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Evidence from the UK Millennium Cohort Study

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Evidence from the UK Millennium Cohort Study

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Abstract

We use data from the four sweeps of the UK Millennium Cohort Study (MCS) of children born at the turn of the century to document the impact that poverty, and in particular *persistent* poverty, has on their cognitive development in their early years. Using both regression-based *seemingly unrelated regressions estimation* (SURE) and *structural equation modelling* (SEM), we show that children born into poverty have significantly lower test scores at ages 3, 5 and 7, and that continually living in poverty in their early years has a cumulative negative impact on their cognitive development. For children who are persistently in poverty throughout their early years, their cognitive development test scores at age 7 are more than 10 percentile ranks lower than children who have never experienced poverty, even after controlling for a wide range of background characteristics and parenting investment.

Keywords: child poverty, cognitive development

JEL classification codes: I32, J13, J62

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"Give me a child until he is seven and I will give you the man."

(attrib.) St. Francis Xavier (1506 – 1552)

1. Introduction

In this paper we investigate the impact of persistent poverty on the cognitive development of children in the very early years of their lives. We use the UK Millennium Cohort Study (MCS), which is a sample of 19,000 children born in UK around the turn of the century. We trace their cognitive development as measured in a series of standard tests up until they are 7 years old. Our focus is on the impact of living in poverty on this cognitive development. We construct measures of *episodic* (period-by-period) poverty and of *persistent* poverty, in order to examine the cumulative impact of multiple and continuous periods of deprivation. Using both regression-based and structural equation modelling (SEM) approaches, we show that children living in poverty have significantly lower cognitive test scores, and that the legacy of persistent poverty in their early years has a cumulative negative impact on their cognitive development.

It has become increasingly apparent that there is a strong link between children's development and educational attainment, and their family background (e.g. Blanden et al., 2007; Feinstein, 2003; Gregg and Macmillan, 2009; Heckman and Masterov, 2007). Carneiro and Heckman (2002) use US data to study the relationship between family income and schooling of children. Their findings suggest that it is long-term factors, such as better family resources throughout the child's formative years, rather than short-term liquidity constraints, that largely account for the family income gap in college enrolment. Findings by Cameron and Heckman (2001), again based on US data, also demonstrate that it is long-term influences associated with parental background and parental income throughout the child's adolescent years that largely account for the racial-ethnic college enrolment differential.

For the UK, using data drawn from the 1970 British Cohort Study (BCS), Feinstein (2003) showed that parental social class or socio-economic status (SES) has an important and long-lasting impact on children's development and attainment. While early cognitive development is a good predictor of educational qualification attainment 20 years later, children from low SES families are particularly disadvantaged. He also argued that children in low SES families are less likely to demonstrate high early scores, and even if they do show signs of good initial cognitive development, this advantage is soon eroded. Any upward mobility of children with low initial attainment is for children from medium and high SES families[1].

The link between early educational attainment and the SES of families has also been emphasised by policy-makers. Coupled with his administration's emphasis on education, in 1999 Prime Minister Tony Blair also famously pledged to end child poverty "within a generation"[2]. This commitment was accompanied by a range of reforms and initiatives designed to tackle what had become a crisis, with one quarter of all children in Britain living in poverty in 1999[3]. The following decade saw significant reductions in the child poverty rate measured in both relative and absolute income terms (Waldfogel, 2010). The rate of progress slowed somewhat after 2003/04, and progress towards the intermediate target of cutting the child poverty rate in half by 2010 was missed. Consequently, the prospect of 'eliminating' child poverty by 2020 looks increasingly difficult. However in March 2010, the UK Child Poverty Act enshrined in law the commitment to end child poverty by 2020. Explicit targets have been set in terms of relative income, material deprivation and absolute income measures. In addition, and as a late addition to the legislation, the significance of 'persistent poverty' was recognised, with a target to be set in regulations by 2014.

Most recently, the Field Review (Field, 2010) on ‘Poverty and Life Chances’ called into question the focus on income poverty. Instead, the review recommended greater attention be paid to the problem of the intergenerational transfer of poverty[4]. The role of family background, the quality of parenting, and children’s opportunities for learning and development were argued to be crucially significant in determining children’s adult outcomes because of their importance in children’s development before age 5 (‘foundation years’ in the terminology of the review). Consequently, the review argued that supporting parents and their children in these early years through directed government spending should be the priority. Thus, rather than making income transfers to poorer families through the tax credit system, the Field review recommends that consideration should always be given to whether that income would be more effectively spent in improving early years provision of services such as Sure Start[5] in order to improve the outcomes that children from poor families might achieve in their adult lives. Such recommendations represent a clear change in focus.

Any empirical estimation of the relationship between cognitive achievement and poverty has to address the issues of endogeneity of inputs and measurement error. These problems have often been raised when trying to estimate the effect of family income on children’s development; similar issues apply to the analysis of poverty and children’s development. The SEM estimation approach used in our paper explicitly addresses both of these issues. Firstly, we are able to separate out the effects of family income and background. In this instance, we examine the relative importance of <u>both</u> family background (including parenting, and opportunities for learning and development) and income poverty – especially the persistence of poverty – for children’s early cognitive development. Secondly, we model key variables such as children’s cognitive ability as latent constructs. A fuller description of our methodological approach is provided in section 3.4. As far as we are aware, this is the first paper to systematically and robustly examine the impact of persistent poverty on young children’s cognitive development in contemporary Britain. We show that children born into poverty have significantly lower test scores at ages 3, 5 and 7, and that continually living in poverty in their early years has a cumulative negative impact on their cognitive development. This result is robust to the ‘quality’ of parenting and family background, etc. It therefore suggests that income poverty remains important for children’s development and cannot be mitigated completely by the better provision of parenting support services.

The remainder of this paper is organised as follows. In the next section, we briefly review the relevant literature on cognitive development, family background and poverty. Section 3 describes the data and the tests that are used to measure children’s cognitive development, together with the methodology we employ to measure persistent poverty and to link child poverty with cognitive development. Section 4 presents our main results, and section 5 draws some conclusions and implications.

2. Background literature

Feinstein (2003) examined the impact of parents' socio-economic status (SES) on the cognitive development of children in the BCS70 (i.e. born in 1970). The BCS70 children were assessed at 22 months, 42 months, 5 years and 10 years (and subsequently followed up at age 26). Feinstein is able to exploit information on test scores for 1,292 children in his analysis[6]. Pre-school educational inequality is both persistent and pervasive, and is heavily influence by family background. He showed that the children of high SES parents who scored poorly in the early tests had a tendency to catch up, and indeed surpass, the cognitive attainment of children who did well in the early tests but were born to low SES parents. In contrast, the children of low SES parents who scored poorly in the initial tests were unlikely to ever overcome these initial disadvantages. One criticism of his research is that it may be reflecting, at least partially, 'regression to the mean'. But even in their careful reassessment of Feinstein's work, Jerrim and Vignoles (2011) clearly corroborate his central finding that children from more advantaged backgrounds have much better cognitive skills development.

Our paper has a number of parallels with Feinstein's study in that we are also interested in the impact of family background on children's early cognitive development, although our focus is on poverty and the persistence of poverty rather than differences over time by social status. Moreover, we have the advantage that we have considerably more children in the MCS, and hence can potentially examine different sub-groups within the population[7]. Furthermore, unlike the BCS70, our sample also includes children in one parent families. This is important for our analysis of the impact of poverty on cognitive development, since we know that children of one parent families are considerably more likely to be in poverty than those in two parent families (for example HBAI, 2010). Finally, of course, the BCS70 children were born more than 40 years ago.

Gregg and Macmillan (2009) examine the impact of parental income on children's education and test scores using various UK cohort studies: the 1958 National Child Development Study (NCDS); BCS70; three separate cohorts constructed from the British Household Panel Survey (BHPS, for children born in the late 1970s, early 1980s, and late 1980s); the Avon Longitudinal Study of Parents and Children (ALSPAC, a Bristol-based birth cohort of children born in 1991-92); and the Longitudinal Study of Young People in England (LSYPE, a national sample of children born in England in 1989-90). They consistently find that children born into poorer families have a lifelong disadvantage. However, the youngest children for which they have test score information are aged 7.

Goodman and Gregg (2010) utilise the second and the third sweeps of the MCS (ages 3 and 5). The focus of their work is on explaining the rich-poor gap in the cognitive ability of children by analysing the influence of aspirations and behaviour of parents on the educational outcomes of their children. However they do not take into account the persistence of poverty in documenting or explaining the existence of the gap in ability. Blanden and Machin (2010) also utilise the second and the third sweeps of the MCS. The focus of their work is on examining the connection between parental income and child's vocabulary and behaviour. Consistent with the previous literature, their findings also suggest that better child outcomes (vocabulary development and behaviour) are associated with wealthier parents. For example, children from families in the top quintile in terms of income are more than one year ahead in vocabulary development at age 5 as compared to children from the bottom quintile. For the US, Cunha and Heckman (2007) find similar gaps in vocabulary and maths development of children by the age of 5 when making comparisons across quartiles of parents' 'permanent income'.

None of the studies cited above examine the impact of persistent poverty. In contrast, Schoon et al. (2010) use the MCS data to look at the impact of persistent financial hardship (measured as the family being in receipt of state benefits) on the cognitive and behavioural development of children at age 5. Their findings suggest that persistent financial hardship has a large and negative impact on children's cognitive development, while the impact on children's behavioural adjustment is rather less. Further, this negative impact is mitigated by the 'protective factors in the family environment'. In a related paper using the same data, Schoon et al. (2011) examine the impact of persistent (income) poverty and 'family instability' (defined as changes in mothers' relationship status: married, cohabitating, or single) on children's cognitive ability. The results from this paper confirm their earlier findings and further illustrate that, after controlling for poverty, family instability has no significant association with the cognitive development of children.

Kiernan and Mensah (2009) also use the MCS data to investigate the impact of persistent poverty, maternal depression, and 'family status' (defined as mothers' relationship status) on the cognitive and behavioural development of children at age 3. Their findings also suggest that poverty has a negative impact on the development of children and, once poverty is taken into account, the effects of both maternal depression and family status are weak. In a related paper Kiernan and Mensah (2011) look at the impact of parenting and persistent poverty on cognitive development of children at age 5. Their findings echo those of Schoon et al. (2011): the negative impact of persistent poverty is mitigated by positive parenting.

Our paper is different from Schoon et al. (2010, 2011) and Kiernan and Mensah (2009, 2011) in number of important aspects. First, we address the issues of endogeneity of inputs and of measurement errors, which these papers do not. Second, we consider a longer time horizon by examining children's development at ages 3, 5 and 7. This gives us an important advantage of modelling the persistence in cognitive development, and also allows us to include a period when the children have been attending school. Third, we explicitly model the parental investment in children; what Schoon et al. (2010) refer to as the 'protective factors', and Kiernan and Mensah (2011) refer to as the 'index of parenting'. Finally, we utilise more robust measures of 'persistent poverty'[8].

Barnes et al. (2010) also examine the impact of persistent poverty (defined as being in poverty for at least 3 of the 4 annual interviews of the *Growing up in Scotland* study) on young children in Scotland. They note that poverty is multi-dimensioned and that many, if not most, of its effects can be captured through correlated characteristics such as low parental education, poor health, etc. Indeed, low income is not statistically significantly correlated with child outcomes (such as being overweight, poor language, social and emotional development, etc.) once all of these other family and various area factors are taken into account. Of course, this does not mean that income is not important for child outcomes, but rather that its impact is indirect, through its effect on other factors which are correlated with outcomes. In our analysis, we are able to capture and distinguish between both the direct and the indirect impact of income poverty.

