention to detail and task focus (attention) and their ability to self-regulate their emotions so as not to either become excessively withdrawn (internalising) or naughty (externalising). See Rutter, Tizard and Whitmore (1970) for more detail here. The reported reliabilities of these subscales are .67 inattention, .54 internalising and .72 externalising problem behaviours respectively.

2.3.3 Key controls: emerging ability and behaviour at 42 and 22 months

Cognitive ability, language development and emerging behaviour at age 42 months

Health visitors administering the survey assessed children and asked them to complete a range of different, age appropriate tasks to test current development and emerging IQ. Children were given a number of tasks including measures of early cognitive ability such as counting sequential blocks and a shorter version of the copying designs test administered at age 5 (see footnote #, Appendix B), again without assistance. Speaking and basic vocabulary were assessed by pointing and naming picture tasks, including discrimination tests in which the child had to point to the correct picture when asked "Which one do we eat?" and "Which one swims in the water?".

Health visitors also reported on simple, single-item measures of observed behaviour and rated the child on each of the following items: how easily distracted they were, how shy/withdrawn they were, and how cooperative they were during the assessment. These three early indicators of observed behaviour parallel our age 5 mother-reported problem behaviours of inattention, internalising and externalising problem behaviour respectively.

Cognitive ability, language development and emerging behaviour at age 22 months

Again assessed by health visitors, fine locomotor control was assessed by a cube stacking task in which children had to build the tallest tower they could from one inch cubes. Language was measured by maternal responses to questions such as "Can he say 'ma ma'?" and "Does he put two/three/four word sentences together?", as well as interviewer observations of the child's speech, for example, by the child pointing to their eyes, hair and nose to illustrate understanding. Responding correctly to commands to "give mummy the pencil" and "put the pencil on the table" were indicators of personal and social development. A more basic, age appropriate version of the copying designs test was also administered. Children were first allowed to scribble spontaneously on the page and then, in turn, the interviewer showed the child how to draw a circle, a vertical line and a cross and asked them to copy each design.

Interviewers could show the child again if they failed to try and copy the design the first time.

These tests together with those at 42 months were intended to indicate the general development and ability of children based on the tests used for screening in child health clinics (Chamberlain and Davey, 1976). A pilot study found high correlation between the tests used here and similar, standard tests of development such as the Bayley Scale of Infant Behaviour or the Newcastle Survey (Neligan and Prudham, 1969).

2.3.4 Covariates

Means and standard deviations of the full set of covariates can be found in Appendix Table 1. We control for a range of measures of child and family characteristics collected at all four time points detailed above, 5 years, 42 months, 22 months as well as baseline characteristics at birth.

Information about the child's home environment, including the mother's anti-TV attitude, mother's low-authoritarian attitude and the number of days the child is read to per week was collected at age 5 interview. Maternal reports of depressive symptoms were assessed when the cohort member was 5 years old using the Malaise scale.

Measures of height and weight were collected at both the 22 and 42 month sub-samples and were entered in quintile dummy variables to the regression equation. Baseline information detailing parental characteristics such as parents' SES, age, family size and structure and the presence of a foreign language being spoken in the home was provided by the mother at the time of study enrolment, i.e. birth. Parental SES was updated at the age 5 assessments. Mother's and father's highest educational qualifications as well as additional income proxy measures such as cost of housing and telephone ownership were also included. Information on whether the mother worked full- or part-time was also gathered.

2.4 Analysis plan

The focus of this report is the relative importance of children's school entry capabilities on later school and labour market success. We want to estimate the contribution that developed capabilities at school entry make to subsequent school success. In other words, we are interested in the benefit that children gain from arriving at school with particular personal characteristics that have developed in the previous pre-school years, above and beyond innate capabilities. In these terms, we are interested to know what the benefits are of behavioural development relative to cognitive development in the pre-school years and we are also interested to know about the relative benefits of particular features of development within each of these domains.

The key difficulty in estimating these effects is that of differentiating between effects of innate characteristics and of features of development. Obviously, the two are strongly correlated but we are interested here in the contribution made by the latter, holding the former constant so that we can get a guide to the issue of the extent to which different features of pre-school development should be the focus of prior childcare and pedagogy.

For each outcome we estimate the same set of regression models to test the importance of the age 5 cognitive ability, attention skills and internalising and externalising problem behaviour scores, given baseline developmental controls at 22 and 42 months and family context measures.

The resulting general form of the equation is as follows:

$$(1)\ OUTCOME_{ij} = a_1 + ß_1COG_i + ß_2ATTN_i + ß_3SE_i + e_{ij}$$

where $OUTCOME_{ij}$ is one of four j outcomes (two age 10 or two age 30 outcomes) of child i; COG_i is the set of cognitive ability measures that child i has acquired at age 5; $ATTN_i$ is a mother-reported measure of (in)attention; SE_i are the two measures of child i's mother-reported internalising and externalising problem behaviours; a_1 is a constant and e_{ij} is a stochastic error term.

Our interest is in estimating $ß_1$, $ß_2$, and $ß_3$, which under estimation assumptions can be interpreted as the effects of age 5 cognitive ability, attention skills and socio-emotional skills and behaviours on subsequent achievement and so provide clues about which features of these school entry capabilities might be most powerful in supporting positive developmental pathways for children.

As always, one of the difficulties in estimating such effects using standard OLS regression is ensuring that we have taken into account in our estimation model the possibility that there may be other underlying factors that influence affecting the outcomes considered of our model. This will arise since characteristics of the child or her family such as IQ and/or personality will be correlated both with children's school entry measures and their later achievement in mid-childhood and adulthood.
To counter this and obtain more robust estimates of $ß_1$, $ß_2$, and $ß_3$, our principal strategy is to estimate a form of equation (1) that includes as many early measures of relevant child and family characteristics as possible. In addition, we include prior measures of the child's cognitive ability and behaviours measured at 42 and 22 months.

With these measures, our model becomes:

$$(2)\ OUTCOME_{ij} = a_1 + ß_1COG_{i\ age5} + ß_2ATTN_{i\ age5} + ß_3SE_{i\ age5} + \alpha_1COG_{i\ early} + \alpha_2ATTN_{i\ early} + \alpha_3SE_{i\ early} + \gamma_1CHILD_i + \gamma_2FAM_i + e_{ij}$$

where $CHILD_i$ and FAM_i are sets of child and family background characteristics included in analyses to control for individual differences.

These earlier measures of ability and behaviour (α_1, α_2 and α_3) are the same as those measured at age 5 and so manipulation of equation (2) leads to a kind of *change* model[1]. This estimation provides extra power against omitted-variable bias in estimating ß$_1$, ß$_2$ and ß$_3$ to the extent that unobserved age invariant features of the child, for example IQ and/or personality, and family, for example parental education, are differenced out of the estimation and the coefficients on the age 5 measures represent the effect of change in cognitive ability, attention skills and socio-emotional behaviours between 42 months and age 5 years. This equation can be written as:

$$OUTCOME_{ij} = b_1 + \delta_1 \Delta COG_i + \delta_2 \Delta ATTN_i + \delta_3 \Delta SE_i + \lambda_1 COG_{i\ early} + \lambda_2 ATTN_{i\ early} + \lambda_3 SE_{i\ early} + \gamma_1 CHILD_i + \gamma_2 FAM_i + \eta_{ij}$$

"Δ" indicates a simple difference between 42 month measures and the age 5 measures, i.e. the change or development in that measure. Algebraic manipulation shows that the parameters δ_1, δ_2 and δ_3 are identical to the ß$_1$, ß$_2$ and ß$_3$ parameters of equation (2) and can be interpreted as the effects of changes in measures of school entry capabilities.

From a developmental perspective one should recognise that there is not absolute continuity of meaning and measurement across these ages here as cognitive ability and behaviour are still in the early stages of formation. Hence, it is inevitable that error and instability in measurement remain and so reduce the extent to which a change interpretation in a strict econometric sense is appropriate. Change across periods of time in human development is not identical to change across time for more stable phenomena such as the average wage in macro-economic analysis. Developmental analysis can never be reduced to time-series because of the importance of age in human development, particularly during childhood, a period of profound change in the individual. The change model is considerably more robust to omitted variable bias than is a model using measures at a given age. However, we cannot be certain that the comprehensive set of control variables used from our rich, longitudinal data capture all of the important confounding variables on early measures of child development and so remain cautious in making strong claims of causality; it remains possible that this approach will still produce biased estimates of ß$_1$, ß$_2$, and ß$_3$. Nonetheless, the change model (equation 2) should be a substantially more robust estimate of the ß-coefficients than would result from the first model (equation 1) using levels, i.e. static measures, for a given point in time.

Moreover, it is important to note that both models provide estimates of the same coefficients, the ß-coefficients, which are estimates of the effects on subsequent school success of achieved developmental capabilities at school entry. They thus provide a guide as to the importance for school success of capabilities learned and developed in the previous period, i.e. a guide to pedagogical focus for the pre-school period.

As noted above, research that examines the importance of "softer", non-cognitive skills highlights the value in considering the separate influences of skills related to attention, internalising and externalising problem behaviours. There is also evidence

[1] We have exact earlier measures of the copying designs test and comparable measures for vocabulary, attention, and internalising and externalising problem behaviours. However, we do not have prior measures of the human figure or profile drawing tests. This changes the interpretation of the coefficients for these measures and is discussed in the Results and Discussion sections where relevant.

to suggest that attention skills in particular are positively related to later academic achievement, independent of cognitive ability. However, non-cognitive skills are harder to measure than cognitive skills (for example, see Carneiro and Heckman, for a review) and it may also be the case that aspects of attention and/or behaviour are picked up in measures of cognitive ability. This may be particularly true for the assessment of 5 year old children.

Therefore, a third specification examines the influence of the three non-cognitive school entry measures alone, to explore whether they show any further contributions to the four outcomes considered when school entry cognitive skills are excluded from the regression. This estimation also enables us to better assess the relative importance of school entry capabilities on later school and labour market success. Carrying with it the same change interpretations discussed above, this equation can be written as:

$$(3)\ OUTCOME_{ij} = a_1 + ß_1ATTN_{i\ age5} + ß_2SE_{i\ age5} + \alpha_1ATTN_{i\ early} + \alpha_2SE_{i\ early} + \gamma_1CHILD_i + \gamma_2FAM_i + e_{ij}$$

We estimate equations 1, (typically referred to as models 1 and 4 in the Results section and related tables), 2 (models 2 and 5) and 3 (models 3 and 6). All three estimation models control for the gender of the child, age (in days) at assessment and sub-sample group membership.

