NCDS User Support Group

Working Paper No. 50

Family Disruption and the cognitive and behavioural development of children in longitudinal data from Britain and USA

March 1998

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Funded under ESRC Programme *Children 5-16: Growing into the 21st Century*, Grant. L129251027.

Earlier reports on this project have been presented at the *European Society for Population Economics* Meeting, at Essex University, June 1997, and the *IUSSP* Conference in Beijing, October 1997. Earlier versions of the present paper have been presented at the *Norwegian Research Council Seminar*, Oslo, September 1997, and the *ESRC Marraige and Divorce Seminar*, London, November 1997. Further analyses will be done using the (slightly) revised NCDS Dataset from CHRR at Ohio State, issued too late to be incorporated in this paper, at the end of February 1998.

ABSTRACT

Does the increasing number of children living outside a conventional two-parent nuclear family, mean bad news for children? Is cognitive and emotional development being harmed by the breakdown of the family, or has a moral panic been overstated? Evidence comes from the second generation of the British NCDS (1958 birth cohort), collected in 1991, when the study members were 33, and the American NLSY (1958-1965 cohorts), interviewed in 1992, when the sub-sample of their children studied were at least 4. Models relating family structure to child well-being are presented with and without adjustment for other demographic, social and economic circumstances. A multi-variate, multi-level strategy estimates heterogeneity within and between families. Simple associations between family disruption and child well-being are shown to be mediated through material and other factors. The high variability in the data defies deterministic modelling but there appear to be differing associations in the two countries.

INTRODUCTION

Does disruption of the family disrupt children's development? In most Western industrialized countries, the family has become more diverse and fluid: more single parenthood, more ruptures in partnerships, more step-parents. These changes may have brought benefits of greater freedom to at least some adults, but what about the kids? Have they suffered when deprived of one of their two natural parents? To some, it seems self-evident that children thrive on family stability, and must therefore lose out if their upbringing is less conventional. This view is supported by the argument that the enterprise of child-rearing stands more chance of success if undertaken by two adults rather than one. The 'production' of high 'quality' children, requires an investment of parental resources which are likely to be more abundant and effective where there are two parents working together than in other arrangements. Single parents are usually handicapped by less access to some of the inputs a partnership can muster. These resources are material, emotional and social: cash, time and access to a wider social network. It is also suggested that there are economies of scale and complementarities in the business of child rearing, best realised by a long-term and loving partnership of the child's natural parents, with its built-in checks and balances (McLanahan and Sandefur 1994). Growing up with only one parent or a step-parent is plausibily fraught with problems.

But are the suppositions behind these arguments always correct? Have the new modes of family life offered new models of socialisation in which children thrive as well as those in conventional intact families, if not better, than in some of the less successful partnership. The assertion that single parents lack resources is not always true, and should not be taken to suggest that they are inadequate parents, or to stigmatise their families. It could also be suggested that [1]single motherhood is, in some cases deliberately and responsibly chosen by women who cope well with the single-handed challenge. Have children, or at least some children, more resilience than in the model which sees them simply as vessels for parental investment? The processes and dynamics of family life and disruption may affect childhood outcomes. They can be managed better, or more badly, by the family members themselves (including the children) and by the wider society (kin, schools, peer groups etc). Thus, unconventional family forms are neither necessary nor sufficent conditions for children to fail, and their proliferation need not be a cause for concern.

This paper presents new evidence to quantify the existence, if any, of an association between child development and various sorts of family disruption. The data comes from two of the countries where the demographic trends have resulted in the most diversification, the UK and USA. Britain has one in six dependent children living in a single parent family (17% at 1991 Census); nine out of ten of them single-mother families. Over one third (34 percent) of births were outside of marriage in 1995, although roughly half of them were registered by two parents living at the same address (Office of National Statistics 1997). Currently, 41 percent of marriages are projected to end in divorce in England and Wales if divorce rates remain at their 1993-4 levels (Haskey 1994). Similarly, children born to married parents face a 28 percent risk that their parents will divorce before they reach age 16 (Haskey, 1997).

In the United States, approximately one quarter of all children lived with single parents in 1990 (using the Census Bureau definition), and over one half of all marriages end in divorce (Bumpass, Raley & Sweet 1995) . As in Great Britain, nearly one third of infants born in the

United States today are born to unmarried mothers. American children born to married parents face a 45 percent risk that their parents will divorce in the next 18 years (Bumpass, 1984). Although the rates of divorce and lone parenting are higher in the United States than in Europe, in many ways Britain appears closer to the United States than it does to its European neighbours in terms of these demographic trends.