Our brief review of the literature suggests that the impact of the persistence of poverty remains a largely unexplored aspect of the importance of family background and other characteristics on children's cognitive development and educational attainment. Our paper is a contribution towards an investigation of this important issue.

3. Data and measurement

The UK Millennium Cohort Study (MCS) is following a large sample of around 19,000 babies born in 2000-01. The first sweep (MCS1) took place in 2001-02 when these babies were around 9 months old, and recorded details of their family background, parents, mothers' pregnancy and birth, and the early months of their lives. The second sweep (MCS2) took place when the children were around 3 years old, while the third sweep (MCS3) was administered when the children had reached age 5 and had started school. Finally, the fourth sweep (MCS4) was undertaken in 2008 when the children were on average 7 years old[9]. Information is gathered in face-to-face interviews on a wide range of socio-economic and demographic characteristics about the child, their family (parents and grandparents), parenting activities, cognitive assessment, and, latterly, early education. The survey has a clustered stratified design (oversampling ethnic minorities, and areas with high child poverty for example) and hence appropriate statistical techniques and sampling weights need to be employed in order to generate statistics which are relevant to the population as a whole. We use all of the first four sweeps of the MCS[10].

3.1 Measuring child poverty

Poverty incidence

We compute three different measures of the incidence of child poverty. Poverty rate (1) is the poverty measure recorded in the MCS data. This is set at a level of equivalised household income less than 60 per cent of the median household income, where income is equivalised according to the OECD equivalence scale. Poverty rate (2) has been calculated from the banded income information recorded in the MCS. First, households are assigned an income equal to the mid-point of the income band that they select at each sweep[11]. This is then equivalised using information on their household composition to derive an OECD equivalence scale measure. A household is then designated to be in poverty if their equivalised income is less than 60 per cent of the contemporary median household income threshold derived from the relevant HBAI/FRS (source: Joyce et al., 2010). Poverty rate (3) has been calculated similarly to poverty rate (2), with the exception that the poverty line used is 60 per cent of the median of the equivalised income of the households in the MCS i.e. measured relative to families within the MCS cohort (and thus families with at least one young child) rather than for all households as in the HBAI/FRS.

Persistent poverty

There are three papers which propose alternative measures of persistent poverty: Foster (2009), Bossert et al. (2008) and Dutta et al. (2011). All three propose variants on a similar basic metric. The persistent poverty measure at time *T*, PPM_T , can be expressed as:

$$PPM_T = \frac{1}{T}\sum_{t=1}^{T}\omega_t P_t \qquad (1)$$

i.e. as a weighted average of all past poverty episodes, where P_t is the poverty indicator for time period *t* defined as:

$$P_t = \begin{cases} 1 & \text{if } y_t < z_t \\ 0 & \text{if } y_t \geq z_t \end{cases} \qquad (2)$$

y_t is income, z_t is the poverty line/threshold and ω_t is the weight given to being in poverty at time t. The three papers only differ in the assumptions they make about ω_t.

Foster (2009) sets $\omega_t = 1 \;\forall\; t = 1,...,T$, and thus his measure of persistent poverty is simply the proportion of periods that an individual has been in poverty over the time horizon T, irrespective of the timing of those episodes of poverty. Bossert et al. (2008) set $\omega_t = m_t$, where m_t is the number of consecutive episodes of being in poverty, including period t. This measure allows for the 'bunching' effect of poverty i.e. if poverty states occur together, then they may have a bigger impact than if the poverty states are interrupted by periods of relative affluence. Finally, Dutta et al. (2011) set $\omega_t = (1+n_t)^{-\beta}$, where n_t is the number of consecutive non-poor episodes (i.e. periods of (relative) affluence) prior to period t; and $\beta \geq 0$ is a parameter of choice, which depends on how much the planner/researcher wants to discount the impact of episodes in poverty. This measure allows for the bunching effect of periods of affluence i.e. it allows the periods of affluence to mitigate the effect of poverty. If an individual has had a longer spell of affluence before a given poverty state then s/he is less impacted by being in poverty relative to the person with a shorter prior spell of affluence.

In this paper, we choose a weighted average of the Bossert et al. (2008) and the Dutta et al. (2011) persistent poverty measures. We define the weights, ω_t, as:

$$\omega_t = \alpha m_t + (1-\alpha)(1+n_t)^{-\beta} \tag{3}$$

This allows us to combine the separate impacts of the bunching effect of multiple spells of poverty and also of the periods of affluence. For longer time horizons (T), when the number of different potential poverty profiles increases[12], the weights we propose are able to differentiate more finely between the larger numbers of profiles. Specifically, in the empirical application we set $\alpha = 0.5$ and $\beta = 1$[13]. We also remove the T^{-1} averaging to ensure that our persistent poverty metric retains 'time monotonicity' as a property (Mendola et al., 2011).

3.2 Cognitive test scores

The MCS records a number of standard tests of cognitive development. In each case, these are age-appropriate tests administered to the children themselves. We focus on the children's performance across all of these tests since they each reflect different cognitive abilities and educational concepts and performance. There are two tests in MCS2 (age 3), and three in each of MCS3 (age 5) and MCS4 (age 7). These tests are described briefly below.[14]

The British Ability Scales (BAS) are a set of standard age-appropriate individually-administered tests of cognitive abilities and educational achievements suitable for use with young children – see Elliott et al. (1996, 1997) for further information. Six different BAS tests have been administered across the MCS sweeps. The BAS Naming Vocabulary test (BAS-NV) is a verbal scale which assesses spoken vocabulary. The children are shown a series of coloured pictures of objects one at a time which they are asked to name. The scale measures the children's expressive language ability. The raw scores are then adjusted using a set of standard adjustment tables to take account of the age of the child and the difficulty of the item set administered. This test was administered in MCS2 and MCS3. In the BAS Pattern Construction test (BAS-PC), the child constructs a design by putting together flat squares or solid cubes with black and yellow patterns on each side. The child's score is based on both speed and accuracy in the task. Once again, the raw scores are adjusted for age and the difficulty of the test with reference to a set of standard tables. This test was administered in MCS3 and again in MCS4. The BAS Picture Similarity test (BAS-PS) was administered in MCS3. This test assesses pictorial reasoning. Finally, in the BAS Word Reading test (BAS-WR), the child reads aloud a series of words presented on a card. This was administered in MCS4 (age 7).

In addition to the six BAS-based tests, two further tests were administered. First, the Bracken School Readiness Assessment (BSRA) is used to assess the conceptual development of young children across a wide range of categories, each in separate subtests – see Bracken (2002). MCS2 employs six of the subtests that specifically evaluate: colours; letters; numbers/counting; sizes; comparisons; and shapes. The BSRA test result used is a composite score based on the total number of correct answers across all six subtests. Second, in MCS4, children's numerical and analytical skills are assessed using a variant of the National Foundation for Educational Research (NFER) standard Progress in Maths (PiM) test in which a range of tasks covering number, shape, space, measures and data are assessed.

For each of the tests, we use the age-standardised versions[15] where appropriate, and construct the child's percentile ranking across all children in the MCS who complete the test to take account of differences in scale and dispersion between the tests. The percentile rankings record on a scale of 0 to 100 the percentage of children in the sample completing the test who are ranked at or above the child's score. Thus a child's ranking of 90 on a particular test indicates that 90 per cent of children scored lower in the test and the child is in the top 10 per cent of the specific test score distribution. Percentile rankings also provide a convenient and informative metric against which to record the influence of poverty on the different cognitive skills assessed in each of the tests.

3.3 Independent variables

There is considerable evidence in the literature that children's cognitive test scores are influenced by the background characteristics of the child, parental investment and parenting style (Field, 2010; Ermisch, 2008; Kiernan and Huerta, 2008; Kiernan and Mensah, 2011; Schoon et al., 2010). Thus, the independent variables that we consider capture a range of family and other background characteristics which impact on children's cognitive development. These additional variables can be divided into three categories: background characteristics, parental investment, and parenting style. The respondent is the main carer of the child, which in the majority of cases is the mother[16].

Background characteristics:

The background characteristics include:

- the child's age
- birth weight
- ethnicity (6 categories)
- mother's education (6 categories)
- mother's work status (=1 if working)
- housing tenure (=1 if renting from local authority or Housing Association)
- mother's score on the Kessler (K6) psychological distress scale.

The Kessler et al. (2002, 2010) scale is a measure of psychological distress and ranges from 0 to 24, with a score of 12 or more considered as ‘high risk’.

Parental investment:

These variables capture the parental investment in the active learning of the child. They include:

- how often the child is read to (5 categories from ‘never’ to ‘every day’)
- how often the child paints or draws at home (5 categories)
- how often the child is helped with reading (5 categories)
- how often the child is helped with writing (5 categories)
- how often the child visits the library (3 categories
- how often the child is helped with maths (5 categories).

In addition, fathers are also asked how often they read to their child (5 categories).

Parenting style:

These variables record the different ways that parents regulate their child’s behaviour and their relationship with the child. They include:

- whether the child has a regular bedtime
- how much TV the child watches
- whether the parents smack or shout at the child if they are being naughty (3 categories).

Finally, in MCS2, the Pianta parenting scale (Pianta, 1995) is used to capture the mother-child relationship. This has 7 positive (PPS) items (such as ‘I share an affectionate, warm relationship with the child’) and 8 negative (NPS) parenting items (such as ‘the child is sneaky or manipulative with me’). For each item, the mother responds on a five point scale from ‘definitely does not apply’ to ‘definitely applies’.

3.4 Estimation Methodology

We employ two different empirical methodologies to understand the link between poverty and cognitive development. Within each approach, we examine two different specifications. In the first specification, we correlate the children's test scores with our measures of poverty using only age as a control variable (since there is evidence that the performance on the tests differs significantly by the age of the child, despite the test scores being normalised for age). In the second specification, we include the additional independent variables as described in the previous sub-section since these have been found in the literature to have an important influence on children's cognitive development (e.g. Cunha and Heckman, 2008).

Seemingly unrelated regressions estimation (SURE)

For the first methodological approach, the measures of cognitive ability as reflected in the individual test scores are regressed on the indicators capturing the incidence of poverty, past and present. We estimate the resulting models by SURE (Zellner, 1962) so that unobserved influences on test scores are allowed to be correlated across tests. More specifically, we estimate a system of equations for the cognitive test rankings as follows:

$$Y = \alpha + \beta_1 X + \beta_2 PI + \epsilon \qquad (4)$$

where Y' = {BSRA(3), BAS-NV(3), BAS-PS(5), BAS-PC(5), BAS-NV(5), BAS-WR(7), BAS-PC(7), PiM(7)} is an (8 × 1) vector of the different test scores, across ages 3, 5 and 7 (as indicated in parentheses); X is a matrix of the (sweep-specific) background characteristics including the poverty measures; *PI* is a matrix of parental investment and parenting style indicators; α, β_1, and β_2 are parameter vectors to be estimated; and ϵ is the (8 × 1) vector of error terms, assumed to be uncorrelated across observations but correlated across tests.