2.4.1 Sub-group analysis

Socio-economic status is one of the strongest predictors of performance differences in children at the beginning of school (Entwistle and Alexander, 1990; Alexander and Entwisle, 1988) and gender differences, particularly for mid-childhood outcomes, are consistently reported throughout both economic and developmental literatures. We therefore perform sub-group analyses, reporting results separately for low and high SES groups, and males and females, to explore any differences in the influence of the school entry measures for our data.

2.4.2 Sensitivity analysis

To explore possible nonlinearities in, and interactions between, our measures, we present summary tables of different model specifications. With full controls included, we run models including dummy variables for being in the bottom quartile of the behavioural measures, i.e. those individuals with the worst scores on these mother-reported attention skills and socio-emotional behaviours, as well as interactions of some of the most predictive measures from the full sample analysis.

Other sensitivity analysis explores the role of formal schooling and any effects it may have on the impact of our key independent variables because, although the cohort members were all born within the same week, the age at which they enter primary school and the exact age at the time of the age 5 assessments varies. Thus, when the age 5 assessments took place, some children were already in school while others had yet to start. All the analyses control for age (in days) at the time of testing; range = 1794 (4.91 years) – 2207 days (6.04 years), mean = 1853 days (5.07 years). We consider whether any experience of formal schooling affects our results by conducting sensitivity analysis by primary school status. We split our sample by “main present placement” status at the time they completed the age 5 assessments into two groups, those in primary school and those not in primary school, and repeat the analysis. This is a rather coarse measure of the effects of formal schooling, as it does not take into account the length of time for which children have been in school, but data on the duration of formal schooling at age 5 were not collected.

3. Results

Bivariate correlations between all outcome and key independent variables are presented in Table 3 and are all statistically significant at at least *p<.05,* and nearly all at , *p<.01*. Age 30 academic achievement and log wage are strongly correlated (r = .34) as are maths and reading at age 10 (r = .75). Both age 10 measures of achievement correlate highly with highest academic qualification by age 30 (maths, r = .46; reading, r = .46), but show slightly weaker associations with age 30 wage (maths, r = .32; reading, r = .26) [1].

Within-domain associations between earlier cognitive measures and later achievement scores are stronger than the between-domain association of measures of earlier behavioural problems and later achievement. For example, children's age 5 copying score is highly correlated with age 10 reading (*r* = .42) and maths (*r* = .43) achievement. The correlations of age 5 inattention with age 10 achievement scores however, are weaker and negatively associated with age 10 outcomes: reading (*r* = -.15) and maths (*r* = -.15). For externalising problem behaviour the correlations are also negative but slightly higher than for inattention: reading (*r* = -.21) and maths (*r* = -.18). Internalising behaviour problems show even weaker, although still statistically significant, relations with age 10 academic reading and maths achievement. Internalising and externalising problem behaviours are negatively associated with all other outcomes across ages. All three age 5 problem behaviour measures also show negative associations with both age 30 outcomes.

It is also important to note that the age 5 copying score is strongly correlated with the other age 5 cognitive measures and therefore may be subject to multi-collinearity. This should be borne in mind when considering the relative coefficients on the array of age 5 measures in the multivariate regressions to follow.

[1] The interpretation of the strength of the correlations is based on the size of the correlation, its statistical significance and the degree to which theory suggests the measures should be related.

Table 3: Correlation matrix for adult outcomes, achievement, attention skills and socio-emotional behaviours

Variable	1	2	3	4	5	6	7	8	9	10	11
Age 30 outcomes											
1. Highest academic qualification	1.00										
2. Log wage	.34	1.00									
Age 10 achievement outcomes											
3. Reading test score	.46	.26	1.00								
4. Maths test score	.46	.32	.75	1.00							
Age 5 achievement scores											
5. Human figure drawing	.20	.10	.31	.26	1.00						
6. Vocabulary	.21	.15	.34	.31	.28	1.00					
7. Profile drawing	.12	.03	.15	.13	.29	.22	1.00				
8. Copying designs	.31	.22	.42	.43	.46	.30	.25				
Age 5 mother report of attention skills and socioemotional behaviours											
9. Inattention	-.14	-.07	-.15	-.15	-.11	-.10	-.06	-.16	1.00		
10. Internalising behaviour	-.02	-.05	-.04	-.06	-.02	-.06	-.02	-.04	.20	1.00	
11. Externalising behaviour	-.19	-.07	-.21	-.18	-.13	-.14	-.07	-.18	.46	.27	1.00

Note: All correlations are statistically significant at, at least $p < .05$

3.1 Prediction of age 10 mid-childhood achievement outcomes

Turning to the results of the multiple regression analyses, Table 4 shows the regression of the age 10 outcomes on age 5 achievement test scores, attention skills and socio-emotional behaviour measures. Models 1 and 4 show the effects for each school entry measure on age 10 reading and maths respectively (see discussion of equation 1 in the Analysis Plan, section 2.4 above). Models 2 and 5 show the effects for the same measures once our comprehensive controls for child and family background characteristics have been introduced (see equation 2).

These results show a strong pattern of continuity across both cognitive and behavioural development and with the exception of profile drawing, all age 5 cognitive measures are substantial predictors for age 10 reading and maths. Moreover, introducing additional control sets into the regression model does not substantially reduce the size of these estimates.

The conditional age 5 copying score is particularly important in predicting mid-childhood achievement and has a much larger effect on age 10 maths ($\beta = 0.36$, $p<.001$) than does the age 5 human figure drawing or vocabulary score ($\beta = 0.09$, $p<.01$ for both measures). As noted above, this is particularly interesting as the copying score has a change interpretation; since we have measures of the same skill at 42 months, the age 5 coefficient shows the association of *change* in copying ability prior to school entry on later achievement. It is also rather striking that the age 5 copying measure also has a larger effect than the age 5 vocabulary measure on age 10 reading ($\beta = 0.25$, $p<.001$ and $\beta = 0.13$, $p<.001$, respectively).

Mother-reported inattention at age 5 carries particularly strong negative predictions for both age 10 reading ($\beta = -.08$, $p <.01$, model 2) and maths ($\beta = -0.09$, $p<.01$, model 5) abilities, highlighting the risk of this particular developmental problem.

In models 3 and 6, we report the conditional effects for the three behavioural measures only in order to better assess the contributions of these non-cognitive measures that could have been diluted through inclusion of the age 5 cognitive measures. For both reading and maths ability, the conditional coefficients for inattentiveness increase when the four achievement measures are excluded from the regression model. There are no effects of internalising or externalising problem behaviours on either intermediate outcome in any of the models.

Table 4: Coefficients and standard errors from regression models of age 10 achievement on early academic skills, attention skills, and socio-emotional behaviours

	Age 10 achievement outcomes					
Dependent variable at age 10:	**Reading test score**			**Maths test score**		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Achievement scores						
Human figure drawing	.12***	.09**		.10**	.09**	
	(.03)	(.03)		(.03)	(.03)	
Vocabulary	.21***	.13***		.17***	.09**	
	(.03)	(.03)		(.03)	(.03)	
Profile drawing	-.01	.00		-.02	-.02	
	(.03)	(.03)		(.03)	(.03)	
Copying designs	.38***	.26***		.45***	.36***	
	(.03)	(.03)		(.03)	(.03)	
Mother report of attention skills						
Inattention	-.07*	-.08**	-.11***	-.09**	-.09**	-.12**
	(.03)	(.03)	(.03)	(.03)	(.03)	(.04)
Mother report socioemotional behaviours						
Internalising problem behaviour	.02	.01	.03	.02	.02	.04
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Externalising problem behaviour	-.06	-.03	-.05	-.03	.00	-.03
	(.04)	(.03)	(.03)	(.04)	(.03)	(.04)
Control variables		X	X		X	X
Observations	1778	1778	1778	1753	1753	1753
R-squared	.30	.45	.38	.30	.45	.34

Note: Standard errors are not corrected for classroom clustering as there is none. All variables are standardised by full sample standard deviation. All models include missing data dummies. Inattention, internalising and externalising problem behaviours are not reverse scaled. Control variables include: child age and gender, parent education, parent occupation, number of siblings, maternal depression, maternal attitudes, amount the child is read to. Age 22 and 42 month control variables include: early cognitive and developmental abilities, test observer reports of the child's early behavioural development, height and weight.

* p< .05, ** p< .01, *** p< .001

3.2 Prediction of age 30 adult outcomes

Turning to the results of the multiple regression analyses, Table 5 shows the summary results for the age 30 outcomes and reports a similar pattern of continuity across both cognitive and behavioural development. The age 5 cognitive development score of copying designs remains highly predictive for both adult outcomes, even when all additional control sets are included in the regression model ($\beta = 0.27$, $p<.001$ and $\beta = 0.08$, $p<.01$, respectively). Again, this is particularly interesting as the copying score has a change interpretation when controls for prior ability in this skill are included, see models 2 and 5.

The unconditional effect observed for vocabulary in model 1 is knocked out once controls are included and neither human figure drawing nor profile drawing show even unconditional associations with either age 30 adult outcome. Given the possible multi-collinearity between the copying designs score and the other age 5 cognitive measures (see Table 3 above), it is interesting to note that even if we exclude the age 5 copying designs measure from the regression model (results not reported), none of the remaining three cognitive skills predict to either adult outcome once controls are included. We can therefore be more confident that the copying measure is uniquely identifying an element of cognitive ability not picked up by the other pre-school cognitive measures.

For the attention skills and behaviour problem measures, models 2 and 5 are specified as above. Mother-reported externalising behaviour problems predict negatively to highest academic qualification by age 30 ($\beta = -0.11$, $p<.05$). For age 30 log wage, only inattention is predictive, showing a negative conditional effect ($\beta = -0.06$, $p<.01$).

As for the age 10 outcomes, models 3 and 6 present the conditional summary results for the behavioural measures only (see discussion of equation 3 in section 2.4). For highest academic qualification, the effect of externalising problem behaviour remains but the coefficient does not increase suggesting that the cognitive measures do not mask additional aspects of this behaviour problem. The conditional effect of inattention however, is now significant ($\beta = -0.12$, $p<.05$), its coefficient rising by 30% from the model which also included cognitive measures. For log wage, both internalising and externalising problem behaviours remain insignificant and the conditional effect of inattention increases ($\beta = -0.08$, $p<.001$).