A substantial body of research evidence from both America and Britain (reviewed below) tends to find family instability or lone parenthood associated with unfavourable outcomes for children in childhood, adolescence or adulthood. The considerations outlined in our first paragraph would imply this is cause and effect. A number of issues remain only partly resolved: whether it is the lack of one parent, the arrival or presence of a step-parent, the disruption of family life, the experience of conflict, or the lack of material or community resources that presents the child with difficulties; whether such difficulties affect health , scholastic achievement or other aspects of behaviour and well being: how long such difficulties persist or how long it takes them to emerge; which children are most, or least, at risk. There is also the question of whether the association really is causal or, if it is, in which direction causation runs: whether some parents have characteristics or circumstances which predispose them to poor parenting as well as partnership failure, or indeed whether some children have such physical and/or emotional difficulties that their parents' partnership as well as their own development is jeopardised. The assumption that family disruption determines child outcomes is easier to make than to prove.

In this paper we take several possible indicators of the well-being of children while still of school age: a summary index of their emotional adjustment along with measures of educational attainment. Behavioural problems are reported by mothers on standard items used in the Rutter A Scale (Rutter et al. 1970) and the Behaviour Problems Index (BPI; Peterson and Zill 1986). We examine the association of this and children's numeracy and literacy with four broad types of deviation from an 'intact' two-natural-parent family. Among current lone parent families we distinguish those where the child started life with a lone mother and those where the child was born into a two parent family which has split; reconstituted families are likewise divided by whether the child started life with one or with both natural parents.

We address these questions using national data from Great Britain and the United States. In both countries we compare the attainments and composite behavioural scores of children from disrupted and intact families, controlling for two sets of prior and possibly intervening factors. Our aim is to identify the extent to which the development of cognitive skills and emotional maturity is related to changing family structure controlling for other child-specific and family-specific factors. Models are presented with and without adjustment for factors such as economic resources and parental involvement, through which any effect of family structure may work. This approach is realised via a statistical framework which conceptualises the data as hierarchical (Goldstein 1995). Test scores are nested within children, children are nested within families. Formally this describes a 3-level hierarchical or multilevel mulitivariate model, where test scores are level 1 units, children are level 2 units nested within families as level 3 units.

The models identify distinct sources of variability - that between families and that within. Put another way, the models describe the extent to which individual children within a family may share some unmeasured characteristics. We are therefore potentially able to examine the degree to which children with similar degrees of educational attainment congregate in families

and the extent of variation in these child outcomes within and between family settings. The modelling extends earlier work by Wiggins and Wale (1996) on intergenerational transmission of literacy and numeracy. The formal specification of these models encourages the analyst to explain these sources of variation by explcity modelling family-level or individual -level variation.

A QUICK TOUR OF THE LITERATURE

Studies that attempt to identify those factors which affect children's attainments can be found in the economic, sociological, demographic and psychological literature (Amato et al. 1995, Burghes 1994, Cherlin et al. 1991, Cockett and Tripp 1994, Cooksey & Fondell 1996, Ermisch & Francesconi 1996, Ferri 1976, Kiernan 1992 & 1996, McLanahan and Sandefur 1994, Thomson et al. 1994, Wadsworth and Maclean 1986).

Haveman and Wolfe (1995) identify consistent patterns in the determinants of children's attainments across the economic studies they review. Their principal conclusions relevant to this study are:

- reduced access by children to economic resources or opportunities increases the chances of low attainment.
- growing up in a family in which the mother has paid work appears to have a modest adverse effect on educational attainment, suggesting a negative effect of the loss of child care time.
- growing up in a single-parent or step-parent family (or experiencing a parental separation or divorce) has a negative effect on educational attainment.
- stressful events during childhood (e.g., changes in geographic location) appear to have large and independent negative effects on a variety of indicators of children's attainments.

The economic literature emphasizes the substantial effect of family background and parental choices on the quantity and quality of resources devoted to children. Children's schooling, including pre-school experience, is also found to play an important intervening role.