We estimate a SURE model to allow our results to be interpreted in the context of the previous UK literature (Feinstein, 2003; Gregg and Macmillan, 2009; Goodman and Gregg, 2010; and Blanden and Machin, 2010). However the SURE model and other reduced-form regression-based approaches have been criticised (Cunha and Heckman, 2008; Jerrim and Vignoles, 2011), specifically on the grounds of endogeneity of inputs and measurement error.

First is the issue of endogeneity of inputs (see Todd and Wolpin, 2003, 2007, for details). It is common to find that low family income and low parental investment co-exist. Children from low income families (and thus families potentially in poverty) also have, on average, low parental investment (Mayer, 1997; Dahl and Lochner, 2008). This makes identification of the separate effects of income (or poverty) and parental investment difficult. Low income (or poverty) is associated with increased levels of stress and poor parental health, which in turn influence investments that parents make (or do not make) in their children (McLoyd, 1990). This problem becomes acute mainly because of a lack of data on parenting inputs. "*A proper measure of disadvantage would account for parenting inputs, but data on parenting are limited. The traditional focus on family income as a source of childhood disadvantage is probably misleading.*" Heckman (2008, pp. 317).

The solutions that exist in the literature to solve the problem of endogeneity are typically based on the instrumental variable approach. For example, Dahl and Lochner (2008), in the absence of any data on parenting inputs, use the changes in the Earned Income Tax Credit to identify the causal effect of income on children's achievements. However, this approach also has its criticisms because of lack of consensus on what constitutes an appropriate instrument. Another approach

(Cunha and Heckman, 2008) is the use of Structural Equation Modelling (SEM). In the presence of detailed data on parenting input (which we have), using the SEM we can identify: (i) the direct impact of poverty on children's ability, (ii) the direct impact of parenting inputs on children's ability, and (iii) the indirect impact of poverty, via reduced parenting inputs, on children's ability.

Second is the issue of measurement error both in estimating cognitive ability and in measuring the parental investment in the child. Consider first the unobserved (latent) cognitive ability of the child. What we observe are the test scores that are correlated with the latent cognitive ability, but measure it with error. This leads to standard problems econometrically and in interpretation. Cunha and Heckman (2008) discuss the issue in terms of 'measurement error' while Jerrim and Vignoles (2011) focus on the implications in terms of 'regression to the mean'. The basic argument is that the imperfection/randomness in testing means that classifying children as high or low ability on the basis of a single test (and one administered when they are young and therefore when testing is likely to be less than perfect) is liable to be subject to error since getting a relatively high (low) score on a given day is likely to be followed by a less extreme score (i.e. will be lower (higher)) if they were tested on another day. This is the basis of 'measurement error' and 'regression to the mean'. To address this problem we use *multiple* tests at each age to estimate a latent construct that represents the cognitive ability of the child. A similar, though less problematic, issue is the measurement of parental investment in the child. However, we have numerous proxies available in our data which are related to the latent parental investment in the child.

Structural equation modelling (SEM)

Thus, while we present the results from the SURE model, we also use a second methodological approach – SEM. Here we explicitly treat the test scores as imperfect measures of the latent cognitive ability of the child and use the multiple tests at each age to estimate the latent cognitive ability of the child. While the tests might be individually imperfect, they are correlated with the same underlying latent ability, and these multiple measures of the latent cognitive ability serve to mitigate the measurement error problem. The SEM has two components – a structural model and a measurement model. Following Cunha and Heckman (2008), let $\theta = (\theta_3, \theta_5, \theta_7)'$ be the vector of latent cognitive skills of the child at ages 3, 5 and 7; $\lambda = (\lambda_3, \lambda_5, \lambda_7)'$ be the vector of latent parental investment in the child at ages 3, 5 and 7; and X be a (k × 1) matrix of the background characteristics, including the poverty status of the child. The structural model is specified as:

$$\theta = A\theta + B_1 X + B_2\lambda + \eta \quad (5)$$

$$\lambda = B_3 X + \nu \quad (6)$$

where B_1 is (3 × k) parameter matrix associated with X in equation (5) for the latent cognitive development; B_3 is (3 × k) parameter matrix associated with X in equation (6) for the latent parental investment;

$$A = \begin{pmatrix} 0 & 0 & 0 \\ a_{21} & 0 & 0 \\ 0 & a_{32} & 0 \end{pmatrix}; \qquad B_2 = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix}$$

and η and ν are (3 × 1) multivariate normal error terms with zero mean and diagonal covariance matrix.

Let Y_1 be an (8 × 1) vector with the eight different test scores, across the ages 3, 5 and 7, stacked on top of each other; Y_1' = {BSRA(3), BAS-NV(3), BAS-PS(5), BAS-PC(5), BAS-NV(5), BAS-WR(7), BAS-PC(7), PiM(7)}. The measurement model for the latent cognitive skills of the child is then specified as:

$$Y_1 = C_1 + D_1\theta + \varepsilon_1 \tag{7}$$

where C_1 is a (8 × 1) vector of intercepts; ε_1 is a multivariate normal measurement error term, with zero mean and diagonal covariance matrix; and

$$D_1 = \begin{pmatrix} 1 & 0 & 0 \\ d_{21} & 0 & 0 \\ 0 & 1 & 0 \\ 0 & d_{42} & 0 \\ 0 & d_{52} & 0 \\ 0 & 0 & 1 \\ 0 & 0 & d_{73} \\ 0 & 0 & d_{83} \end{pmatrix}.$$

A similar measurement equation is written for the latent parental investment:

$$Y_2 = C_2 + D_2\lambda + \varepsilon_2 \tag{8}$$

where Y_2 is a (32 × 1) vector with all the measures for the latent parental investment and parenting style, across the ages 3, 5 and 7, stacked on top of each other; and C_2 and D_2 are the corresponding matrices. From equation (5) we obtain:

$$\theta = (I - A)^{-1}(B_1X + B_2\lambda + \eta)$$

where I is an indentity matrix, and hence:

$$E[\theta \mid X, \lambda] = (I - A)^{-1}(B_1X + B_2E[\lambda \mid X]) \tag{9}$$

Similarly from equation (6) we obtain:

$$E[\lambda \mid X] = B_3X \tag{10}$$

Combining equation (9) with equation (7) and equation (10) with equation (8) we obtain:

$$E[Y_1 \mid X] = C_1 + D_1E[\theta \mid X, \lambda] = C_1 + D_1(I - A)^{-1}(B_1 + B_2B_3)X$$

$$E[Y_2 \mid X] = C_2 + D_2E[\lambda \mid X] = C_2 + D_2B_3X$$

A diagrammatic representation of the estimated structural model is given in Figure 1. Estimation is performed using Mplus v6.1 (Muthén & Muthén 2010).

There are a number of other important advantages of the SEM approach over and above those mentioned above in dealing with the measurement error in cognitive ability. First, it allows us to utilise more observations. As described in sub-section 3.3, we are using a range of independent variables to capture the impact of background characteristics and parental investment and style.

For example, we use 12 independent variables to measure parental investment in any given year. In SURE, if there is no response on any one of these 12 variables, the observation is necessarily dropped from estimation, even if the other 11 questions were answered. For SEM, however, to identify the *latent* parental investment, then as long as the parent has answered at least two of the 12 questions, the observation can still be included in the estimating sample in the SEM approach. Similarly, for identifying the latent cognitive skill – as long as we have scores for the child on at least two of the cognitive tests, the child can be included in the SEM.

A second advantage of the SEM approach is that it allows us to introduce dynamics or persistence in the development of cognitive ability. While the previous measure of latent cognitive ability can reasonably be expected to influence the child's current latent cognitive ability as shown in equation (5), the same cannot be said about the individual specific test scores. By definition, the tests are not repeated as they are age-specific, and thus we cannot include lagged values of tests in the SURE model[17]. However, persistence in cognitive ability can be explicitly incorporated in the SEM approach since it is modelled as a latent variable.

Third, the SEM approach allows us to capture and identify both the direct and the indirect effects of poverty on cognitive development. The direct effects are simply how poverty affects cognitive development, while the indirect effects capture how poverty affects parental investment and parenting style, which in turn impact upon cognitive development. Equation (5) gives us the direct impact of the exogenous variables (including poverty) on cognitive skills while equation (6) gives us the direct impact of exogenous variables on parental investment. Equations (5) and (6) together give us the indirect effects of the exogenous variables on cognitive skills through their impact on parental investment. Separately identifying the direct and indirect effects allows us to compute the total effect of each of the exogenous variables on cognitive skills development.

4. Results

4.1 Episodic and persistent poverty

Table 1 reports the episodic incidence of child poverty in the MCS data according to the three measures described in sub-section 3.1. While there is some variation, the correlations between the three measures of poverty incidence are very high – essentially, the same households are designated to be in poverty on all three measures. The subsequent analysis presented below uses poverty rate (1) throughout, but none of the findings are sensitive to which of the three measures is used[18].

Table 2 presents the individual poverty profiles, together with our measure of persistent poverty and the proportion of children who experience each poverty profile. The interpretation is as follows. For $T = 2$, there are 4 different poverty profiles: PS = 00 indicates no episodes of poverty while PS = 01 indicates that the child was not in poverty in the first sweep but was in poverty in the second sweep etc. Analogously, for $T = 4$, there are 16 different poverty profiles, and PS = 1111 denotes being in poverty in all four sweeps. PPM is the persistent poverty measure using weights, ω_t, which are a convex combination of the Dutta et al. (2011) and the Bossert et al. (2008) measures of persistent poverty. The key properties of our measure are that not only will a higher number of episodes of poverty increase the measure, but that the earlier the episodes of poverty, the higher is the measure. Compare, for example, for $T = 4$, PS = 1100 (row 11) which has a PPM of 2.500 with PS = 0011 (row 9) which has a PPM score of 2.167. Finally, PPP is the prevalence of persistent poverty, calculated using poverty rate (1). As can been seen, (100-64=) 36 per cent of all children have experienced at least one spell of relative poverty by the time they are aged 7. This is higher than the 29 per cent of children who are in poverty at age 7 (Table 1).

The correlations between the eight test scores are shown in Table 3. As can be seen, children's performance on each of the tests is positively correlated with their ranking on other tests. Moreover, the tests would appear to capture different dimensions of cognitive development: for example, the highest correlation in the ranking for BAS-PC(7) is the equivalent test taken two years earlier, BAS-PC(5), rather than with any other test administered at age 7.

Figure 2 shows the average test score according to the poverty status of the household at the time the test was taken. As can be clearly seen, the average test scores for the non-poor children are significantly higher than the average scores for the children in poverty across all tests in all years. This finding is consistent with the previous literature in this area. Figure 3 shows the average scores for the two extreme poverty profiles: children who have never been in poverty and those who have been in poverty at each sweep. The differences are larger here than in Figure 2 and this is *prima facie* evidence to suggest that there may be cumulative effects from poverty persistence on cognitive test score outcomes.

There may be a number of possible explanations for the differences observed in the raw data. For example, even though the test scores are age-adjusted (within 3-month age bands), children's cognitive development is extremely rapid in their early years, and the tests are not administered to all children at exactly the same age. Hence the age of the child when tested can impact significantly on the test score outcome. Also, as suggested by the previous literature and the Field (2010) review, the background characteristics of the child, parental investment and parenting style may also influence the test scores. Our two modelling approaches directly address these various issues.