As one would expect given the age 30 outcomes considered, the coefficients on the age 5 achievement variables decline by more than the coefficients on the problem behaviour measures as earlier cognitive measures are introduced. In the change model, a one standard deviation increase in copying score at age 5 would result in a 0.27 unit increase in academic achievement by age 30. For age 5 externalising problem behaviours, the same standard deviation increment would result in a 0.11 unit decrease in the standard deviation of age 30 academic achievement.

Table 5: Coefficients and standard errors from regression models of age 30 outcomes on early academic skills, attention skills and socio-emotional behaviours

	Age 30 adult outcomes					
Dependent variable at age 30:	**Highest academic qualification**			**(Log) Wage**		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Achievement scores						
Human figure drawing	0.05	0.03		0.00	-0.01	
	(.05)	(.05)		(.02)	(.02)	
Vocabulary	0.11*	0.05		0.03	0.03	
	(.05)	(.05)		(.02)	(.02)	
Profile drawing	-0.03	0.00		-0.02	-0.01	
	(.05)	(.04)		(.02)	(.02)	
Copying designs	0.43***	0.27***		0.11***	0.08**	
	(.05)	(.05)		(.02)	(.03)	
Mother report of attention skills						
Inattention	-0.07	-0.09	-0.12*	-0.06*	-0.06**	-0.08***
	(.05)	(.05)	(.05)	(.02)	(.02)	(.02)
Mother report of socioemotional behaviours						
Internalising problem behaviour	0.07	0.05	0.06	-0.01	0.00	0.00
	(.04)	(.04)	(.04)	(.02)	(.02)	(.02)
Externalising problem behaviour	-0.18**	-0.11*	-0.11*	-0.01	0.00	0.00
	(.06)	(.05)	(.05)	(.02)	(.02)	(.02)
Control variables		X	X		X	X
Observations	1585	1585	1585	1160	1160	1160
R-squared	0.14	0.34	0.31	0.12	0.25	0.23

Note: Standard errors are not corrected for classroom clustering as there is none. All variables are standardised by full sample standard deviation. All models include missing data dummies. Inattention, internalising and externalising problem behaviours are not reverse scaled. Control variables include: child age and gender, parent education, parent occupation, number of siblings, maternal depression, maternal attitudes, amount the child is read to. Age 22 and 42 month control variables include: early cognitive and developmental abilities, test observer reports of the child's early behavioural development, height and weight.

* p< .05, ** p< .01, *** p< .001

3.3 Subgroup analysis: age 10 mid-childhood achievement outcomes

Table 6 presents the results for the sub-group analysis of the age 10 mid-childhood achievement outcomes according to gender and low/high SES groups. All the results presented include the full sets of controls for prior ability as well as child and family background characteristics. High SES is defined as those in SES groups I and II and low SES IV and V, with SES groups III (manual) and III (non-manual) as the reference category. The resulting sample sizes are:

- Age 10 Reading
  - Male = 964 / Female = 814
  - Low SES = 420 / High SES = 261
- Age 10 Maths
  - Male = 952 / Female = 801
  - Low SES = 417 / High SES = 256

As in the full sample analyses, the age 5 copying score continues to strongly predict to achievement in reading and maths at age 10 for both males and females and for those in the high SES group. Here, a one unit increase in the standard deviation of copying for males results in a 0.29 unit increase for reading ($p < .001$) and 0.37 for maths ($p<.001$). For females this unit increase is 0.26 ($p < .001$) for reading and 0.33 for maths ($p<.001$).

For both outcomes, the effect of the copying score is substantially and significantly greater for the high SES children than for the low SES group; a one unit increase results in a 0.43 rise in reading achievement and 0.52 in maths (both $p<.001$). These estimated effect sizes are roughly five times those for the low SES group and, as above, such results are particularly striking given the considerable reduction in sample sizes. Conversely, the effect of the human figure drawing score is stronger for the low SES group ($p<.01$) for both reading and maths.

Age 5 vocabulary is also important for both genders for reading achievement and for males for maths achievement, but as in the full sample analyses the conditional effects are substantially lower than those for copying designs. Age 5 human figure drawing predicts to reading achievement for females ($\beta = 0.10$, $p<.05$) and maths achievement for males ($\beta = 0.10$, $p<.05$).

For females, inattention at age 5 has negative effects on both age 10 reading achievement (-.10) and maths achievement (-.11, both $p<.01$). For age 10 reading achievement, this result is statistically significantly different from males. There is also a positive effect of internalizing problem behaviour (.18, $p<.01$) for reading achievement for those in the high SES group. Again, this difference is statistically significantly different from those in the low SES group.

Table 6: Coefficients and standard errors from regression models for subgroups of age 10 achievement on early academic skills, attention skills, and socio-emotional behaviours

	Age 10 achievement outcomes							
Dependent variable at age 10:	**Reading**				**Maths**			
	Male	Female	Low SES	High SES	Male	Female	Low SES	High SES
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables								
Achievement scores								
Human figure drawing	0.08	0.10*	0.15**	-0.03	0.10*	0.05	0.19**	-0.01
	(.04)	(.04)	(.06)	(.07)	(.04)	(.04)	(.07)	(.08)
Vocabulary	0.10*	0.12**	0.09	0.05	0.09*	0.05	-0.01	0.13
	(.04)	(.05)	(.07)	(.07)	(.04)	(.05)	(.07)	(.07)
Profile drawing	0.02	-0.01	-0.05	-0.05	0.00	-0.04	-0.03	-0.10
	(.04)	(.04)	(.05)	(.06)	(.04)	(.04)	(.06)	(.06)
Copying designs [a b]	0.29***	0.26***	0.08	0.43***	0.37***	0.33***	0.10	0.52***
	(.04)	(.05)	(.07)	(.06)	(.04)	(.05)	(.07)	(.06)
Mother report of attention skills								
Inattention [c]	-0.06	-0.10*	-0.07	-0.12	-0.05	-0.11*	-0.09	-0.11
	(.04)	(.04)	(.06)	(.08)	(.05)	(.04)	(.06)	(.09)
Mother report of socioemotional behaviours								
Internalising problem behaviour [d]	0.01	-0.01	-0.05	0.18**	0.02	0.02	-0.01	0.03
	(.04)	(.04)	(.06)	(.07)	(.04)	(.04)	(.07)	(.07)
Externalising problem behaviour	-0.07	0.04	-0.07	-0.01	-0.01	0.05	0.08	0.02
	(.05)	(.05)	(.07)	(.07)	(.04)	(.06)	(.07)	(.08)
Control variables	X	X	X	X	X	X	X	X
Observations	964	814	420	261	952	801	417	256
R-squared	0.49	0.51	0.61	0.75	0.50	0.48	0.60	0.75

Note: Standard errors are not corrected for classroom clustering as there is none. All variables are standardized by full sample standard deviation. All models include missing data dummies. Inattention, internalizing and externalizing problem behaviours are not reverse scaled. Control variables include: child age and gender, parent education, parent occupation, number of siblings, maternal depression, maternal attitudes, amount the child is read to. Age 22 and 42 month control variables include: early cognitive and developmental abilities, test observer reports of the child's early behavioural development, height and weight.

[a] Low SES coefficient is significantly different from High SES for reading outcome at $p < .001$.

[b] Low SES coefficient is significantly different from High SES for maths outcome at $p < .001$.

[c] Female coefficient is significantly different from male for reading outcome at $p < .01$.

[d] Low SES coefficient is significantly different from High SES for reading outcome at $p < .01$.

* p< .05, ** p< .01, *** p< .001

3.4 Sub-group analysis: age 30 outcomes

Table 7 presents the results for the sub-group analysis of the age 30 adult outcomes, again split by gender and low/high SES groups and including all controls for prior ability as well as child and family background characteristics. The resulting sample sizes are:

- Age 30 Highest Academic Qualification
  - Male = 796 / Female = 789
  - Low SES = 363 / High SES = 254
- Age 30 Log Wage
  - Male = 619 / Female = 541
  - Low SES = 253 / High SES = 177

As in the full sample analyses and sub-group results reported above, the age 5 copying score continues to strongly predict to adult academic achievement for both males and females. Thus, for example, a one unit increase in the standard deviation of copying for males results in a 0.33 unit increase for academic achievement by age 30 ($p < .001$). For females this unit increase is 0.21 ($p < .01$).

For the SES sub-group analyses, the copying score only matters for the high SES group for highest academic qualification at 30 ($\beta = 0.35$, $p<.01$). The coefficient for those in the low SES group is substantially smaller ($\beta = 0.08$) and suggests that low SES children are not getting the age 30 benefits of high age 5 copying scores. This result is particularly interesting given that the size of the low SES coefficient is so much smaller for the low SES group. Moreover, the precision of these relationships is particularly noteworthy given the considerable reduction in sample size imposed by sub-group analysis.

Age 5 vocabulary is also important for the high SES group only for income at age 30 ($\beta = 0.15$, $p<.05$). This result is also particularly striking since the size of the coefficient for those in the high SES group is much larger than both the low SES group and from the full sample results, as well as resulting from the smallest sub-group sample size.

Externalising behaviour problems now only has negative effects for males in terms of highest academic qualification ($\beta = -0.27$, $p<.001$). Again, the size of the coefficient here is particularly noteworthy, more than doubling from the full sample analyses and is statistically significantly larger than for females. Inattention has strong negative implications for both age 30 outcomes. For educational attainment, it is negative for females ($\beta = -0.13$, $p<.05$) and those in the low SES group ($\beta = -0.30$, $p<.01$). For our age 30 income measure, greater levels of inattention have negative effects for males ($\beta = -0.06$, $p<.05$) and, again, those in the low SES group ($\beta = -0.08$, $p<.05$). Note that the effect sizes for the wage outcome are smaller than for academic qualifications. As in the full sample analyses, there are no effects for internalising problem behaviours.