A more recent study from the United States has, however, found relatively little effect of the marital status of a child's mother at birth and the instability of living arrangements during a child's life on the cognitive development of children (Cooksey 1997)- with the exception of reading recognition where step families were formed after an extra-marital birth. In this study the sample of children in the early years of elementary school had mothers who were members of the National Longitudinal Study of Youth (NLSY) aged under 23 at the time of the first birth. Although children born to mothers who were not married had lower cognitive ability scores than those born and brought up in a stable home with married parents, for the most part these differences did not persist when further measures of social, human and financial capital available to the children are introduced. Cooksey (1997) concludes that it was not the marital status of parents that was driving these results per se, so much as the poor educational attainment of young mothers themselves, lower levels of family income and less stimulating home environments in the father-absent families.

There have been many other studies: qualitative, clinical and quantitative (Amato & Bruce 1991). These tend to concentrate on sociological, demographic or psychological exlanations. The latter based on the concept of family stress which views divorce as a major strain for children. Hess (1995), for example, stresses that any link between family disruption

and behavioural disorders among adolescents is mediated by the degree of parental conflict, from which those in intact families are not immune. Marital conflict can be at least as harmful as parental separation for children's well-being (Amato et al 1995). Accompaniments to divorce, such as moving house, changing schools and the loss of contact with family memebers are also stressful for children. However, children vary in their responses to stress and adversity and it is this point that we shall investigate in this paper: which children thrive and which, if any, are less resistant.

Many children successfully adapt to their changed family circumstances after a crisis period, which seems to last typically for about two years (Chase-Lansdale and Hetherington 1990). It is difficult to establish when this upset can occur. The family's social and economic position both before and after parental separation can affect a child's well-being. Both British and American studies using longitudinal data have shown that long before parents separate there are observable differences in the behaviour of their children when compared with children in marriages that remain intact (Cherlin et al 1991, Elliott and Richards 1991). This suggests that divorce should be viewed as a process and may include conflict, poor parenting and other family disfunction that are significant in themselves for children's behaviour problems (Rutter 1981).

One of the problems in disentangling any "divorce effects" or "lone parent effects" is being able to take into account the conditions that lead couples to separate. Ni Bhrolchain eloquently details the challenges to be faced when attempting to establish causality between any measure of behaviour and experience of parental separation (N☼ Bhrolch☐in et al, 1994, N☼ Bhrolch☐in 1997). She correctly emphasises that any comparison between one and two parent families must take account of the ways in which these families differ from each other and hold constant all factors influencing the likelihood of divorce and the outcome being measured. Ideally, counterfactual measurements are needed, of what the children of divorce would have been like had their parents not divorced, and what the children of intact partnerships would have been like had their parents split. Repeated measures on the same child, before and after a split, can help approximate and answer, but even these are bedevilled by the impossibility of knowing whether the 'before' measures are not affected by the anticipation of a split. Unfortunately the best we can do is to compare one cross-section of child data with their history of family disruption, controlling for confounding factors.

Quantitative studies have often been, like this one, secondary analysis of longitudinal data sets. The National Child Development Study (NCDS) has been used to study the children born in 1958 to unmarried mothers (Crellin et al 1971). After controlling for social class, number of siblings and birthweight, the 'illegitimate' children still had mildly worse maths and reading scores than children in a two parent family, but were not noticeably more 'maladjusted'. Children born out of wedlock whose natural fathers subsequently married their mothers did not do better than the other 'illegitmate children'. Ferri (1976) studied the cohort members' behaviour and attainments at 7 and 11 in relation to family structure. The rating of behaviour was based on a number of items reported by parents and teachers. Controlling for a set of variables describing the demographic and economic status of the family, along with parental aspirations, accounted for the differences in behaviour and reading between the several family settings she distinguised. An indicator of poverty in the form of receipt of free school meals was most strongly associated with fatherless families. Background factors reduced the differences in maths scores but they remained statistically significant. Children in two-parent families and

those of widowed mothers did best, and fatherless families resulting from a broken partnership did worst.