4.2 Child poverty and cognitive development

The results from the SURE estimation approach are presented in Tables 4 and 5 for episodic and persistent poverty respectively. In each table, Panel A includes only the poverty measure (and the child's age) while Panel B includes all of the control variables. Table 4 reveals that the coefficients on all of the episodic poverty dummies – past and present – up until age 5 (MCS3) are significantly negatively correlated with test score rankings. Thus for children who have any experience of poverty in their early years, their cognitive development test scores will be lower. It is interesting to note that not only does the incidence of poverty matter for their test scores, so too does the timing of the poverty episodes. In general, the most recent and/or current episode of poverty has the least impact. Indeed, by age 7, the impact of contemporaneous poverty (P4) is small and insignificantly different from zero once any earlier episodes of poverty are taken into account. In contrast, being born into poverty (P1) has the biggest impact on the child's subsequent cognitive development. However, a single episode of poverty, even if it is preceded and followed by non-poverty states still leaves a significant impact on test scores. The magnitudes of these effects are large. For example, *ceteris paribus*, a child age 3 who has been in poverty since birth can be expected to be (10.2+10.8=) 21 ranks lower on the BAS-NV than a child who has experienced no episodes of poverty.

Panel B of Table 4 presents the results when all of the control variables are included[19]. Even after controlling for all of the background characteristics, parental investment and parenting style, a child age 3 who has been in poverty since birth can still be expected to be 10.5 percentile ranks lower on BAS-NV than a child who has experienced no episodes of poverty. The control variables tend to have their anticipated effects. For example, a mother's education has the expected positive impact on the child's cognitive development. A child born to a mother with degree level qualifications or equivalent can be expected to perform around 10 percentile ranks higher (depending on the test) as compared to a child of a mother with no or only few qualifications, consistent with the previous literature in this area. This intergenerational advantage appears at a very early age, and seems to remain high over the early years. The order of magnitude of the advantage for the different tests is variable, however, and is particularly strong in the naming vocabulary tests in the early years.

For the other control variables, mother's employment has a very small positive but insignificant impact on the child's test scores at all ages; maternal depression has negative, though largely insignificant, impact on child's cognitive development; and renting from the local authority or Housing Association is negatively correlated with test performance. 'Positive' parenting activities like reading to the child, taking the child to the library, etc, where significant, have a positive impact on a child's development. Similarly, 'negative' parenting variables such as excessive TV watching, smacking and shouting at the child, where significant, tend to have a negative impact[20]. However, the magnitudes of all of these effects are much smaller than the impact of poverty and mother's education on test scores.

As seen in Table 2, as the number of time periods *T* increases, the potential number of different poverty profiles increases. In order to capture and evaluate the impact of the persistence of poverty on children's cognitive development, Table 5 reports the results when we use our persistent poverty measure rather than the episodic poverty incidence dummies. Recall that this measure gives greater weight to earlier episodes of poverty in the overall poverty profile, consistent with the pattern observed in Table 4. As shown in Table 5, the coefficient on PPM is significantly negative for all of the cognitive tests at every age. In order to interpret the magnitude of the coefficient on the persistent poverty measure, it is necessary to take into account the possible range of values that the measure can take for each *T*. For example, from Panel A of Table 5, consider a child at age 3, who has always been in poverty (PPM = 2.500). On the BAS-NV test, this child will be (2.500×7.81=) 20 percentile ranks lower than a child who has never been in poverty (PPM = 0.000). Similarly, for a child at age 7 who has always been in poverty (PPM = 7.000), on the BAS-WR test this child will be (7.000×2.97=) 21 percentile ranks lower than a child who has never been in poverty (PPM = 0.000). Panel B of Table 5 gives a summary of the results from the SURE estimation when all of the control variables are included[21]. The coefficients on the control variables are not very different from those in Panel B of Table 4, and while the magnitude of the effect of persistent poverty is reduced, as expected, it still remains large and statistically significantly negative for test performance.

The results from the alternative SEM approach are reported in Tables 6 and 7 for the episodic and persistent poverty measures respectively[22,23]. The results using both poverty measures are similar. First, there is clear persistence with respect to cognitive ability (θ) – previous latent cognitive ability is positively and significantly correlated with current latent cognitive ability. Thus a child developing well at age 3 is also likely to do well at ages 5 and 7, even after controlling for all other factors. In Table 6, a 1 standard deviation (SD) higher latent cognitive ability at age 3 is associated with a 0.683 SD higher latent cognitive ability at age 5; this is equivalent to 20 percentile ranks. Similarly a 1 SD higher latent ability at age 5 is associated with a 0.877 SD higher latent ability at age 7; equivalent to 26 percentile ranks. The results using the persistence of poverty measure, PPM, in Table 7 are numerically very similar.

Second, Table 6 also reveals that at age 3, latent parental investment (λ) has a positive and significant impact on a child's latent cognitive ability. If parental investment increases by 1 standard deviation (SD), then the child's cognitive ability would increase by 0.408 SD, equivalent to an increase of 12 percentile ranks. However, this effect is reduced as we move from age 3 to age 5 and, somewhat perversely, appears to be negative at age 7. One possible explanation is that the latent parental investment, which is correlated across time, is already embodied in the child's latent cognitive ability at age 5 since this has such a large impact on age 7 cognitive ability. Once again, the results in Table 7 using PPM are numerically very similar.

The significance of the poverty dummies is somewhat reduced in the SEM approach in comparison to the SURE results. In Table 6, only 3 (6) of the 9 estimated coefficients are significantly different from zero at the 5 per cent (10 per cent) level, although 7 are negatively signed. For the poverty dummies in Table 6, a child age 3 who has been in poverty since birth can be expected to be (0.177+0.215) = 0.392 SD below the latent cognitive ability score of the child who has never been in poverty. This is equivalent to 11 percentile ranks, similar in magnitude to the findings from the SURE model with full set of controls. However, in Table 7, the PPM measure is not statistically significant at any age. However, this does not imply that poverty is unimportant for children's cognitive development – a more nuanced and detailed analysis of the SEM results is required.

As noted above, one important benefit of the SEM approach is that it allows us to separately identify the direct and indirect effects of poverty on latent cognitive ability. These are presented in Table 8. The interpretation of the table is as follows. Reading down the first column, the total effect of P1 (poverty at birth) on latent cognitive ability at age 3 is -0.252 SD. The direct effect is -0.177 (the coefficient on the poverty dummy in Table 6). However, there is also an indirect effect through the impact of P1 on latent parental investment in the child, λ_3, which then affects the child's cognitive ability. The total effect of P1 on latent cognitive ability is then the sum of the direct and indirect effects. Similarly, the total effect of P2 (poverty at age 3) on latent cognitive ability at age 3 is -0.286 SD. The direct effect is -0.215 (the coefficient on the poverty dummy in Table 6), while the indirect effect is

-0.071. Combining the effects of P1 and P2, the total (direct+indirect) effect of being always in poverty at age 3 is (0.252+0.286=) = 0.538 SDs, equivalent to 15 percentile ranks.

We can perform similar calculations at each age. For example, at age 5, while none of the direct effects of poverty on latent cognitive development are statistically significant, the indirect effects of P1 and P2 are strongly negative. These indirect effects of poverty on cognitive development are manifested through latent parental investment at age 3, λ_3, as well as through poorer cognitive ability at age 3, θ_3, which in turn impacts on cognitive development at age 5 through persistence in cognitive ability. The total effect of being in poverty on latent cognitive development at age 5 is again significantly negative (-0.244-0.112-0.047=) -0.403, although this impact is driven mainly by the indirect effects rather than both the direct and indirect effects as at age 3. Similarly, at age 7, P1, P2 and P3 all have statistically significant negative effects in total, although their direct effects are only weakly significant. Of the total impact of being in poverty on cognitive development, more than half derives from its indirect effects on parental investment and the persistence in cognitive ability. Finally, it is interesting to note that being in poverty in MCS4 has no significant direct or indirect impact on latent cognitive ability at age 7. This finding is also consistent with the SURE results presented earlier.

5. Conclusions

This paper documents the impact of episodic poverty and, in particular, persistent poverty, on the cognitive development of children in their early years. There is a consensus in the literature that family background, parenting skills and income poverty can all have significant effects on children's early cognitive development. Much has been written about the importance of education and cognitive skills for future life trajectories. However, this is the first paper to systematically examine alternative measures of poverty and separate out their respective impacts from parenting investment and style on children's very early cognitive development.

The key findings of this paper suggest that persistent poverty has a larger cumulative negative impact on children's cognitive development than episodic poverty. For children who are persistently in poverty throughout their early years, their cognitive development test scores at age 7 are more than 10 percentile ranks lower than children who have never experienced poverty. This result is robust to the quality of parenting investment and family background. It is also robust to the methodological approach adopted – SURE or SEM – with the latter providing for a richer interpretation while being more resilient to the weaknesses in the regression-based approach.

Using the SEM approach, we document evidence of strong negative indirect effects of poverty and persistent poverty on children's cognitive development. Poverty adversely affects parental investment, which in turn has a negative impact upon cognitive development. Thus it is not simply that poverty somehow adversely affects children's cognitive development, but rather that low income does not facilitate good parenting investment. There is also evidence of strong persistence in cognitive development, so any detrimental impact of poverty on cognitive development has a lasting legacy effect well beyond the episodic incidence of poverty. Poverty at birth and at age 3 can still have an adverse impact on cognitive ability at age 7. Interestingly, poverty at age 7 appears to have neither direct nor indirect effects on cognitive development at age 7. One interpretation is that the importance of the child's early years' development, coupled with the strong persistence in cognitive ability, dominates the impact of the episodic incidence of poverty at this age[24].

Those who would argue that the quality of parenting skills and investment are more important for children's development than income may draw some encouragement from the results in this paper. It is clear that parenting investment and parenting style do indeed impact significantly on children's cognitive ability, controlling for income, and that the measured impact of low income is apparently lessened once a sufficiently large set of control variables are included. However, such a conclusion would disregard the importance of having low income for parenting investment. As shown in this paper, the indirect effect of low income on cognitive development through its impact on parenting investment is very important. Moreover, poverty is seen to still have a direct effect on cognitive development, controlling for parenting investment, especially if the household is in poverty at birth and/or age 3. Together with the strong persistence in cognitive ability, poverty at birth and/or age 3 can therefore seriously impact on children's development by the time they enter school, and thus, as seen in the previous literature, well into their adult lives. This suggests that policy targeted at poverty alleviation should be directed at these very early years.

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Table 1: Poverty incidence

Sweep	MCS1 2001-2	MCS2 2004-5	MCS3 2006	MCS4 2008
Average age of the child	9 months	3 years	5 years	7 years
Poverty rate (1)	27.9%	28.9%	30.4%	29.1%
Sample size	*15,352*	*13,198*	*13,802*	*14,023*
Poverty rate (2)	29.2%	32.4%	28.6%	39.3%
HBAI/FRS base year	2001-2	2004-5	2005-6	2007-8
Sample size	*17,185*	*13,306*	*12,384*	*13,973*
Poverty rate (3)	26.2%	26.2%	23.2%	29.6%
Sample size	*17,185*	*13,306*	*12,384*	*13,973*

Notes to Table 1:

1. Poverty rate (1) is based on the poverty indicators provided by the MCS. The threshold is household equivalised income less than 60 per cent of median household income where income is equivalised according to the OECD equivalence scale. Note that these rates differ very slightly from the rates reported in Hansen et al. (2010, p. 285), which are poverty rates for households not children, as they are here.