Table 7: Coefficients and standard errors from regression models for subgroups of age 30 outcomes on early academic skills, attention skills, and socio-emotional behaviours

	Age 30 adult outcomes							
Dependent variable at age 30:	**Highest academic qualification**				**(Log) Wage**			
	Male	Female	Low SES	High SES	Male	Female	Low SES	High SES
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables								
Achievement scores								
Human figure drawing	-0.04	0.07	0.18	-0.19	0.03	-0.06	0.03	-0.03
	(.07)	(.07)	(.12)	(.12)	(.03)	(.05)	(.04)	(.07)
Vocabulary	0.08	0.04	-0.15	0.14	0.02	0.04	0.06	0.15*
	(.07)	(.07)	(.11)	(.12)	(.03)	(.03)	(.05)	(.06)
Profile drawing	-0.04	0.04	-0.15	0.11	-0.02	-0.01	-0.06	-0.03
	(.07)	(.06)	(.10)	(.11)	(.02)	(.03)	(.04)	(.06)
Copying designs	0.33***	0.21**	0.08	0.35**	0.07*	0.10*	0.03	-0.02
	(.08)	(.08)	(.12)	(.13)	(.03)	(.04)	(.04)	(.06)
Mother report of attention skills								
Inattention	-0.03	-0.13*	-0.30**	-0.10	-0.06*	-0.03	-0.08*	-0.06
	(.07)	(.06)	(.10)	(.14)	(.03)	(.03)	(.04)	(.11)
Mother report of socioemotional behaviours								
Internalising problem behaviour	0.03	0.07	0.00	-0.06	-0.02	0.04	-0.01	-0.04
	(.07)	(.05)	(.10)	(.12)	(.03)	(.03)	(.04)	(.07)
Externalising problem behaviour [a]	-0.27***	0.06	-0.04	-0.11	-0.01	0.00	-0.03	0.05
	(.07)	(.08)	(.12)	(.12)	(.03)	(.04)	(.04)	(.08)
Control variables	X	X	X	X	X	X	X	X
Observations	796	789	363	254	619	541	253	177
R-squared	0.40	0.42	0.48	0.66	0.33	0.37	0.66	0.71

Note: Standard errors are not corrected for classroom clustering as there is none. All variables are standardized by full sample standard deviation. All models include missing data dummies. Inattention, internalizing and externalizing problem behaviours are not reverse scaled. Control variables include: child age and gender, parent education, parent occupation, number of siblings, maternal depression, maternal attitudes, amount the child is read to. Age 22 and 42 month control variables include: early cognitive and developmental abilities, test observer reports of the child's early behavioural development, height and weight.

[a] Female coefficient is significantly different from male for highest academic qualification at $p < .01$.

* p< .05, ** p< .01, *** p< .001

3.5 Sensitivity analysis: nonlinearities in the age 5 measures

We also explored possible nonlinearities in, and interactions between, our age 5 school entry capabilities and the four outcomes considered. The summary results of these different model specifications are presented in Tables A2 – A5 in the Appendix.

The three dummy variables for the worst 25% of externalising, internalising and inattention behaviours have little effect on any of the final models, suggesting that it is not the lower end of the distribution that drives significance in the continuous variable. The exception here is for the highest academic qualification outcome, where those in the bottom 25% of the externalising behaviour distribution drive the significance of the continuous measure in model 1 (see Table A4). When entered, the dummy variable for those in the bottom 25% of the externalising behaviour distribution is significant and knocks out the effect of the continuous measure. Following from this, *risk* (defined as the sum of the three behavioural problem dummy variables) is not significant for any of the four outcomes assessed (model 6).

The interaction of the worst 25% of externalising behaviour problems and the worst 25% of inattention distribution is significant and positive for both age 10 outcomes (see model 3 in Table A2 and A3). Similarly, without the inclusion of the single worst 25% behavioural dummies, the interaction of the worst 25% of externalising behaviour problems and the worst 25% of inattention distribution is significant and positive for wages at 30 (model 5, Table A5). These results highlight the complex relationships between these behavioural measures and will be discussed further in Section 4 below. There is no significant effect of the interaction between those in the bottom 25% of copying scores and externalising behaviours – with or without the inclusion of the three dummy behaviour variables.

There is no further effect of being in the bottom 25% of the copying score distribution (nor is there any significant effect of being in the top 25% of the copying score distribution – results not reported), for age 10 maths and reading highlighting the very linear effect of the copying score (see models 2 and 3 in Tables A2 and A3). However, for the outcome of highest academic qualification by age 30 (Table A4), being in the bottom quarter of the copying score distribution has a significant and positive effect, indicating a non-linear relationship between copying and this outcome. We also find that being in the top 25% of the copying score distribution knocks out the effect of the continuous copying score (results not reported). This may reflect a ceiling effect for this outcome since over 35% of those in this top quartile go on to gain the highest level of academic qualification (level 4) by age 30, in comparison with just 16% of those in the rest of the distribution.

3.6 Sensitivity analysis: primary school experience at age at testing

As noted above, some children had already started in primary school at the time of the age 5 assessments, while others had not. We considered the potential influence of formal schooling experience in these results by conducting sensitivity analysis by primary school status. We split our sample by “main present placement” status at the time they completed the age 5 assessments into two groups, those in primary school and those not in primary school, and repeated the analysis.

Splitting the sample with respect to whether the child was already in school at the time of the age 5 assessments leaves only a small group without any formal school experience, i.e. not in primary school. Unfortunately however, there is no information regarding how long children had been in school for at the time of the age 5 assessments and so we are unable to further unpack the differences observed here.

For the four different outcomes, resulting sample sizes are:

- Age 10 Reading: In primary school = 1433 / Not in primary school = 345
- Age 10 Maths: In primary school = 1417 / Not in primary school = 336
- Age 30 Highest Academic Qualification: In primary school = 1284 / Not in primary school = 301
- Age 30 Log Wage: In primary school = 929 / Not in primary school = 231

Despite the reduced sample sizes however, the copying score is still very important in predicting all four outcomes in both samples.

For those in primary school, inattention is significant and negative for age 10 reading $\beta = -.09$ (s.e. = .03, $p < .01$) and maths $\beta = -.10$ (s.e. = .04, $p < .01$) and age 30 log wage $\beta = -.09$ (s.e. = .02, $p < .001$). The effect of inattention is much smaller for those not in primary school for maths and for age 30 log wage. The results are age 10 reading $\beta = -.07$ (s.e. = .06) and maths $\beta = .00$ (s.e. = .07) and age 30 log wage $\beta = .03$ (s.e. .05). Statistical insignificance for those not in primary school at the time of testing is in part a product of the much smaller sample but the size of coefficients suggest that this may also result from genuine differences in effect size between the two groups.

For those children in primary school at the age of testing, internalising problem behaviours become significant and positive for log wage at age 30, $\beta =.13$, s.e. = .05 (vs. $\beta = -.02$, s.e. = .02 for those not in primary school when tested). And for those children not in primary school at the time of testing, internalising problem behaviours are negatively related to age 10 maths, $\beta =.-16$, s.e. = .08 (vs. $\beta = .05$, s.e. = .03). While the coefficient itself does not reach statistical significance, the difference between the two coefficients is statistically significant. This result is again in part a product of the reduced sample sizes but does suggest genuine differences between the two groups.

Externalising behaviour does not emerge as significant for any of the outcomes assessed for either group.

Table 8: Coefficients and standard errors from regression models of age 10 achievement on early academic skills, attention skills, and socio-emotional behaviours, by primary school placement at time of testing

	Achievement test score					
Dependent variable at age 10:	**Reading**			**Maths**		
Independent variables	Original	In primary school	Not in primary school	Original	In primary school	Not in primary school
Achievement scores						
Human figure drawing	.09**	.10**	.15*	.09**	.07*	.12
	(.03)	(.03)	(.06)	(.03)	(.03)	(.08)
Vocabulary	.13***	.11**	.19**	.09**	.06	.17*
	(.03)	(.04)	(.06)	(.03)	(.03)	(.08)
Profile drawing	.00	.01	-.07	-.02	-.03	.02
	(.03)	(.03)	(.06)	(.03)	(.03)	(.06)
Copying designs	.26***	.25***	.26**	.36***	.37***	.35***
	(.03)	(.04)	(.07)	(.03)	(.04)	(.08)
Mother report of attention skills						
Inattention	-.08**	-.09**	-.07	-.09**	-.10**	.00
	(.03)	(.03)	(.06)	(.03)	(.04)	(.07)
Mother report of socioemotional behaviours						
Internalising problem behaviour [a]	.01	.02	-.08	.02	.05	-.16
	(.03)	(.03)	(.07)	(.03)	(.03)	(.08)
Externalising problem behaviour	-.03	-.03	.03	.00	.01	.04
	(.03)	(.04)	(.07)	(.03)	(.04)	(.08)
Control variables	X	X	X	X	X	X
Observations	1778	1433	345	1753	1417	336
R-squared	.45	.46	.69	.45	.45	.68

Note: Standard errors are not corrected for classroom clustering as there is none. All variables are standardised by full sample standard deviation. All models include missing data dummies. Inattention, internalising and externalising problem behaviours are not reverse scaled. Control variables include: child age and gender, parent education, parent occupation, number of siblings, maternal depression, maternal attitudes, amount the child is read to. Age 22 and 42 month control variables include: early cognitive and developmental abilities, test observer reports of the child's early behavioural development, height and weight.

[a] Not in primary school coefficient is significantly different from in primary coefficient for maths at p <.05.