Cherlin et al. (1991) looked at the behaviour and test score from 7 and 11 together, in the search for factors which might pre-date, perhaps predispose, family breakup. Children whose parents divorced between 7 and 11 had lower scores than children from intact families before as well as after the divorce. Allowing for this (and other variables) the lower scores for boys were completely explained, but for girls the behaviour scale and the maths score still showed a direct disadvantage following divorce. The authors found the opposite 'effect' of divorce on girls in a similar data set in the US, noting the difficulty of finding universal results. Similar lines of enquiry have been pursued to age 16 by Elliot and Richards (1991). They too find indications that children whose parents divorce have lower test scores and more disruptive behaviour, and are also more 'unhappy and worried' than those whose parents stay together, with evidence that the problem sometimes predates the divorce. There was no difference in the test scores of children whose lone parents stayed single or repartnered, though there was raised disruptive behaviour in step families. Kiernan (1992) looked at a number of outcomes at age 16 and 23 for cohort members with and without various sorts of family disruption in childhood. The outcomes range from early school leaving to early parenthood. The estimated coefficients of being in a step family or a one-parent family at 16 are, as elsewhere, moderated by the inclusion of controls and different for males and females, but they are consistently significant. The fact that cohort members from broken homes were among the first to enter parenthood means that their own children will be over-represented in the second generation sample taken when NCDS members reached age 33. Kiernan (1997) has since looked at the legacy of divorce for more outcomes in adulthood - educational attainment, economic situation, partnership formation and dissolution and parenthood behaviour - when the cohort members were aged 33. She found that in most domains children who experienced parental divorce had more negative experiences than those reared by two parents. However, the relationship between divorce and non-demographic adult outcomes were attenuated by financial hardship. In other words, the advantages of the two parent family are at least partly economic.

One study which has already looked at the next generation, the children of NCDS members in 1991, is that of Wiggins and Wale (1996). This was primarily intended as an investigation of inter-generation transmission, but lone parenthood was included as a control. It was somewhat surprising that Wiggins and Wale found no significant difference in the test scores of children whose mother lived alone compared to those in two-parent families. The present study investigates these children further, and compares them with the chidren of the NLSY cohorts.

DATA

The data sets we use are both prospective longitudinal studies: from Britain, the National Child Development Study (NCDS) of the 1958 birth cohort, and from the USA, the National Longitudinal Study of Youth (NLSY). These studies have sufficient similarities to provide a strong resource for international comparison. The NCDS is a study of over 17,000 people in Britain, born between the 3rd and 9th of March in 1958. Follow up sweeps took place in 1965, 1969, 1974, 1981 and 1991 with a further 10% postal follow up in 1997. The data holds

extensive information on the economic, social and health status of individuals and their parents at several points in time. For further details of the NCDS see Ferri (1993).

The 1991 NCDS follow-up was designed to obtain information not only from the cohort member; but among others, from the children, of 1 in 3 cohort members; and from the mother of these children. The mother and child questionnaires are based on instruments used from the NLSY, and their inclusion in NCDS5 was designed to permit comparisons to be made. The tests were administered to children aged 4 and above. The oldest was 17 and the average age around nine. From a wider range of cognitive tests, this study draws just two: Peabody individual achievement tests in maths and reading recognition (Dunn & Markwardt 1971). The child assessment component contained a series of well established tests designed to assess the childs emotional adjustment (through questions to the mother or mother figure). For children between the ages of 4 and 6, the instrument was the Behavioural Problems Index [Peterson and Zill 1986], and for children over the age of 6 the Rutter A scale was used to assess the childs emotional adjustment. The validity and reliability of these instruments has been previously tested in the US where, in the NLSY, the mothers of children who are 4 years old or older report on emotional adjustment via the BPI (Chase-Landsdale et al. 1991). The replication of this item in NCDS affords us a unique opportunity for international comparison . In our main regression sample 782 children were the offspring of male cohort members and 1524 had mothers in the 1958 cohort. They came from 1561 families.

The NLSY is a nationally representative sample of approximately 14,000 young men and women in the USA born between 1958 and 1965. Respondents were first interviewed in 1979 when they were between 14 and 21 years of age, and they have been reinterviewed every year since 1979. Beginning in 1986, the NLSY also collected data on the children born to the women only of this youth cohort; this information has been collected biannually since. To allow comparison with the NCDS cohort we use data from the 1992 mother and child supplements and restrict our sample to children whose mothers were then between 30 and 34 years old.

The children in each study are selected on the basis of their mother's age (or father's in some NCDS cases). They do not typify all children since they do not include any children born to older, or younger, parents. The latest mother's age at birth for the children of NCDS women would be 29, with a child aged 4. Any children of NCDS women over 13 would themselves have been born to a teenage mother. Where the NCDS cohort member is a man, there is a wider range of mother's ages, but they are predominantly younger than 33 at interview. Thus sample design imposes an artificial inverse correlation of the ages of children and parents. Even though the NLSY has a somewhat less narrow range of mothers' ages than the children of NCDS women, the same principles apply. These data are therefore more representative of teen mothers, and hence less educated mothers than a full cross-section of mothers or children. This relatively disadvantaged sample of women and children also more closely resembles the population that is most often targeted for public policy intervention.