2. Poverty rate (2) has been calculated by the authors from the income information recorded in the MCS. This is then equivalised using the OECD equivalence scale computed from their household demographics as recorded in the MCS, and a household is designated to be in poverty if their equivalised income is less than 60 per cent of the contemporary median BHC household income (source: Joyce et al., 2010, based on HBAI/FRS).

3. Poverty rate (3) has been calculated similarly to Poverty rate (2) with the exception that the poverty line used here is 60 per cent of the median of the equivalised income of the MCS sample itself.

4. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 2: The prevalence of persistent poverty

Row	Time horizon $T=2$ PS	PPM	PPP	Time horizon $T=3$ PS	PPM	PPP	Time horizon $T=4$ PS	PPM	PPP
1	00	0.000	68.6%	000	0.000	65.2%	0000	0.000	64.0%
2	01	0.750	8.3%	001	0.667	5.2%	0001	0.625	2.9%
3	10	1.000	7.3%	010	0.750	4.4%	0010	0.667	3.5%
4	11	2.500	15.9%	100	1.000	4.5%	0100	0.750	3.4%
5				101	1.750	2.4%	1000	1.000	3.8%
6				011	2.250	3.8%	0101	1.500	0.8%
7				110	2.500	3.1%	1001	1.667	0.6%
8				111	4.500	11.4%	1010	1.750	1.1%
9							0011	2.167	1.6%
10							0110	2.250	1.4%
11							1100	2.500	1.8%
12							1011	3.250	1.2%
13							1101	3.250	1.2%
14							0111	4.250	2.2%
15							1110	4.500	2.3%
16							1111	7.000	8.2%
			100.0%			100.0%			100.0%
	Sample size: 11,854			Sample size: 9,897			Sample size: 8,886		

Notes to Table 2:

1. PS is the poverty profile or status. The digits describe the poverty status in each sweep, so that, for example, 001 represents individuals who were not in poverty in MCS1 nor in MCS2 but are in poverty in MCS3 – see text for details.
2. PPM is our index or measure of persistent poverty. This measure uses weights which are a convex combination of the Dutta et al. (2011) and the Bossert et al. (2008) measures of persistent poverty – see text for details.
3. PPP is prevalence of persistent poverty (i.e. the proportion of the sample in each poverty state) calculated using the poverty rate (1) measure reported in Table 1.
4. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 3: Cognitive assessment scores

	Test	MCS2: age 3		MCS3: age 5			MCS4: age 7		
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
		BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
1	BSRA(3)	1.000 *(14,039)*							
2	BAS-NV(3)	0.574 *(13,753)*	1.000 *(14,776)*						
3	BAS-PS(5)	0.259 *(12,381)*	0.212 *(13,014)*	1.000 *(15,157)*					
4	BAS-NV(5)	0.500 *(12,398)*	0.515 *(13,033)*	0.303 *(15,130)*	1.000 *(15,168)*				
5	BAS-PC(5)	0.328 *(12,360)*	0.255 *(12,993)*	0.330 *(15,074)*	0.327 *(15,103)*	1.000 *(15,110)*			
6	BAS-WR(7)	0.435 *(11,204)*	0.303 *(11,756)*	0.227 *(12,848)*	0.362 *(12,861)*	0.323 *(12,830)*	1.000 *(13,590)*		
7	BAS-PC(7)	0.331 *(11,315)*	0.260 *(11,873)*	0.313 *(12,958)*	0.306 *(12,971)*	0.554 *(12,943)*	0.318 *(13,483)*	1.000 *(13,702)*	
8	PiM(7)	0.376 *(11,359)*	0.277 *(11,915)*	0.313 *(13,009)*	0.373 *(13,022)*	0.392 *(12,992)*	0.499 *(13,554)*	0.474 *(13,651)*	1.000 *(13,755)*

Notes to Table 3:

1. The tests scores are:

   BSRA(3) – percentile rank Bracken School Readiness Assessment, age 3

   BAS-NV(3) – percentile rank BAS naming vocabulary, age 3

   BAS-PS(5) – percentile rank BAS picture similarity, age 5

   BAS-NV(5) – percentile rank BAS naming vocabulary, age 5

   BAS-PC(5) – percentile rank BAS pattern construction, age 5

   BAS-WR(7) – percentile rank BAS word reading, age 7

   BAS-PC(7) – percentile rank BAS pattern construction, age 7

   PiM(7) – percentile rank Progress in Maths, age 7

2. Correlations are (weighted) pairwise Pearsonian correlations between the percentile ranking on each test. The number of observations is given in parentheses for each correlation.
3. All correlations are statistically significantly different from zero at the p = 0.01 level.
4. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 4: Cognitive development and the incidence of poverty

PANEL A	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
P1	-11.68***	-10.20***	-5.77***	-10.03***	-6.70***	-9.64***	-7.44***	-7.43***
	(0.91)	*(0.92)*	*(0.99)*	*(0.92)*	*(0.99)*	*(0.98)*	*(1.01)*	*(0.97)*
P2	-13.43***	-10.84***	-2.79**	-10.05***	-4.98***	-8.19***	-5.99***	-7.08***
	(0.89)	*(0.90)*	*(1.02)*	*(0.94)*	*(1.01)*	*(1.01)*	*(1.04)*	*(1.01)*
P3			-2.04*	-1.65*	-2.20*	-1.96*	-2.69**	-3.54***
			(0.95)	*(0.79)*	*(0.93)*	*(0.94)*	*(0.99)*	*(0.95)*
P4						-1.25	0.28	0.34
						(0.92)	*(0.87)*	*(0.89)*
Controls	No	No	No	No	No	No	No	No
Constant	23.67***	36.16***	74.74***	73.53***	146.92***	107.25***	24.55**	-70.35***
	(4.52)	*(4.75)*	*(6.52)*	*(5.47)*	*(6.14)*	*(8.29)*	*(8.49)*	*(8.27)*

PANEL B	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
P1	-4.84***	-5.46***	-4.61**	-3.68*	-1.32	-5.20***	-2.98	-3.13*
	(1.40)	*(1.47)*	*(1.60)*	*(1.45)*	*(1.58)*	*(1.50)*	*(1.63)*	*(1.53)*
P2	-7.19***	-4.99***	1.02	-5.77***	-3.24*	-6.17***	-3.88*	-5.06**
	(1.42)	*(1.49)*	*(1.65)*	*(1.48)*	*(1.63)*	*(1.53)*	*(1.67)*	*(1.57)*
P3			-2.20	-0.03	-1.26	-3.00*	-1.37	-3.83*
			(1.61)	*(1.35)*	*(1.58)*	*(1.52)*	*(1.67)*	*(1.56)*
P4						-2.07	-0.34	-0.32
						(1.67)	*(1.64)*	*(1.65)*
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Set 2	*Set 2*	*Set 3*	*Set 3*	*Set 3*	*Set 4*	*Set 4*	*Set 4*
Constant	-28.11**	-26.46*	84.59***	53.59***	125.20***	105.48***	7.67	-91.26***
	(10.34)	*(11.03)*	*(10.34)*	*(8.79)*	*(9.76)*	*(12.18)*	*(12.97)*	*(12.36)*

Notes to Table 4:

1. Estimation is by SURE to take into account cross-test correlations in test performance.
2. P1, P2, P3 and P4 denote being in poverty in MCS1, MCS2, MCS3 and MCS4 respectively.
3. Standard errors in parentheses; *** significant at 1%, ** significant at 5%, * significant at 10%.
4. Sample size: *Panel A* 7,681; *Panel B* 3,927.

5. All specifications in *Panel A* and *Panel B* also control for the child's age. The additional controls in *Panel B* are:

   Set 2: child's birth weight (in kilos), ethnicity of the child (5 categories: base category is 'white'), mother's work status, mother's education at sweep 2 (5 categories: base category is 'overseas qualifications' and 'none of these'), Kessler, tenure, read to, paint, reading, library, counting, father read, bedtime, TV, smack, shout, PPS, NPS.

   Set 3: child's birth weight (in kilos); ethnicity of the child (5 categories: base category is 'white'); mother's work status; mother's education at sweep 3 (5 categories: base category is 'overseas qualifications' and 'none of these'), Kessler, tenure, read to, paint, reading, writing, library, counting, father read, bedtime, TV, smack, shout.

   Set 4: child's birth weight (in kilos); ethnicity of the child (5 categories: base category is 'white'); mother's work status; mother's education at sweep 4 (5 categories: base category is 'overseas qualifications' and 'none of these'), Kessler, tenure, read to, paint, reading, writing, library, counting, father read, bedtime, TV, smack, shout.

6. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 5: Cognitive development and the persistence of poverty

PANEL A	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
PPM	-9.36***	-7.81***	-2.18***	-4.68***	-2.78***	-2.97***	-2.17***	-2.53***
	(0.34)	*(0.35)*	*(0.22)*	*(0.21)*	*(0.22)*	*(0.15)*	*(0.15)*	*(0.15)*
Controls	No	No	No	No	No	No	No	No
Constant	24.02***	36.45***	74.80***	73.31***	146.91***	108.43***	25.47**	-69.30***
	(4.53)	*(4.76)*	*(6.53)*	*(5.48)*	*(6.15)*	*(8.32)*	*(8.51)*	*(8.28)*

PANEL B	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
PPM	-4.64***	-3.99***	-1.20*	-2.22***	-0.90	-2.47***	-1.05**	-1.75***
	(0.70)	*(0.74)*	*(0.52)*	*(0.46)*	*(0.50)*	*(0.34)*	*(0.37)*	*(0.35)*
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	set 2	*set 2*	*set 3*	*set 3*	*set 3*	*set 4*	*set 4*	*set 4*
Constant	-28.71**	-26.72*	84.57***	53.28***	124.56***	105.22***	7.27	-91.74***
	(10.34)	*(11.03)*	*(10.34)*	*(8.79)*	*(9.76)*	*(12.19)*	*(12.98)*	*(12.38)*

Notes to Table 5:

1. Estimation is by SURE to take into account any cross-test correlations in performance.
2. PPM is the measure of persistent poverty – see text for details.
3. Standard errors in parentheses; *** significant at 1%, ** significant at 5%, * significant at 10%.
4. Sample size: *Panel A* 7,681; *Panel B* 3,934.
5. All specifications in *Panel A* and *Panel B* also control for the child's age. The additional controls in *Panel B* are:

   Set 2: child's birth weight (in kilos), ethnicity of the child (5 categories: base category is 'white'), mother's work status, mother's education at sweep 2 (5 categories: base category is 'overseas qualifications' and 'none of these'), Kessler, tenure, read to, paint, reading, library, counting, father read, bedtime, TV, smack, shout, PPS, NPS.

   Set 3: child's birth weight (in kilos); ethnicity of the child (5 categories: base category is 'white'); mother's work status; mother's education at sweep 3 (5 categories: base category is 'overseas qualifications' and 'none of these), Kessler, tenure, read to, paint, reading, writing, library, counting, father read, bedtime, TV, smack, shout.

Set 4: child's birth weight (in kilos); ethnicity of the child (5 categories: base category is 'white'); mother's work status; mother's education at sweep 4 (5 categories: base category is 'overseas qualifications' and 'none of these), Kessler, tenure, read to, paint, reading, writing, library, counting, father read, bedtime, TV, smack, shout.

6. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 6: Latent cognitive development and the incidence of poverty

	Latent cognitive development θ					
	MCS2: age 3		MCS3: age 5		MCS4: age 7	
	θ_3		θ_5		θ_7	
	effect	p-value	effect	p-value	effect	p-value
P1	-0.177	0.001	-0.073	0.103	0.015	0.739
P2	-0.215	0.000	0.086	0.102	-0.101	0.042
P3			-0.046	0.447	-0.093	0.061
P4					-0.036	0.502
θ_3			0.683	0.000		
θ_5					0.877	0.000
λ	0.408	0.000	0.088	0.000	-0.183	0.000
Controls	Yes		Yes		Yes	

Notes to Table 6:

1. All the reported coefficients are standardised. For the continuous independent variables, the coefficient represents the change in the dependent variable associated with a one standard deviation (SD) change in the independent variable. For the binary independent variables the coefficient represents the change associated with a shift in the variable from 0 to 1.

2. Sample size: 7,295.

3. The controls are: child's sweep specific age, child's birth weight (in kilos), ethnicity of the child (6 categories: base category is 'white'), mother's sweep specific work status, mother's sweep specific education (6 categories: base category is 'overseas qualifications' and 'none of these'), sweep specific Kessler score, sweep specific housing tenure.

4. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 7: Latent cognitive development and the persistence of poverty

	Latent cognitive development θ					
	MCS2: age 3		MCS3: age 5		MCS4: age 7	
	θ_3		θ_5		θ_7	
	effect	p-value	effect	p-value	effect	p-value
PPM	-0.065	0.237	-0.058	0.554	-0.003	0.965
θ_3			0.674	0.000		
θ_5					0.890	0.000
λ	0.415	0.000	0.087	0.000	-0.186	0.000
Controls	Yes		Yes		Yes	

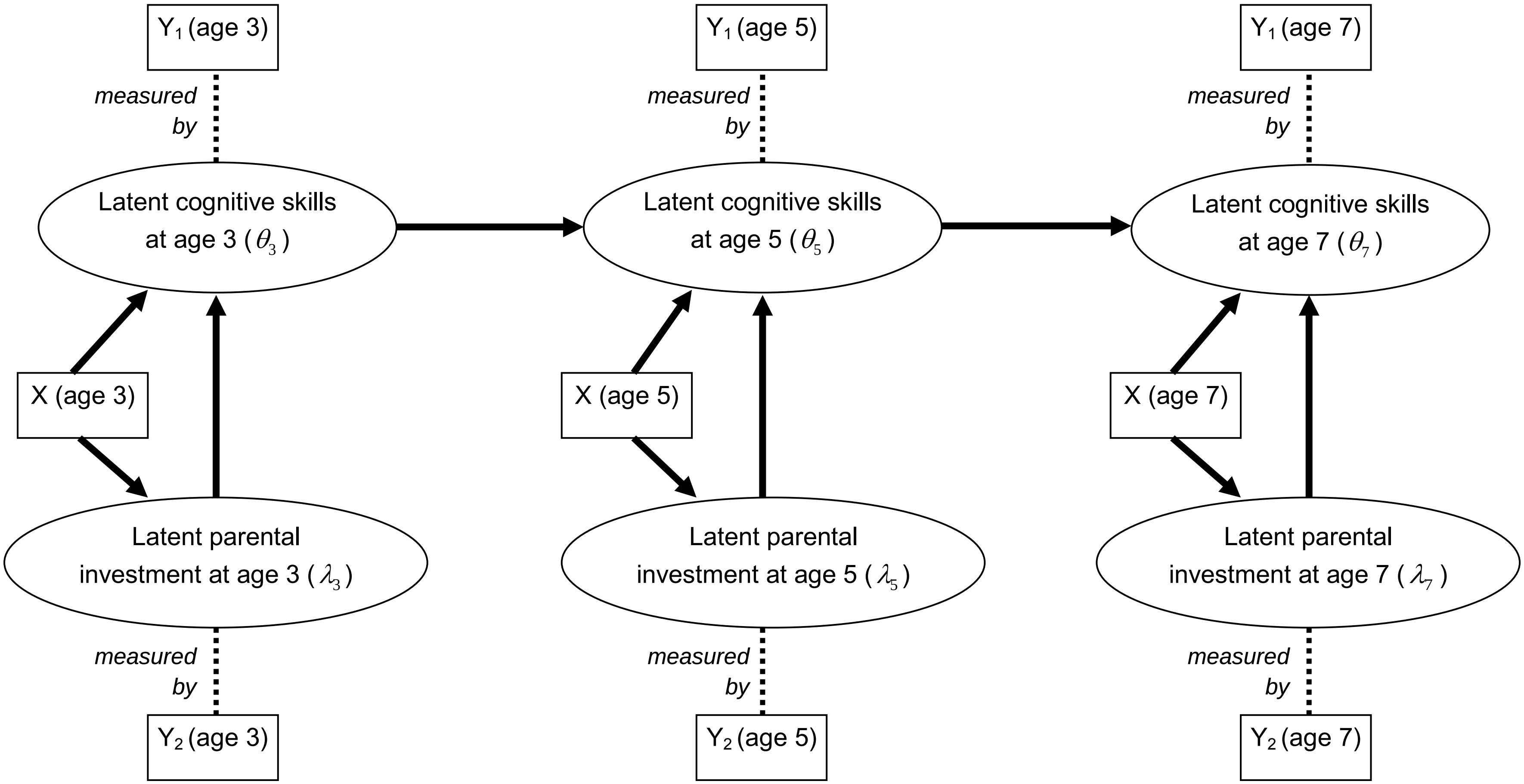
Notes to Table 7:

1. All the reported coefficients are standardised. For the continuous independent variables, the coefficient represents the change in the dependent variable associated with a one standard deviation change in the independent variable. For the binary independent variables the coefficient represents the change associated with a shift in the variable from 0 to 1.
2. Sample size: 7,295.
3. The controls are: child's sweep specific age, child's birth weight (in kilos), ethnicity of the child (6 categories: base category is 'white'), mother's sweep specific work status, mother's sweep specific education (6 categories: base category is 'overseas qualifications' and 'none of these'), sweep specific Kessler score, sweep specific housing tenure.
4. In all reported statistics, the MCS weights that take into account the survey design, non-response bias and attrition over time have been taken into account.

Table 8: Identifying direct and indirect effects of poverty on cognitive development

	Latent cognitive development θ					
	MCS2: age 3		MCS3: age 5		MCS4: age 7	
	θ_3		θ_5		θ_7	
	effect	p-value	effect	p-value	effect	p-value
Effects from P1:						
Total effect on θ	-0.252	0.000	-0.244	0.000	-0.205	0.000
Direct effect on θ	-0.177	0.001	-0.073	0.103	0.015	0.739
Indirect effect on θ	-0.076	0.000	-0.171	0.000	-0.220	0.000
Indirect via λ_3	-0.076	0.000	-0.052	0.001	-0.045	0.000
Indirect via λ_5			0.002	0.691	0.002	0.691
Indirect via λ_7					-0.006	0.543
Indirect via θ_3			-0.121	0.001	-0.106	0.001
Indirect via θ_5					-0.064	0.104
Effects from P2:						
Total effect on θ	-0.286	0.000	-0.112	0.039	-0.196	0.000
Direct effect on θ	-0.215	0.000	0.086	0.102	-0.101	0.042
Indirect effect on θ	-0.071	0.003	-0.198	0.000	-0.095	0.057
Indirect via λ_3	-0.071	0.003	-0.048	0.003	-0.043	0.003
Indirect via λ_5			-0.003	0.527	-0.003	0.525
Indirect via λ_7					0.004	0.735
Indirect via θ_3			-0.147	0.000	-0.129	0.000
Indirect via θ_5					0.076	0.105
Effects from P3:						
Total effect on θ			-0.047	0.437	-0.121	0.024
Direct effect on θ			-0.046	0.447	-0.093	0.061
Indirect effect on θ			-0.001	0.810	-0.029	0.594
Indirect via λ_5			-0.001	0.810	-0.001	0.810
Indirect via λ_7					0.012	0.168
Indirect via θ_5					-0.040	0.448
Effects from P4:						
Total effect on θ					-0.038	0.491
Direct effect on θ					-0.036	0.502
Indirect effect on θ					-0.002	0.843
Indirect via λ_7					-0.002	0.843

Figure 1: Structural Model



Key:

Y_1: Age 3: BAS-NV(3), BSRA(3); Age 5: BAS-NV(5), BAS-PC(5), BAS-PS(5); Age 7: BAS-WR(7), BAS-PC(7), PiM(7)
Y_2: Read to, paint, reading, writing, library, counting, read–father, bedtime, TV, smacking, shouting
X: Age, Birth weight, ethnicity, mother's education, mother's work status, Kessler, tenure, poverty status or persistent poverty measure