* p< .05, ** p< .01, *** p< .001

Table 9: Coefficients and standard errors from regression models of age 30 outcomes on early academic skills, attention skills and socio-emotional behaviours, by primary school placement at time of testing

	Age 30 adult outcomes					
Dependent variable at age 30:	**Highest academic qualification**			**(Log) Wage**		
Independent variables	Original	In primary school	Not in primary school	Original	In primary school	Not in primary school
Achievement scores						
Human figure drawing	0.03	.05	.02	-0.01	.01	.00
	(.05)	(.05)	(.12)	(.02)	(.03)	(.06)
Vocabulary	0.05	0.03	0.08	0.03	0.02	0.03
	(.05)	(.05)	(.11)	(.02)	(.02)	(.05)
Profile drawing	0.00	.00	.14	-0.01	-.02	-.06
	(.04)	(.05)	(.12)	(.02)	(.02)	(.04)
Copying designs	0.27***	.28***	.17	0.08**	.08*	.14***
	(.05)	(.06)	(.15)	(.03)	(.03)	(.04)
Mother report of attention skills						
Inattention [a]	-0.09	-.09	-.02	-0.06**	-.09***	.03
	(.05)	(.05)	(.15)	(.02)	(.02)	(.05)
Mother report of socioemotional behaviours						
Internalising problem behaviour [b]	0.05	.04	-.03	0.00	-.02	.13**
	(.04)	(.04)	(.13)	(.02)	(.02)	(.05)
Externalising problem behaviour	-0.11*	-.11	-.11	0.00	.02	-.07
	(.05)	(.06)	(.14)	(.02)	(.03)	(.05)
Control variables	X	X	X	X	X	X
Observations	1585	1284	301	1160	929	231
R-squared	0.34	.36	.62	0.25	.28	.67

Note. Standard errors are not corrected for classroom clustering as there is none. All variables are standardised by full sample standard deviation. All models include missing data dummies. Inattention, internalising and externalising problem behaviours are not reverse scaled. Control variables include: child age and gender, parent education, parent occupation, number of siblings, maternal depression, maternal attitudes, amount the child is read to. Age 22 and 42 month control variables include: early cognitive and developmental abilities, test observer reports of the child's early behavioural development, height and weight.

[a] In primary school coefficient is significantly different from not in primary coefficient for log wage at p <.01.
[b] Not in primary school coefficient is significantly different from in primary coefficient for log wage at *p* <.01.

* p< .05, ** p< .01, *** p< .001

4. Discussion

This study explored the relationship between early measures of child development and measures of later achievement to better understand the benefit that children gain from arriving at school with particular personal characteristics that have developed in the previous pre-school years, above and beyond innate capabilities. Our primary focus was in estimating the relative importance of children's school entry capabilities and of development in those skills. To do this, we examined the extent to which change in measures of cognitive achievement, attention skills and socio-emotional behaviours at, or around, entry to school mattered for subsequent school success as well as for later adult outcomes.

Supporting our hypotheses, positive development in measures of cognitive ability between 42 months and 5 years of age were more predictive in relation to subsequent measures of achievement than those of attention or problem behaviours. The single measure most predictive of later achievement was children's ability to accurately copy shapes and simple patterns. However, the attention and behavioural measures considered also have effects on later achievement outcomes. Of these, (in)attention was the most important, being statistically significant for the sample population and for all the sub-groups tested. Of the other behavioural characteristics measured, externalising behaviours had a negative, and internalising behaviours a positive, association with outcomes, but only for some measures and for particular sub-groups.

We concur with Blanden, Gregg and MacMillan (2006) who also find that non-cognitive skills are important for the 1970 cohort. However, in line with previous research, we do find particular importance for cognitive skills in the pre-school period in predicting the human capital outcomes explored in this paper. Our results show strong continuity in cognitive ability across childhood and demonstrate substantive power in predicting both educational success and income at age 30. If we had looked at wider outcomes, such as health and civic engagement, we would have expected to find greater importance for these non-cognitive skills. A further difference between the research presented here and that of Blanden et al. is that we break the Rutter score of non-cognitive development down into three factors, discriminating skills relating to (in)attention from externalising and internalising behaviour problems.

In this final section, we discuss our three substantive findings in more detail and put forward possible interpretations for what they might mean in terms of policy. We also highlight three sets of other interesting results that emerge from these findings that require further analysis.

4.1 Key findings

4.1.1 The importance of the copying designs test

First and foremost, the long-term explanatory power of the copying score is striking and shows substantive implications for all four outcomes assessed. Positive development in copying ability between 42 months and 5 years appears to cause gains in reading and maths scores at age 10 and is strongly associated with highest educational qualifications and log wage at age 30 (see also Bynner and Steedman, 1995; Parsons and Bynner, 1998). To the extent that unobserved age invariant child and family factors are conditioned out of this model (see section 2.4 for further discussion here), the implication is that the copying designs test is a very good measure of long-term cognitive skill and that the underlying features of cognitive ability that it assesses may bring lasting benefits to children in terms of their school attainment and subsequent labour market productivity. It is also interesting to note, that the skills involved in scoring highly in this test appear to be more beneficial and yield higher gains in school than the skills assessed in the age 5 vocabulary test, for reading as well as for maths.

As noted in our introduction, early developmental skills lay the foundations for deeper understanding of more complex skills and problem solving abilities and it may be that the copying designs test and the development which this measures better assesses underlying features of the developing cognitive capability of the child than the other age 5 measures available here. For example, the encoding and decoding elements assessed within it may provide the foundations upon which pre-reading and pre-maths skills are then built. More formal, but very similar tests, such as the Bender-Gestalt test, which are used to evaluate visual-motor maturity and to screen children for developmental delays, note the importance of integration of information assessed by copying geometric shapes. This test has been associated with language ability and various aspects of intelligence such as visual perception, manual motor ability, memory, and temporal and spatial concepts of organisation. The copying designs task used here may similarly pick up these early features of intelligence and developing cognitive abilities.

However, as with the findings of other developmental research that highlight important differences between surface knowledge and meaningful understanding of process and underlying concepts, this result does not mean that "teaching to the test" per se will result in gains for all, but rather that such a test might provide a very good early indicator for the early identification of basic skill difficulties.

4.1.2 Social stratification in the copying designs test

Our second key finding further supports this view that copying score has value as a screening or diagnostic tool rather than providing the basis for a remedy, in that the gains associated with the highly predictive copying score are not universal across socio-economic status. This result is particularly striking. Sub-group analyses reveal that low SES children with high copying scores are not realising the same positive benefits for either the mid-childhood measures of achievement or adult success in terms of the highest academic qualification by age 30.

Social immobility may result from a number of factors such as features of the macro-social context, i.e. features of wider society and economy, such as labour markets, the media, neighbourhood effects, culture, housing and so on, that limit the opportunities available to children from low resource environments as well as differences between children from low and high resource environments in terms of capabilities and competencies. Yet these capabilities and competencies are not immutable and part of the impact of context is through impacts on the development of capabilities and competencies. The focus of this paper has been on that latter issue, yet the interaction with SES is also indicative of macro-social impacts on development that are highly germane to the question of social mobility.

Feinstein (2003) finds that there are many low SES children who score well on tests of early cognitive achievement (22 months) but are in time surpassed on such tests by children from high SES backgrounds whom they earlier outscored. The reverse event is extremely rare. That finding indicates that SES differences in cognitive and school attainment may not be a simple matter of fixed relationships between innate ability and socio-economic grouping, but rather the result of more complex interactions between innate ability and the wider social and family environment (for further discussion on such gene-environment interactions see, for example, Moffitt, 2005; Rutter, 2002; Vineis and Kriebel, 2006). That interpretation must remain unproven as the study did not assess the genetic contributions to the development of the sample children and was not set up in a way that could test such an interpretation. The finding that early abilities did not necessarily carry over to later scores may reflect the slow, developmental release of genetic impact on the children through childhood, not all present at 22 months. However, the interpretation that the socially differentiated changes over time were principally attributable to genetically determined ability would be to assert a very strict and inflexible association of parental SES and child potential that to our reading overstates the impact of genetically determined ability and neglects the capability of environmental factors to interact positively or negatively with inherited features of intelligence and temperament (see also Turkheimer, Haley, Waldron, D'Onofrio and Gottesman, 2003).

The finding of this current study is that children from low SES families who are scoring highly on the age 5 copying test do not appear to get the benefits of such early signs of cognitive capability that is achieved by children from more advantaged backgrounds. This may be indicative of an important gene-environment interaction, an essential part of the mechanism for social immobility.

Taking these two key findings together, one particularly interesting use for the copying designs task might be to help teachers recognise those with specific basic skills difficulties early on, particularly as evidence here suggests that the problems experienced by those in difficult circumstances who are doing badly become worse over time (Feinstein, 2003).

4.1.3 The importance of skills related to attention

Our third substantive finding relates to the remarkable persistence of skills related to attention in the prediction of later achievement. The mother-reported measure of inattention at age 5, which, as it also contains a change interpretation, carries particularly strong negative predictions for both measures of achievement in mid-childhood and log wage at 30. Moreover, when we exclude the age 5 cognitive achievement measures (models 3 and 6), the coefficients for inattention increase considerably, indicating that the four cognitive skills assessed also contain elements of attention skill and so mask some of the negative effects of inattention. For highest academic qualification, the effect only becomes significant in these two models.

This finding is consistent with other research in suggesting a particular role for skills related to attention, independent of cognitive ability (see also Alexander et al., 1993; McClelland et al., 2000; Yen et al., 2004). More so than for either externalising or internalising problem behaviours, positive development in skills related to attention predict later achievement outcomes. It is important to emphasize however, that the age 5 behaviour measures are taken from mothers' reports and so one must be concerned about the extent of bias in measurement. Moreover, the baseline measures of behaviour used come from single item questions, making the interpretation of *change* more open to scrutiny. Nonetheless, these measures have clear predictive power from age 5 to age 10 achievement and into adulthood, conditional on the full set of controls and cognitive measures.

Interestingly, inattention is only predictive of later outcomes (all but highest academic qualification by 30) for those in primary school at the age of testing. As noted above, we must take into account when interpreting these measures that they are mother-reported and so may suffer from various forms of bias. Moreover, there is a question about what being "inattentive" means for children who are in a formal schooling environment compared to its meaning for children who are not and whether they can be conceptualised and defined in the same way. The small sample sizes here again make further exploration of this issue difficult in the current data.

4.2 Summary of other findings

We now turn to three other interesting sets of results that emerge from the current analyses but are of lesser importance than those discussed above and require additional analysis in order to be fully understood and interpreted.

4.2.1 The role of externalising and internalising problem behaviours

For the two socio-emotional behaviour measures considered, the presence of externalising behaviour problems is shown to be a risk factor for educational attainment in adulthood but interestingly shows no effects on either age 10 reading or maths. Moreover, when we exclude the four age 5 cognitive measures from the regression analyses (models 3 and 6), the coefficient for externalising behaviours stays the same suggesting that unlike those for attentional skills, these early measures of cognitive achievement do not contain additional aspects of this behaviour problem.

Barriga et al. (2002) note the high levels of co-morbidity of problem behaviours and suggest that both externalising and internalising problem behaviours are related to academic underachievement not directly, but rather through their association with attention-related difficulties. Our results could lend support to such an interpretation but would require further analysis to explore the possible mediating role of attention problems in these data.