The family structure experienced by children is strongly related to the age of the child and therefore, the age of the cohort member parent at the time the child was born. There are three potential factors at work: younger women are more likely to have births outside partnerships; the longer a child lives the more chance there is of a change in the family situation; and, at any given age of child, children born to young mothers may have experienced more change because of a

greater instability of the partnerships of young parents. Clarke et al. (1997) show that the first two factors apply to the children of NCDS but not the third.

The data reflect this influence of sample design on its composition. In NCDS5, 32% of children aged 14 had been born to an unpartnered parent, but only 5% of children aged 5. In the NLSY where lone parenthood also varies by ethnic group, 6% of White children aged 5 and 24% aged 14 were born to a single mother; for Black and Hispanic children combined comparable figures are 28% and 70%. We have no evidence on children whose parents were the wrong age to get into the samples, nor of the disruption that the younger children in the sample may go on to have at later ages.

Where families are affected by parental repartnering, each child in a currently co-resident group could have a different history of living arrangements. For example, if an unmarried mother married someone who is not the father of her first child, they have a second and all four live together, the first child is living as a stepchild and has a history of living with a lone parent but the second has (so far) lived all her/his life with two natural parents. In our NLSY sample there are 150 out of 1423 families whose children have different family histories, in NCDS there are 47 out of 1561. This means that, paradoxically, family structure is a child-level variable in the multi-level framework, it is not a family-level term.

VARIABLES INCLUDED IN THE ANALYSIS

Definitions and descriptive statistics are set out in Table 1. The focus of the analysis is the child's experience of family change. Building on work on the NCDS by (Di Salvo 1997a and b), this is coded to reflect the child's family status at the time of birth and at the date of the interview. Our indicator does not record the full detail of histories with multiple changes in living arrangement, but these were a minority. The measure of family change we are able to construct from the NLSY uses legal marital status to define the partnership. Single-parent families thus include cases where the mother has a cohabiting partner. The measure of family change constructed from the NCDS encompasses both legal marriage status and cohabitation as partnerships, ie de facto rather than de jure.

We distinguish children (1) whose parents were living together at the birth of the child and are still living together (intact), (2) born to a single parent and currently living with only one parent, (3) who were born to a lone parent but are now living in a step-parent family, (4) whose parents were living together at the birth of the child but who have separated and where the custodial parent remains unpartnered, and (5) whose parents parted company since the birth and where the custodial parent has subsequently repartnered. All adopted children and children presently living with a lone father in the NCDS were removed from the analysis. There were only 20 children living with a lone father, too few to analyse separately. Other groups of potential interest were retained in the analyses, but not separately identified, in particulr, 12 children living with a stepmother. In the NCDS it is known whether the child's biological father joined the household after the child's birth. These children were added into the intact category. This group amounted to approximately 60% of the children who were born outside of a partnership but are currently living with two parents. Eight of the thirty children who were born to a lone mother who was also currently a lone parent had lived through an intervening episode. In the US, a husband had come and gone between birth and interview in 14% of cases with such

unmarried mothers, and some of the cases labelled lone-step, may have been, in the American sample histories where a biological (possibly even cohabiting) father married the child's mother. They are certainly more numerous, along with the 'lone-lone' cases in the US sample (Table 2).

Children's cognitive development is measured in this paper by two subscales of the Peabody Individual Achievement Test (PIAT) which are available in both samples. The mathematics subscale assesses a child's ability in mathematics as taught in mainstream education and the reading recognition subscale measures ability in oral reading (Table 2). A child's educational development is strongly related to age although age is viewed not strictly as a causal variable but as an index of various age-related factors. Instead of standardising our test scores for the influence of age (Dunn & Markwardt 1970), we included linear and quadratic age terms as covariates in all our models. We thus avoided concerns about the suitability of the available norms (Wiggins & Wale 1996) but may have 'over-corrected' for some of the circumstances associated with early parenthood.