Figure 2: Average test rank scores by poverty state: period-by-period

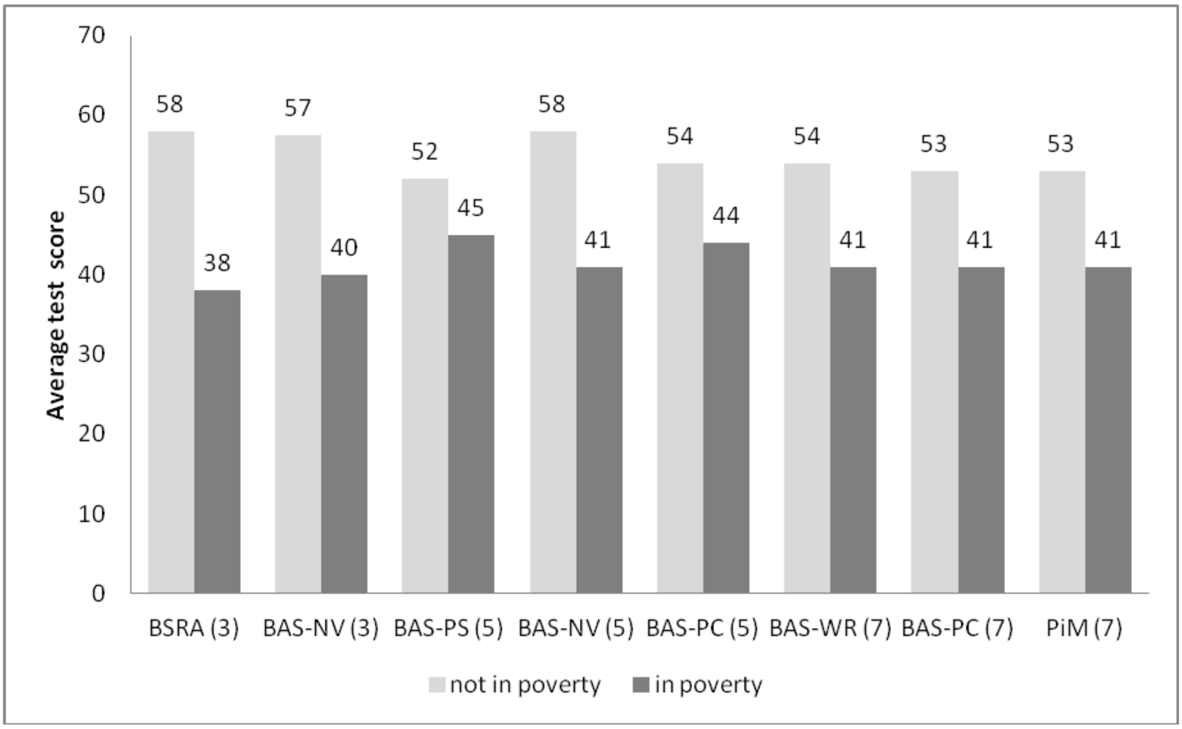
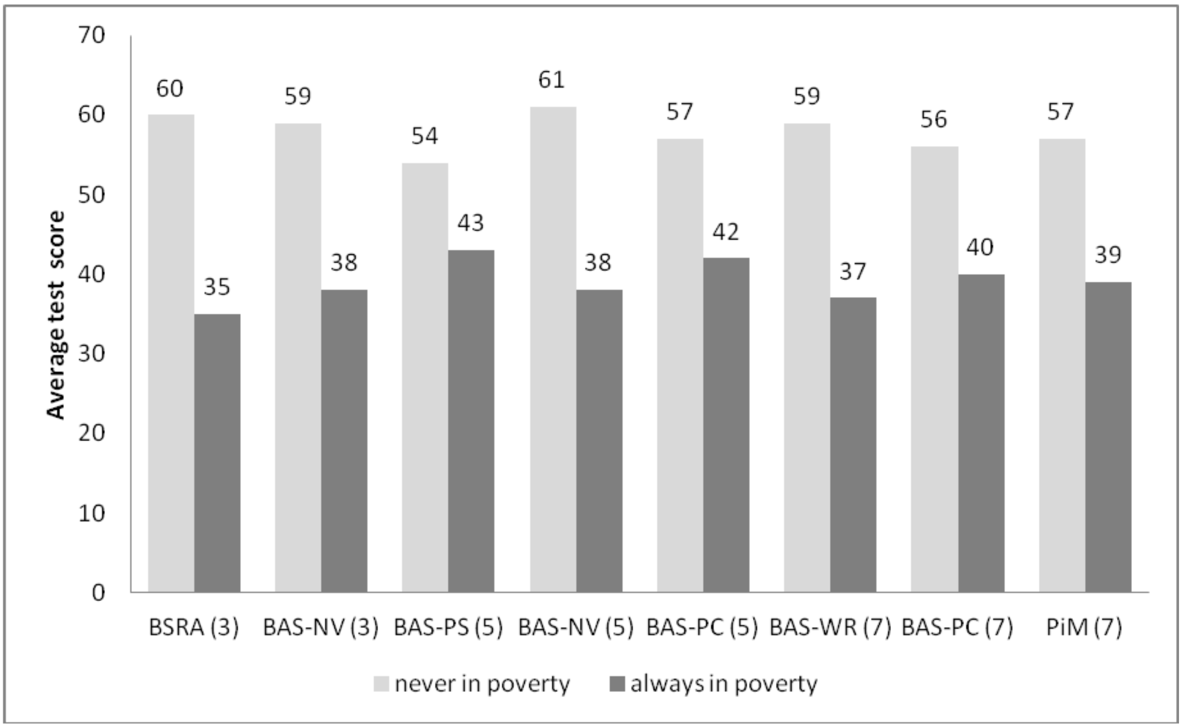


Figure 3: Average test rank scores by poverty state: never *vs* always in poverty



Appendix A: Full results

Table A1: Cognitive development and the incidence of poverty: Table 4, Panel B

PANEL B	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
P1	-4.84***	-5.46***	-4.61**	-3.68*	-1.32	-5.20***	-2.98	-3.13*
	(1.40)	*(1.47)*	*(1.60)*	*(1.45)*	*(1.58)*	*(1.50)*	*(1.63)*	*(1.53)*
P2	-7.19***	-4.99***	1.02	-5.77***	-3.24*	-6.17***	-3.88*	-5.06**
	(1.42)	*(1.49)*	*(1.65)*	*(1.48)*	*(1.63)*	*(1.53)*	*(1.67)*	*(1.57)*
P3			-2.20	-0.03	-1.26	-3.00*	-1.37	-3.83*
			(1.61)	*(1.35)*	*(1.58)*	*(1.52)*	*(1.67)*	*(1.56)*
P4						-2.07	-0.34	-0.32
						(1.67)	*(1.64)*	*(1.65)*
Age	1.02***	0.66***	-0.43**	-0.24*	-1.28***	-0.59***	0.39**	1.57***
	(0.18)	*(0.19)*	*(0.15)*	*(0.12)*	*(0.14)*	*(0.13)*	*(0.14)*	*(0.13)*
Birth weight	0.40	1.90**	-0.01	1.21	3.25***	1.14	3.89***	2.92***
(in kilos)	*(0.70)*	*(0.73)*	*(0.79)*	*(0.72)*	*(0.78)*	*(0.73)*	*(0.79)*	*(0.74)*
Mixed	0.37	1.72	2.90	0.67	3.41	7.22*	-1.69	0.96
ethnicity	*(2.70)*	*(2.84)*	*(3.07)*	*(2.79)*	*(3.04)*	*(2.84)*	*(3.09)*	*(2.90)*
Indian	-2.85	-14.12***	-2.88	-9.28*	-0.79	10.73*	-3.03	-1.78
	(4.07)	*(4.28)*	*(4.61)*	*(4.19)*	*(4.56)*	*(4.27)*	*(4.66)*	*(4.37)*
Pakistani and	-9.62	-28.05***	-6.47	-19.21**	2.73	18.00**	6.29	-6.75
Bangladeshi	*(5.96)*	*(6.26)*	*(6.79)*	*(6.16)*	*(6.71)*	*(6.30)*	*(6.86)*	*(6.44)*
Black or	-6.92	-20.94***	1.05	-20.21***	0.69	11.13*	-16.71**	-0.01
Black British	*(5.38)*	*(5.65)*	*(6.10)*	*(5.54)*	*(6.03)*	*(5.63)*	*(6.14)*	*(5.76)*
Other ethnic	2.56	-32.58***	-11.29	-14.46*	0.36	-6.21	-12.71	1.96
Groups	*(6.91)*	*(7.26)*	*(7.85)*	*(7.13)*	*(7.76)*	*(7.27)*	*(7.92)*	*(7.43)*
Mother works	0.62	0.59	0.25	0.70	-0.81	0.66	-0.30	0.86
	(0.78)	*(0.83)*	*(0.97)*	*(0.83)*	*(0.87)*	*(0.93)*	*(0.94)*	*(0.93)*
NVQ1	0.09	3.00	-0.65	7.96**	-3.02	0.69	0.05	-0.85
	(2.47)	*(2.62)*	*(3.03)*	*(2.71)*	*(2.94)*	*(2.94)*	*(3.17)*	*(3.00)*
NVQ2	4.13*	6.07**	1.32	5.65*	4.36	4.63	4.65	3.97
	(2.00)	*(2.11)*	*(2.45)*	*(2.19)*	*(2.37)*	*(2.39)*	*(2.57)*	*(2.43)*
NVQ3	5.25*	7.70***	2.72	6.55**	3.53	5.03*	4.48	5.13*
	(2.11)	(2.23)	(2.56)	(2.29)	(2.48)	(2.48)	(2.67)	(2.53)
NVQ4	8.92***	9.38***	4.98*	14.05***	7.51**	9.25***	8.50***	8.48***
	(2.02)	*(2.13)*	*(2.46)*	*(2.20)*	*(2.38)*	*(2.38)*	*(2.56)*	*(2.43)*
NVQ5	12.03***	5.34*	7.94**	11.54***	5.33*	9.57***	9.92***	8.64**
	(2.50)	*(2.65)*	*(2.71)*	*(2.41)*	*(2.61)*	*(2.63)*	*(2.81)*	*(2.67)*
Kessler	-0.15	0.02	-0.07	-0.21	-0.11	-0.27*	-0.13	-0.08
	(0.12)	*(0.13)*	*(0.14)*	*(0.12)*	*(0.13)*	*(0.12)*	*(0.13)*	*(0.12)*

PANEL B	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
Tenure	-3.22*	-4.66***	-1.22	-3.26*	-2.25	-2.73	-2.49	-3.39*
	(1.31)	*(1.39)*	*(1.62)*	*(1.42)*	*(1.54)*	*(1.55)*	*(1.64)*	*(1.57)*
Read to	2.06***	1.84***	-0.10	0.93*	-0.52	-0.74	-0.46	-0.55
	(0.49)	*(0.52)*	*(0.54)*	*(0.46)*	*(0.48)*	*(0.40)*	*(0.40)*	*(0.40)*
Paint	1.07**	1.63***	-0.03	0.03	0.77	-0.52	0.55	0.40
	(0.40)	*(0.43)*	*(0.47)*	*(0.40)*	*(0.42)*	*(0.47)*	*(0.46)*	*(0.46)*
Reading	1.26***	0.07	-1.74**	-0.34	-0.33	-2.09***	0.38	-0.71*
	(0.27)	*(0.29)*	*(0.61)*	*(0.52)*	*(0.53)*	*(0.28)*	*(0.28)*	*(0.28)*
Writing			-0.09	0.44	-0.21	-1.09**	-1.19***	-0.47
			(0.44)	*(0.38)*	*(0.39)*	*(0.34)*	*(0.34)*	*(0.34)*
Library	0.93*	-0.10	0.16	1.42*	0.77	1.21	0.10	0.25
	(0.46)	*(0.49)*	*(0.65)*	*(0.55)*	*(0.58)*	*(0.64)*	*(0.63)*	*(0.63)*
Counting	1.22**	0.76	0.10	-0.18	0.11	1.11**	-0.03	0.01
	(0.38)	*(0.41)*	*(0.46)*	*(0.39)*	*(0.40)*	*(0.35)*	*(0.35)*	*(0.35)*
Father read	2.18***	1.64***	0.88*	1.95***	0.24	0.96**	0.07	0.24
	(0.33)	*(0.35)*	*(0.42)*	*(0.36)*	*(0.38)*	*(0.36)*	*(0.36)*	*(0.36)*
Bedtime	1.61***	0.41	0.37	1.15*	0.30	1.96***	0.96	0.82
	(0.45)	*(0.48)*	*(0.61)*	*(0.52)*	*(0.55)*	*(0.56)*	*(0.56)*	*(0.55)*
TV	-0.74	2.32***	-1.95**	0.30	-1.96***	-2.47***	-0.68	-1.82**
	(0.58)	*(0.62)*	*(0.66)*	*(0.57)*	*(0.59)*	*(0.61)*	*(0.61)*	*(0.61)*
Smack	-1.32*	-0.57	1.29	0.16	-0.12	-1.75**	-1.11	-1.11
	(0.56)	*(0.60)*	*(0.66)*	*(0.57)*	*(0.60)*	*(0.64)*	*(0.65)*	*(0.64)*
Shout	0.28	1.21	-0.00	-0.37	0.46	0.07	-0.78	0.51
	(0.72)	*(0.77)*	*(0.88)*	*(0.75)*	*(0.78)*	*(0.81)*	*(0.81)*	*(0.80)*
PPS	0.58**	0.73***						
	(0.19)	*(0.20)*						
NPS	0.01	-0.07						
	(0.07)	*(0.07)*						
Constant	-28.11**	-26.46*	84.59***	53.59***	125.20***	105.48***	7.67	-91.26***
	(10.34)	*(11.03)*	*(10.34)*	*(8.79)*	*(9.76)*	*(12.18)*	*(12.97)*	*(12.36)*