While the sub-group analyses reveal that there is less social stratification in the behavioural outcomes measured, internalising behaviours, though conceptualised and measured as 'problem' behaviours in childhood (Rutter et al., 1970), actually demonstrate positive effects for age 10 reading for those in the high SES group. This finding is interesting given internalising behaviour problems were not significant for any of the four outcomes in the full sample analyses and given the small sample sizes. Such behaviours may then carry protective features against childhood risk factors. However, it is impossible to say in which direction causality operates here. This result may reflect that children from high SES groups are given greater levels of support than those from low SES groups or that high SES children with internalising behaviours have different strategies to deal with such problems, for example, retreating into a book.

Internalising problem behaviours are also positively related to log wage at age 30 for those children *not* in primary school at the time of testing. This finding is again worthy of mention given the particularly small size of the not in primary school sub-sample. This positive effect for wage at 30 parallels results from Feinstein and Bynner (2004), who report that internalising problem behaviours protect against a number of later social exclusion risks including reduced probability of offending in adulthood and membership of a workless household.

4.2.2 Moderation by gender

In terms of gender moderation, the effect of copying on the wage outcome was strong for both males and females. However, sample sizes are particularly low for these sub-group results. Moreover, one must be cautious in relation to gender comparisons for the wage outcome because the wage is only observed for those in work. This selection bias is strongly moderated by gender, as are the returns to skills. The difference in result perhaps reflects a greater degree of returns to skill for females than males.

It is also interesting to note that Human Figure Drawing carries positive gains for female reading and for male maths scores at age 10, whereas vocabulary at age 5 matters for both male and female reading at age 10, but only for male maths scores. Gender differences in achievement are a consistent finding in the developmental literature and are often specific to the types of achievement being examined. Many studies have found that girls perform better than boys in reading skills (Eccles, 1984; Martin and Hoover, 1987; Sabers, Crushing and Sabers, 1987), whereas the gender differences in maths are more inconsistent and have been shown to depend on the particular maths skills being assessed. These findings show similar inconsistencies in gender moderation, but the small sample sizes again make it difficult to further explore the differences.

For the behavioural measures considered, our results are, in part, consistent with previous studies that have generally reported higher levels of externalising problem behaviours in males and higher levels of internalising problem behaviours in females. Externalising behaviour problems have particularly strong, negative effects for males in terms of highest academic qualification. For the mid-childhood outcomes, inattention predicts negatively for females only but as noted above, the mediating role of attention-related difficulties was not tested here.

4.2.3 Sensitivity analysis: linearities and non-linearities

One concern was that the copying score result might be driven by children with a very low score who had mental or physical disabilities and that the variable had no general cognitive predictive power in the rest of the distribution. To test this we relaxed the assumption of continuity in the scoring of this measure and introduced a set of dummy variable measures, indicating the exact score from 1-8 on the copying test (results not reported). The estimated effect is remarkably linear. Moreover, even if one then also drops those who scored 0, the lowest possible score, the predictive power persists for those left, i.e. the predictive power does not lie in any artefact to do with those at the very bottom of the distribution.

The more detailed sensitivity analyses in relation to nonlinearities reported in section 3.6 further support the remarkably linear effects of the copying score for both mid-childhood achievement outcomes and log wage at 30. However, for the highest academic qualifications, being in the bottom 25% of the distribution has a significant and positive effect, indicating a non-linear relationship between copying and this outcome. We also find evidence for a possible ceiling effect for this outcome as over 35% of those in the top quartile go on to gain the highest level of academic qualification by 30 (level 4/5), compared with just 16% of those in the rest of the distribution.

This analysis also reveals interesting complexities with respect to the predictive nature of these three behavioural measures. With the exception of highest academic qualification outcome, the results here suggest that it is not the lower end of the distribution that drives significance in the continuous variable. For age 30 highest academic qualification outcome, those in the bottom 25% of the externalising behaviour distribution drive the significance of the continuous measure.
To further explore these non-linearities, we created interaction terms for those in the bottom quartile of the behavioural distributions. Most interesting here is the finding that the interaction of the worst 25% of externalising behaviour problems and the worst 25% of inattention distribution is significant and positive for both age 10 outcomes. Thus, those children who have both high inattention and high externalising behaviour problems are different from, and doing better in maths and reading, than those who are only reported to have inattention problems.

While it is somewhat surprising that this result is positive, studies exploring the relationships between problem behaviours and academic achievement frequently note the considerable co-morbidity of problem behaviours that often exist among school-age youth (see for example, Barriga et al., 2002). Clearly, there are complex interactions between these variables. The raw age 10 reading and maths scores of those in the high externalising and high inattention group are lower than those in either the high externalising or high inattention groups indicating that this positive result only comes when we control for other features of the model. There are similar complexities for those individuals in both the worst 25% of externalising behaviour problems and the worst 25% of inattention distribution for wages at 30. Taken with the full sample and sub-group analyses, these results further support the wisdom of distinguishing between these two elements of socio-emotional behaviour discussed in our Introduction.

It would be interesting to consider the nature of these relationships in more detail, assessing the importance of changes in behaviour over a longer time period. One might hypothesise two categories of anti-social behaviour at school entry, equivalent to those identified by Moffitt (1993) for the adolescent period, an entry limited and a more persistent conduct disorder group. Such groups may be quite distinct although it would be interesting to consider the school or teacher effects on group membership, conditional on the child and family factors involved.

4.3 Issues of causality

As noted in our discussion of the analytical plan used here (see section 2.4), one of the difficulties in estimating effects using standard OLS regression is to ensure that we have taken into account in the estimation model the possibility that there may be other factors that influence our outcomes. This may result from features of the child, such as IQ or aspects of personality, or characteristics of her family, such as parents' education or income, which are correlated with both the school entry measures (the explanatory variables) and later achievement (outcomes). We have adopted a kind of change model in order to try counter problems of omitted variable bias and included prior measures of relevant child cognitive ability and behaviour, as well as other child and family characteristics measured at 22 and 42 months. In this way, unobserved age invariant features of the child are differenced out of the estimation and the coefficients on the age 5 measures represent the effect of change in cognitive ability, attention skills and socio-emotional behaviours between 42 months and age 5 years.

To the extent that our estimation removes such unobserved child characteristics as well as features of the family that influence children's educational success, the implication is that the effects found can be considered causal. While our ability to identify causality is less than that of an experimental situation, this multivariate, change approach has considerable merits when the control set is as strong and longitudinal as it is here.

4.4 Conclusions

In the introduction to this report we described the major whole-system reform that is currently being put into place in the UK alongside substantial increases in funding. This reform is being developed in line with principles set out in Every Child Matters, namely to achieve five outcomes for all children and young people: being healthy, staying safe, enjoying and achieving, making a positive contribution and economic well-being. Thus, the objectives of the system of public sector provision for young people are not limited to narrowly defined school success or to the achievement of economic benefits. The research in this paper is intended as a contribution to the question of the influences on these narrower outcomes, but in the UK at least, there is a concern with a wider set of objectives and in future research we will also consider the importance of cognitive and behavioural development for these broader objectives. It is important to consider as well the way these different features of development interact to lead to outcomes across these five objectives.

However, it is also important to ensure that we make the most of the opportunity provided by this reform and investment to maximise the benefits for children. That means targeting attention and resources on those features of child development that add most to those capabilities that are most effective for children in augmenting their resilience, functioning and, hence, their life chances. In this regard, we believe that the copying score merits further consideration, to assess in more detail why it has such predictive power, what features of the developing cognitive capability of the child it measures and how these might be enhanced by teaching practices in pre-schools and/or in the home for all children.

We hypothesise that the failure of children from low resource backgrounds who show initially high levels of positive development in terms of early copying skills to translate those early skills into later school success is an important example of such a gene-environment interaction, one which may explain a substantial element of social immobility as it indicates a barrier to the development of the potential of an important group of children in ways which leads to the reproduction across generations of family background effects. Inequality of opportunity is not just a question of the negative impact of environmental insults or developmentally unsupportive contexts, and social immobility may also result from the failure in some contexts to recognise and respond to early and important signs of high levels of cognitive capability. This might be thought of in Vygotskian terms as the result of the relative failure of parents and teachers in low resource environments to scaffold the learning of advanced children.

There may be a number of reasons for this, only some of which are amenable to policy intervention. Factors such as family stress, ill-health, time poverty and other forms of vulnerability such as pathologies, addictions and low attachment and social functioning may need more specific and intensive interventions. However, for many families it may be sufficient to develop a personalised learning programme that recognises the capability and requirements of more advanced children (Connor, Morrison and Katch, 2004; Connor, Morrison and Petrella, 2004), linked to a teacher-parent dialogue that engages parents in the appropriate, specific learning practices that match those of the classroom.

Second, we believe that the findings presented here add to the debate on the appropriate balance between cognitive and non-cognitive skills at different ages and for different groups of children. In particular, failure to place sufficient emphasis on cognitive development may run counter to the interests of children from low SES groups. We believe that pedagogy should continue to address ways in which cognitive and non-cognitive abilities can support one another and how the interactions between these different groups of skills can best be harnessed for different groups.

Thus one of the key implications of this research might be to question the assumed age trend in the appropriate ratio across these domains of cognitive versus non-cognitive skills. Evidence from neuroscientific research (Blakemore and Frith, 2005) supports this position and notes, for example, that adolescence is a time of major neurological change during which the aims of education might be better placed to focus on personal development, locus of control and attention-related issues just as in earlier periods and perhaps more so. We believe the research presented here provides equivalent support for education in the early years and suggest that pedagogy needs to address ways in which cognitive and non-cognitive abilities can support and enhance one another.