For other aspects of the child's development and well-being, which may be more sensitive than academic tests to trouble at home, we draw on the survey's questions about the child's behaviour. There are of course links between academic underachievement and difficulties in behavioural adjustment. Several British epidemiologic investigations in the 1960s and 1970s yielded clear evidence of overlap between reading deficits and behavioural problems [Rutter 1974]. The BPI and Rutter A Scale assess the child's emotional adjustment and are included in this analysis alongside numeracy and literacy. The BPI subscale scores measure antisocial, anxious, headstrong, hyperactive, dependent behaviour and peer conflicts. The Rutter A Scale subscale scores measure aggression, hyperactivity and anxiety. To form a behavioural problems scale we sum the subscale scores. Exploratory factor analysis of the subscales showed that the first component loads positively on all items with approximately equal weight. We therefore interpret the composite score('problems' in the Tables) as describing the child's overall level of emotional adjustment. In our empirical work we divide the test scores for each child by the total number of items in the each test so as to reduce each test score to the same scale.

Based on the literature on the family and child development and our own previous work (Cooksey 1997, Wiggins & Wale 1996) we include a number of variables which may also influence child development. These include: child's gender and birth order, parental education, current economic status of the family measured by the presence of earners and housing tenure in Britain, and per capita family income in the US, whether the child has health problems which restrict school attendance, the duration since the most recent partnership breakup experienced by the child (expressed as a proportion of the child's age), the age of mother at her first birth, and whether she was employed outside of the home before the child started school. The last two pieces of information on the mother are only available in NCDS for children of female cohort members. Otherwise the UK models include children of cohort members of both sexes (apart from the 20 lone fathers). As women tend to have children at earlier ages than men only 34% of our sample is lost when the children of male cohort members is dropped. The US data is drawn from a sample of women only. We also found, in earlier analyses, that a measure of interest in the child's schooling, taken from the mother's self-assessed involvement in school activities, was strongly related to the UK maths and reading scores (see Joshi et al, 1996). This was omitted from the analyses reported here, because there was no equivalent information from the US. Note that any other 'effects' estimated here may work through the degree of parental interest in the child's education.

In the analyses using the NLSY we make a rough allowance for the different family patterns in minority groups by including an indicator for Black or Hispanic children. There are an insufficient number of ethnic minority children in the NCDS sample to allow us to explore the influence of ethnic origin at all.

To examine whether the effects of family disruption on children operate through effects on the economic resources available to the child, we look at the financial standing of the family. In analyses using the NLSY we include total family income for the year of interview divided by the number of individuals in the family. We could not construct an equivalent measure in NCDS because of missing income data. We therefore include indicators for families with no adult currently earning and for families currently living in social housing (i.e. rented from council or housing association). The vast majority of the reference category are owners with a mortgage. This variable also provides some control for the characteristics of children's in 'poor neighbourhood on their educational attainment since social housing tends to be concentrated neighbourhoods'.

STATISTICAL MODELS

To model the educational attainment of children within families we use the framework of the hierarchical linear model. This is a variant of the multiple linear regression model for data with a hierarchical nesting structure. First consider a two-level multi-level model of children nested in families. Children (level-1 units) are indicated by i and families by j. The dependent variable must be defined at the lowest level, the level of the individual, and it is denoted by Y_{ij}. A simple two level model can be formulated as:

$$Y_{ij} = \beta_{0j} + \beta_{1j} x_{ij} + e_{ij} \qquad [1]$$

where Y_{ij} is the value of the dependent variable, β_{0j} is the family-specific intercept, β_{1j} is the family specific-regression slope, x_{ij} is the value of the explanatory variable, and e_{ij} is the unexplained part of the dependent variable Y_{ij}. It is convenient to separate the coefficients β_{01} and β_{1j} in [1] into a fixed part (the mean) and a random part (with mean 0):

$$\beta_{0j} = \gamma_{00} + U_{0j} \qquad [2a]$$

$$\beta_{1j} = \gamma_{10} + U_{1j} \qquad [2b]$$

where γ_{00} is the population mean of the intercepts, γ_{10} is the population mean of the regression coefficients, U_{0j} is the group-specific part of the intercept, U_{1j} is the group-specific part of the regression coefficient. In this paper we restrict the magnitude of the effect of the explanatory variables on the dependent variable to be constant (i.e. $U_{1j} = 0$). Substitution of the models describing the variation of the coefficients between families into [1] then yields the combined model formula:

$$Y_{ij} = \gamma_{00} + \gamma_{10} x_{ij} + U_{0j} + e_{ij} \qquad [3]$$

This is often referred to as a variance components model. The model contains two random effects: U_{0j} and e_{ij}. Each of these indicates a different source of unexplained variation. The random intercept U_{0j} indicates unexplained differences between families in the average Y-values (controlling for the effect of x_{ij}). The random residual e_{ij}, indicates unexplained variation among the individuals, relative to their families.