Table A2: Cognitive development and the persistence of poverty: Table 5, Panel B

PANEL B	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
PPM	-4.64***	-3.99***	-1.20*	-2.22***	-0.90	-2.47***	-1.05**	-1.75***
	(0.70)	*(0.74)*	*(0.52)*	*(0.46)*	*(0.50)*	*(0.34)*	*(0.37)*	*(0.35)*
Age	1.02***	0.65***	-0.44**	-0.25*	-1.28***	-0.60***	0.38**	1.57***
	(0.18)	*(0.19)*	*(0.15)*	*(0.12)*	*(0.14)*	*(0.13)*	*(0.14)*	*(0.13)*
Birth weight	0.44	1.92**	-0.04	1.23	3.28***	1.16	3.90***	2.93***
(in kilos)	*(0.70)*	*(0.73)*	*(0.79)*	*(0.72)*	*(0.78)*	*(0.73)*	*(0.79)*	*(0.75)*
Mixed	0.24	1.65	2.93	0.71	3.27	7.23*	-1.74	0.82
ethnicity	*(2.70)*	*(2.84)*	*(3.07)*	*(2.79)*	*(3.04)*	*(2.84)*	*(3.09)*	*(2.90)*
Indian	-2.87	-14.16***	-3.08	-9.19*	-0.91	10.47*	-3.21	-2.15
	(4.08)	*(4.28)*	*(4.61)*	*(4.19)*	*(4.56)*	*(4.28)*	*(4.66)*	*(4.37)*
Pakistani and	-10.08	-28.37***	-6.39	-19.28**	1.92	18.04**	5.73	-6.98
Bangladeshi	*(5.96)*	*(6.26)*	*(6.80)*	*(6.17)*	*(6.72)*	*(6.31)*	*(6.87)*	*(6.45)*
Black or	-7.39	-21.13***	1.43	-20.78***	0.32	10.61	-17.10**	-0.43
Black British	*(5.38)*	*(5.65)*	*(6.10)*	*(5.53)*	*(6.03)*	*(5.64)*	*(6.14)*	*(5.76)*
Other ethnic	2.60	-32.49***	-11.14	-14.36*	0.41	-5.92	-12.52	2.19
groups	*(6.91)*	*(7.26)*	*(7.85)*	*(7.13)*	*(7.77)*	*(7.28)*	*(7.93)*	*(7.44)*
Mother works	0.66	0.59	0.29	0.55	-0.72	0.59	-0.30	0.88
	(0.78)	*(0.83)*	*(0.96)*	*(0.83)*	*(0.87)*	*(0.93)*	*(0.94)*	*(0.92)*
NVQ1	0.23	3.06	-0.79	7.99**	-2.86	0.73	0.21	-0.76
	(2.48)	*(2.62)*	*(3.03)*	*(2.71)*	*(2.94)*	*(2.95)*	*(3.18)*	*(3.00)*
NVQ2	4.30*	6.19**	1.41	5.77**	4.67*	4.82*	4.97	4.19
	(2.00)	*(2.11)*	*(2.45)*	*(2.19)*	*(2.37)*	*(2.39)*	*(2.57)*	*(2.44)*
NVQ3	5.44**	7.87***	2.86	6.73**	3.90	5.29*	4.88	5.38*
	(2.11)	*(2.23)*	*(2.56)*	*(2.29)*	*(2.48)*	*(2.49)*	*(2.67)*	*(2.53)*
NVQ4	9.20***	9.63***	5.18*	14.31***	7.97***	9.66***	9.01***	8.89***
	(2.01)	*(2.13)*	*(2.46)*	*(2.20)*	*(2.38)*	*(2.38)*	*(2.56)*	*(2.43)*
NVQ5	12.31***	5.59*	8.15**	11.78***	5.77*	9.98***	10.42***	9.05***
	(2.50)	*(2.65)*	*(2.72)*	*(2.41)*	*(2.61)*	*(2.63)*	*(2.81)*	*(2.68)*
Kessler	-0.16	0.02	-0.09	-0.20	-0.11	-0.28*	-0.14	-0.09
	(0.12)	*(0.13)*	*(0.14)*	*(0.12)*	*(0.12)*	*(0.12)*	*(0.13)*	*(0.12)*
Tenure	-3.43**	-4.91***	-1.54	-3.37*	-2.76	-3.46*	-3.22*	-4.18**
	(1.31)	*(1.39)*	*(1.61)*	*(1.42)*	*(1.53)*	*(1.53)*	*(1.63)*	*(1.55)*
Read to	2.06***	1.85***	-0.10	0.93*	-0.51	-0.71	-0.43	-0.53
	(0.49)	*(0.52)*	*(0.54)*	*(0.46)*	*(0.48)*	*(0.40)*	*(0.40)*	*(0.40)*
Paint	1.08**	1.63***	-0.01	0.03	0.77	-0.56	0.53	0.38
	(0.40)	*(0.43)*	*(0.47)*	*(0.40)*	*(0.42)*	*(0.47)*	*(0.46)*	*(0.46)*
Reading	1.26***	0.08	-1.72**	-0.35	-0.32	-2.10***	0.37	-0.70*
	(0.27)	*(0.29)*	*(0.61)*	*(0.52)*	*(0.53)*	*(0.28)*	*(0.28)*	*(0.28)*

PANEL B	MCS2: age 3		MCS3: age 5			MCS4: age 7		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Test	BSRA(3)	BAS-NV(3)	BAS-PS(5)	BAS-NV(5)	BAS-PC(5)	BAS-WR(7)	BAS-PC(7)	PiM(7)
Writing			-0.13	0.44	-0.21	-1.15***	-1.22***	-0.52
			(0.44)	*(0.38)*	*(0.39)*	*(0.34)*	*(0.34)*	*(0.34)*
Library	0.92*	-0.10	0.16	1.44**	0.77	1.19	0.08	0.25
	(0.46)	*(0.49)*	*(0.65)*	*(0.55)*	*(0.58)*	*(0.64)*	*(0.63)*	*(0.63)*
Counting	1.23**	0.76	0.11	-0.18	0.11	1.17***	-0.00	0.04
	(0.38)	*(0.41)*	*(0.46)*	*(0.39)*	*(0.40)*	*(0.35)*	*(0.35)*	*(0.35)*
Father read	2.19***	1.63***	0.90*	1.95***	0.24	0.99**	0.10	0.27
	(0.33)	*(0.35)*	*(0.42)*	*(0.36)*	*(0.38)*	*(0.36)*	*(0.36)*	*(0.36)*
Bedtime	1.61***	0.44	0.41	1.16*	0.30	1.98***	0.96	0.82
	(0.45)	*(0.48)*	*(0.61)*	*(0.52)*	*(0.55)*	*(0.56)*	*(0.56)*	*(0.55)*
TV	-0.73	2.32***	-1.95**	0.34	-1.98***	-2.50***	-0.71	-1.85**
	(0.59)	*(0.62)*	*(0.66)*	*(0.56)*	*(0.59)*	*(0.61)*	*(0.61)*	*(0.61)*
Smack	-1.35*	-0.57	1.32*	0.15	-0.13	-1.78**	-1.12	-1.14
	(0.56)	*(0.60)*	*(0.66)*	*(0.57)*	*(0.60)*	*(0.64)*	*(0.65)*	*(0.64)*
Shout	0.31	1.24	0.01	-0.37	0.48	0.17	-0.75	0.55
	(0.72)	*(0.77)*	*(0.88)*	*(0.75)*	*(0.78)*	*(0.81)*	*(0.81)*	*(0.81)*
PPS	0.57**	0.73***						
	(0.19)	*(0.20)*						
NPS	0.01	-0.07						
	(0.07)	*(0.07)*						
Constant	-28.71**	-26.72*	84.57***	53.28***	124.56***	105.22***	7.27	-91.74***
	(10.34)	*(11.03)*	*(10.34)*	*(8.79)*	*(9.76)*	*(12.19)*	*(12.98)*	*(12.38)*

ENDNOTES

[1] There has been some recent reassessment of the latter finding (Jerrim and Vignoles, 2011), which we address in section 2 below.

[2] "Our historic aim will be for ours to be the first generation to end child poverty", Tony Blair, Beveridge Lecture, 1999.

[3] This was the proportion living in poverty measured before housing costs (BHC); the after-housing-costs (AHC) measure was greater than one third.

[4] The Field review is entitled: *The Foundation Years: preventing poor children becoming poor adults* to reflect this intergenerational focus.

[5] Sure Start has many similarities with Head Start in the US.

[6] While the full BCS70 contains around 17,000 children, only a sub-sample of around 2,400 were tested at 22 and 42 months, and then only about half of these were followed successfully up to age 10.

[7] MCS oversamples ethnic minorities and disadvantaged households and thus provides sufficient observations to separately identify and control for differences between these groups.

[8] Kiernan and Huerta (2008) use the same methodology (SEM) and the MCS as here, however they examine cognitive development only at age 3. So while they address the issues of endogeneity of inputs and measurement errors, they do not consider either the persistence in cognitive development or the persistence in poverty.

[9] The fifth sweep is scheduled to take place in 2012 when the children will be 11 and in their final year of primary school.

[10] Weights that take account of differential sampling, non-response and attrition have been used throughout the analysis – see Hansen (2010) for details.

[11] There are up to 18 income bands in the first three sweeps of the MCS and 19 bands in MCS4 (the income bands are different for single parent families and for couples). Given the large number of income bands, using the midpoints does not seem to be overly restrictive.

[12] The number of different potential poverty profiles is 2^T.

[13] We also tested the sensitivity of our findings to different choices for the weights ω_t. In particular, we considered both extremes of $\alpha = 1$ (the Bossert et al., 2008 measure) and $\alpha = 0$ (the Dutta et al., 2011 measure). The results are qualitatively similar to those presented here and are available on request.

[14] Hansen et al. (2010) provide the relevant information in this subsection.

[15] Age is measured in months given the rate of cognitive development in the early years.

[16] Identical questions are not asked in every sweep of the MCS since the focus is on making the survey age-relevant. Descriptive statistics for each of the independent variables are available on request.

[17] For the same reason, it is not valid to treat the data as a panel – we do not have repeated observations on the dependent variable for the same individual.

[18] We also experimented with an alternative measure of 'economic disadvantage'. All children who lived in households where the main respondent received any of the following benefits: income support, working tax credit, housing benefit, and council tax benefit, were classified as being 'disadvantaged'. The analysis presented here was replicated using this 'disadvantaged' measure instead of the poverty measure. The findings of the paper do not change qualitatively using this alternative measure of economic disadvantage (full results are available on request).

[19] The full results are presented in Appendix A, Table A1.

[20] These findings are consistent with those in Kiernan and Huerta (2008) and Kiernan and Mensah (2010). Kiernan and Huerta (2008) use the MCS sweep 2 (age 3), while Kiernan and Mensah (2010) use the MCS sweep 3 (age 5).

[21] The full results are presented in Appendix A, Table A2.

[22] The full results with the estimated coefficients for the control variables and the factor loadings for the latent variables are available on request.

[23] Recall that the SEM specification assumes persistence in cognitive development, with past cognitive ability impacting current cognitive ability. There are no tests in MCS1, and thus at age 3, there is no lagged cognitive ability factor.

[24] The next sweep of the MCS will allow us to investigate this finding further.

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