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Appendix 1: English Picture Vocabulary Test (survey version)

Interviewer instructions

- Show a page and say the single test word printed on the score sheet for that page, e.g. "drum". Do not say anything else but "drum" for the first page, "time" for the second page, and so on. The test word for each page may, however, be given more than once and, if there is a different local pronunciation, this can be used as well as the standard version.
- If the child points to the correct picture put the number of that picture in the left hand hoe by the test word on the score sheet.
- If the child says he does not know the answer encourage him/her by asking "Which do you think fits the word best?" If he/she still refuses to pick a picture, draw a line through both boxes for that word on the score sheet and continue with the test. Such refusals count as errors for the purposes of this test.
- Continue with the subsequent pages of pictures in the same way

Test words

1. drum
2. time
3. fence
4. skiing
5. chicken
6. climbing
7. leaf
8. digging
9. teacher
10. sewing
11. nest
12. arrow
13. parachute
14. cobweb
15. goat
16. peeping
17. temperature
18. signal
19. river
20. badge
21. hook
22. whale
23. acrobat
24. tweezers
25. submarine
26. balancing
27. binocular
28. ornament
29. barber
30. wasp
31. yawning
32. captain
33. trunk
34. argument
35. coin
36. hive
37. chemist
38. funnel
39. insect
40. cutlery
41. shears
42. exhausted
43. sole
44. walrus
45. weapon
46. sentry
47. waling
48. globe
49. valve
50. plumage
51. assistant
52. carpenter
53. destruction
54. spire
55. reel
56. coast

Appendix Table 1: Summary statistics for control variables

Variable	Mean	Standard deviation
Child and family characteristics at age 5		
Number of younger siblings	.36	(.59)
High TV viewing	.05	(.21)
High TV viewing (missing)	.33	(.47)
People per room	.90	(.27)
People per room (missing)	.01	(.10)
No mother	.00	(.05)
No father	.03	(.18)
Father's SES I	.05	(.21)
Father's SES II	.13	(.33)
Father's SES III non-manual	.06	(.23)
Father's SES III manual	.31	(.46)
Father's SES IV	.09	(.28)
Father's SES V	.03	(.18)
Father's SES other	.00	(.03)
Father's SES (missing)	.31	(.46)
Father unemployed	.03	(.18)
Father unemployed (missing)	.51	(.50)
Mother works part-time	.24	(.42)
Mother work status missing	.30	(.46)
Mother works full-time	.05	(.21)
Mother no qualifications	.38	(.48)
Mother highest qualification (low)	.22	(.42)
Mother highest qualification (medium)	.06	(.23)
Mother highest qualification (high)	.02	(.13)
Mother highest qualification (missing)	.33	(.47)
Father no qualifications	.34	(.47)
Father highest qualification (low)	.18	(.39)
Father highest qualification (medium)	.05	(.23)
Father highest qualification (high)	.09	(.28)
Father highest qualification (missing)	.34	(.47)
Housing type (house)	.61	(.49)
Housing type (flat)	.07	(.26)
Housing type (bedsit)	.01	(.08)
Housing type (missing)	.31	(.46)
Telephone ownership	.40	(.49)
Telephone ownership (missing)	.30	(.46)
Number of younger siblings (missing)	.30	(.46)
Mother depression	.13	(.33)
Mother depression (missing)	.30	(.46)
Mother anti-TV attitude	.00	(.43)
Mother anti-TV attitude (missing)	.30	(.46)
Mother low-authoritarian attitude	.00	(.72)
Mother low-authoritarian attitude (missing)	.30	(.46)
Not read to in past week	.08	(.27)
Read to on 1 or 2 days in past week	.12	(.33)
Read to on 3-5 days in past week	.18	(.39)
Read to on 6-7 days in past week	.29	(.45)
Read to (missing)	.33	(.47)

Variable	Mean	Standard deviation
Age 42 month test scores		
Counting	.00	(.92)
Counting (missing)	.15	(.36)
Speaking	.00	(.92)
Speaking (missing)	.15	(.36)
Copying Designs	.00	(.92)
Copying Designs (missing)	.15	(.36)
Distractibility (Easily distracted)	.16	(.36)
Distractibility (Moderately absorbed)	.38	(.48)
Distractibility (Absorbed)	.25	(.43)
Distractibility (missing)	.25	(.43)
Shy / withdrawn	.21	(.41)
Friendly & outgoing	.25	(.44)
Shy / withdrawn (other)	.51	(.50)
Shy / withdrawn (missing)	.25	(.44)
Co-operative (Very)	.28	(.45)
Co-operative	.21	(.41)
Co-operative (Fairly)	.16	(.37)
Rather uncooperative	.19	(.39)
Uncooperative	.09	(.29)
Cooperativeness (missing)	.16	(.37)
Age 22 month test scores		
Cubes	.00	(.95)
Cubes (missing)	.10	(.30)
Language	.00	(.95)
Language (missing)	.10	(.30)
Personal development	.00	(.95)
Personal development (missing)	.10	(.30)
Copying designs	.00	(.95)
Copying designs (missing)	.10	(.30)
Baseline child and family characteristics		
Gender = Female	.48	(.50)
Sub-group type 1 (10% control group)	.47	(.50)
Sub-group type 2 (Twins)	.09	(.29)
Sub-group type 3 (Post-mature)	.30	(.46)
Sub-group type 4 (Small for dates)	.23	(.42)
Birthweight quintile 1	.19	(.39)
Birthweight quintile 2	.19	(.39)
Birthweight quintile 3	.18	(.39)
Birthweight quintile 4	.17	(.38)
Birthweight quintile 5	.18	(.38)
Birthweight quintile missing	.09	(.28)
No father present	.04	(.21)
Father's SES I	.04	(.20)
Father's SES II	.10	(.30)
Father's SES III non-manual	.10	(.30)
Father's SES III manual	.40	(.49)
Father's SES IV	.13	(.34)
Father's SES V	.06	(.24)
Father's SES other	.03	(.16)
Father's SES missing	.09	(.28)
Father unemployed	.03	(.18)
Father unemployed (missing)	.11	(.31)

Variable	Mean	Standard deviation
Baseline child and family characteristics (continued)		
Mother's SES I or II	.08	(.27)
Mother's SES III non-manual	.25	(.43)
Mother's SES III manual	.04	(.21)
Mother's SES IV	.18	(.38)
Mother's SES V	.01	(.11)
Mother's SES other	.01	(.08)
Mother homemaker	.27	(.45)
Mother's SES (missing)	.16	(.37)
Mother currently employed	.04	(.19)
Mother currently employed (missing)	.35	(.48)
Mother age 14-18	.05	(.22)
Mother age 19-24	.37	(.48)
Mother age 25-34	.43	(.50)
Mother age 35+	.08	(.27)
Mother age (missing)	.06	(.24)
Father's age (no father)	.03	(.18)
Father age 14-18	.01	(.09)
Father age 19-24	.17	(.37)
Father age 25-34	.37	(.48)
Father age 35+	.12	(.32)
Father age (missing)	.31	(.46)
No older siblings	.36	(.48)
1 older sibling	.31	(.46)
2 or 3 older siblings	.22	(.41)
4 or more older siblings	.05	(.21)
Number of older siblings (missing)	.06	(.24)
Mother foreign language	.34	(.47)
Father speaks a foreign language	.34	(.47)

Appendix Table 2: Age 10 reading – nonlinearities sensitivity analysis: overview of different model specifications

Dependent variable at age 10:	**Reading test score**					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Achievement scores						
Human figure drawing	.09**	.09**	.09**	.09**	.09**	.09**
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Vocabulary	.13***	.13***	.12***	.13***	.12***	.13***
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Profile drawing	.00	.00	.00	.00	-.01	.00
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Copying designs	.26***	.23***	.23***	.26***	.26***	.26***
	(.03)	(.04)	(.04)	(.03)	(.03)	(.03)
Lowest 25% of copying designs		-.13	-.16			
		(.09)	(.11)			
Mother report of attention skills and socioemotional behaviours						
Inattention	-.08**	-.08	-.07	-.08**	-.11***	-.08*
	(.03)	(.04)	(.04)	(.03)	(.03)	(.03)
Internalising problem behaviour	.01	.00	.01	.01	.02	.02
	(.03)	(.04)	(.04)	(.03)	(.03)	(.03)
Externalising problem behaviour	-.03	-.01	-.02	-.03	-.06	-.02
	(.03)	(.05)	(.05)	(.03)	(.04)	(.04)
Worst 25% of inattention distribution		-.01	-.20			
		(.10)	(.11)			
Worst 25% of int. problem behav. distribution		.03	.02			
		(.10)	(.10)			
Worst 25% of ext. problem behav. distribution		-.05	-.17			
		(.10)	(.11)			
Worst 25% of copying * Worst 25% of ext. problem behav.			.04	-.03		
			(.16)	(.13)		
Worst 25% of ext. problem behav. * Worst 25% of inattention			.46**		.28*	
			(.14)		(.12)	
Risk (all bad behaviours summed)						-.01
Control variables	X	X	X	X	X	X
Observations	1778	1778	1778	1778	1778	1778
R-squared	0.45	0.46	0.46	0.45	0.46	0.45

Appendix Table 3: Age 10 maths – nonlinearities sensitivity analysis: overview of different model specifications

Dependent variable at age 10:	**Maths test score**					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Achievement scores						
Human figure drawing	.09**	.08**	.08**	.09**	.08**	.09**
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Vocabulary	.09**	.09**	.08*	.09**	.08**	.09**
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Profile drawing	-.02	-.02	-.02	-.02	-.02	-.02
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Copying designs	.36***	.35***	.34***	.36***	.36***	.36***
	(.03)	(.04)	(.04)	(.03)	(.03)	(.03)
Lowest 25% of copying designs		-.05	-.06			
		(.10)	(.12)			
Mother report of attention skills and socioemotional behaviours						
Inattention	-.09**	-.09*	-.08	-.09**	-.11***	-.09*
	(.03)	(.04)	(.04)	(.03)	(.03)	(.04)
Internalising problem behaviour	.02	.05	.06	.02	.03	.02
	(.03)	(.04)	(.04)	(.03)	(.03)	(.03)
Externalising problem behaviour	.00	-.03	-.04	.00	-.03	.00
	(.03)	(.05)	(.05)	(.04)	(.04)	(.04)
Worst 25% of inattention distribution		.00	-.17			
		(.11)	(.12)			
Worst 25% of int. problem behav. distribution		-.08	-.09			
		(.10)	(.10)			
Worst 25% of ext. problem behav. distribution		.11	.01			
		(.10)	(.11)			
Worst 25% of copying * Worst 25% of ext. problem behav.			.01	.05		
			(.17)	(.14)		
Worst 25% of ext. problem behav. * Worst 25% of inattention			.39**		.29*	
			(.15)		(.12)	
Risk (all bad behaviours summed)						.01
						(.06)
Control variables	X	X	X	X	X	X
Observations	1753	1753	1753	1753	1753	1753
R-squared	0.45	0.45	0.45	0.45	0.45	0.45

Appendix Table 4: Age 30 highest academic qualification – nonlinearities sensitivity analysis: overview of different model specifications

Dependent variable at age 30:	Highest academic qualification					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Achievement scores						
Human figure drawing	.03	.03	.03	.03	.03	.03
	(.05)	(.05)	(.05)	(.05)	(.05)	(.05)
Vocabulary	.05	.06	.06	.05	.05	.05
	(.05)	(.05)	(.05)	(.05)	(.05)	(.05)
Profile drawing	.00	.00	.00	.00	.00	.00
	(.04)	(.04)	(.04)	(.04)	(.04)	(.04)
Copying designs	.27***	.37***	.37***	.29***	.27***	.27***
	(.05)	(.06)	(.06)	(.06)	(.05)	(.05)
Lowest 25% of copying designs		.55***	.52**			
		(.15)	(.17)			
Mother report of attention skills and socioemotional behaviours						
Inattention	-.09	-.11	-.11	-.09	-.07	-.07
	(.05)	(.07)	(.07)	(.05)	(.05)	(.05)
Internalising problem behaviour	.05	.03	.03	.06	.05	.07
	(.04)	(.07)	(.07)	(.04)	(.04)	(.05)
Externalising problem behaviour	-.11*	.01	.01	-.13*	-.09	-.09
	(.05)	(.08)	(.08)	(.06)	(.06)	(.06)
Worst 25% of inattention distribution		.03	.08			
		(.17)	(.20)			
Worst 25% of int. problem behav. distribution		.12	.12			
		(.17)	(.17)			
Worst 25% of ext. problem behav. distribution		-.34*	-.32			
		(.16)	(.17)			
Worst 25% of copying * Worst 25% of ext. problem behav.			.12	.36		
			(.28)	(.24)		
Worst 25% of ext. problem behav. * Worst 25% of inattention			-.14		-.20	
			(.25)		(.21)	
Risk (all bad behaviours summed)						-.06
						(.09)
Control variables	X	X	X	X	X	X
Observations	1585	1585	1585	1585	1585	1585
R-squared	0.34	0.35	0.35	0.34	0.34	0.34

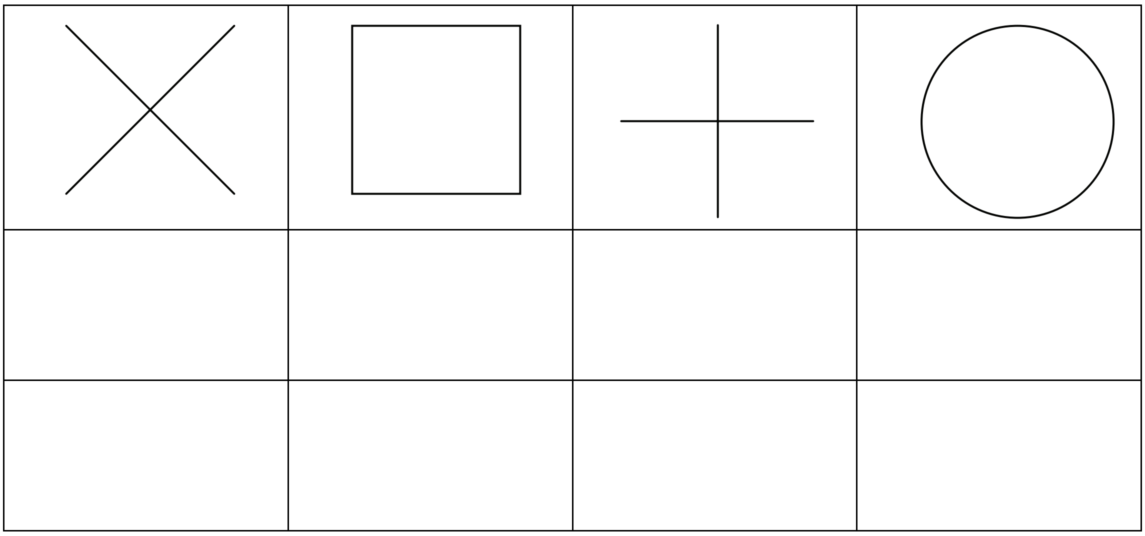
Appendix Table 5: Age 30 log wage – nonlinearities sensitivity analysis: overview of different model specifications

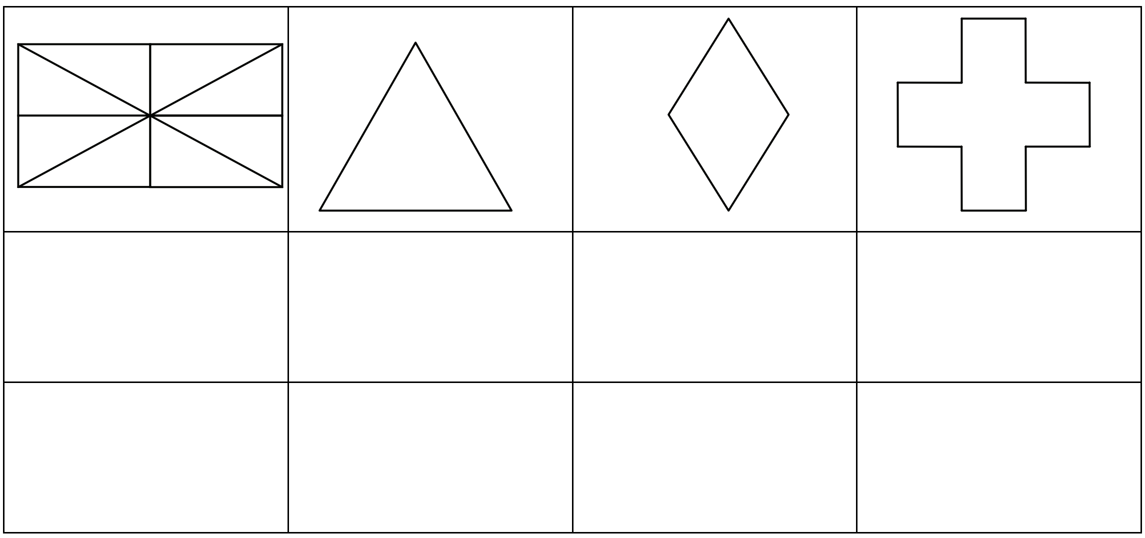
Dependent variable at age 30:	**(Log) Wage**					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Achievement scores						
Human figure drawing	-.01	-.01	-.01	-.01	-.01	-.01
	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)
Vocabulary	.02	.02	.02	.02	.02	.02
	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)
Profile drawing	-.01	-.01	-.02	-.01	-.02	-.02
	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)
Copying designs	.09**	.10**	.10**	.09**	.09**	.09***
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Lowest 25% of copying designs		.02	.02			
		(.07)	(.07)			
Mother report of attention skills and socioemotional behaviours						
Inattention	-.06**	-.06*	-.05	-.06**	-.07***	-.07***
	(.02)	(.03)	(.03)	(.02)	(.02)	(.02)
Internalising problem behaviour	.00	-.02	-.02	.00	.00	-.02
	(.02)	(.03)	(.03)	(.02)	(.02)	(.02)
Externalising problem behaviour	.00	-.03	-.03	-.01	-.02	-.02
	(.02)	(.03)	(.03)	(.02)	(.03)	(.03)
Worst 25% of inattention distribution		.00	-.07			
		(.07)	(.08)			
Worst 25% of int. problem behav. distribution		.07	.06			
		(.07)	(.07)			
Worst 25% of ext. problem behav. distribution		.08	.04			
		(.07)	(.07)			
Worst 25% of copying * Worst 25% of ext. problem behav.			-.03	.05		
			(.12)	(.10)		
Worst 25% of ext. problem behav. * Worst 25% of inattention			.18		.16*	
			(.10)		(.08)	
Risk (all bad behaviours summed)						.05
						(.04)
Control variables	X	X	X	X	X	X
Observations	1160	1160	1160	1160	1160	1160
R-squared	0.26	0.26	0.26	0.26	0.26	0.26

Appendix 2: Copying Designs Test [1]

Interviewer instructions

- Ask the child to copy the designs on the next two pages as carefully as possible
- Fold the book back so that the child can only see one page at a time
- Point to each design in turn and say "see if you can make one just like this – here" and point to the space beside the design
- Two attempts should be made at each design





[1] The age 42 months copying designs task was made up of a vertical line, plus shapes 1, 2 and 4 above.

WIDER BENEFITS OF LEARNING RESEARCH REPORT NO.20

Development in the early years: its importance for school performance and adult outcomes

Early development of children's intellectual, social and physical abilities has the potential to affect their long term achievement, beyond the initial introduction to the classroom, through their school lives and into adulthood. A greater understanding of the processes at work in these early years and their role in later success is therefore important to ensure that resources are appropriately targeted.

Past research has shown that early cognitive attainment is strongly related to later academic success. But we are also interested in the benefit that children gain from arriving at school with particular personal characteristics and the relationship which these may have to cognitive development. We also seek to explore the role of development (as opposed to innate capability) in the pre-school years. Data from the 1970 British Cohort Study is used to examine the importance of early measures of children's cognitive ability and behavioural development for their subsequent school and labour market achievement.

Our results suggest that, of the various measures used in this study, the most powerful predictor of later academic and labour market success is the ability of children to copy basic designs. However, we do not ignore the influence of behavioural factors and highlight the particular importance of skills related to attention with respect to these outcomes.

The results clearly show that early development of both cognitive and behavioural skills have a role in subsequent achievement. In this respect, we believe that the findings in this report add to the debate on the appropriate balance between cognitive and non-cognitive skills at different ages and for different groups of children. In particular, failure to place sufficient emphasis on cognitive development may run counter to the interests of children from low SES groups. We believe that pedagogy should continue to address ways in which cognitive and non-cognitive abilities can support one another and how the interactions between these different groups of skills can best be harnessed for different groups of children.

Dr Leon Feinstein is the Director of the Centre for Research on the Wider Benefits of Learning and Reader in the Economics of Education at the Institute of Education.

Kathryn Duckworth is a Research Officer at the Centre for Research on the Wider Benefits of Learning.

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