Previous research has tended to treat child outcomes as being discrete, unrelated measures. This overlooks whether different outcomes interrelate. By extending the multilevel framework to a multivariate model it becomes possible to assess the degree to which the different behaviours are related. If we collect information from j children within k families on a number of i outcomes then we can produce a multivariate, multilevel structure in which level 1 is a set of response variables, one for each outcome, which nest within children at level 2, who nest within families at level 3.

In this paper, the child's maths, reading and behaviour scores define the level 1 structure. We specify the following relationship between the test scores and explanatory variables

$$F_{ijk} = F^1_{jk} + F^2_{jk} + F^3_{jk} \qquad [4]$$

where F^1 expresses the model for reading score, F^2 the model for maths score.and F^3 the model for emotional adjustment. For each F we specify a variance components model:

$$F^{1jk} = \beta^1_0 + \beta^1_1 x_{1jk} + (e_{jk} + \mu^1_{0k}) \qquad [5a]$$

$$F^{2jk} = \beta^2_0 + \beta^2_1 x_{1jk} + (e_{jk} + \mu^2_{0k}) \qquad [5b].$$

$$F^{3jk} = \beta^3_0 + \beta^3_1 x_{1jk} + (e_{jk} + \mu^3_{0k}) \qquad [5c].$$

Thus, considering the model overall there are three variables $\left[\beta^1_0, \beta^2_0, \beta^3_0\right]$ with higher-level

distributions. Consequently, besides estimating the mean and variance of each of these we can also summarize their joint distribution. In substantive terms two main benefits arise from a multilevel, multivariate approach. First, the outcomes are directly comparable in terms of how each is related to individual-level characteristics. Second, the residual covariance matrix can be estimated at both the level of the individual and at the level of the family. The level 3 between-family random terms
$\left[\mu^1_{0k}, \mu^2_{0k}, \mu^3_{0k}\right]$ represent family specific differences in average reading, maths and behaviour

scores respectively. Their joint distribution allows us to examine whether families whose children have high maths scores are also families with high reading scores and good emotional adjustment, having controlled for the characteristics of the family and child. Different model specifications can be compared using an approximate chi-squared goodness of fit statistic based on changes in the log-likelihood.

RESULTS

The results from estimating multivariate variance components models for PIAT reading recognition, maths and child behavioural problem scores are presented in Tables 3 and 4 , for UK and US children respectively. The analyses are organised as follows: Model 1 contains only age terms (our baseline model, representing internal age-standardization of the scores reported for children ranging in age from 4 to 17). This enables us to see how far age-standardised variation is clustered within families. Model 2 adds the child's gender and a summary of his or her experience of family disruption, if any. Model 3 adds controls for a set of child and parental characteristics available and roughly comparable in both data sets. This list is extended in Model 4 to include age of mother at first birth and indicators of the mothers work history prior to the child attending school, which restricts the British sample to the offspring of female NCDS members (and also results in the loss of a few US cases due to missing data). The comparison of results from this sequence of models allows us to see how far the three scores are associated with family disruption, and how far any association might be accounted for, or mediated, by the inclusion of further information particularly about the social, human and economic capital available to the child.

When scanning the tables of results, 't' ratios are a convenient summary of the strength of the coefficients. In all models for reading and maths (but not for behavioural problems), the age terms are significantly different from zero. Both maths and reading scores increase with age but do so at decreasing rates. Note that in this cross-sectional analysis age and cohort effects are confounded, particularly as age of child is inversely associated with age of the study parent at their birth.

The estimates of the random part of the model suggests that families do differ in their average reading, maths and behaviour scores and that there is even more variation among children within families. In all four sets of analyses the variance component within families (μ_0) in Model 1 is around twice the magnitude of the variance component between families (μ_{0k}). These terms can be found on the diagonals of the two half-matrices reported in the bottom of Table. 3, accompanied by 't' statistics which show how well determined each variance and covariance is. Another way of thinking about the sources of variation in reading and maths scores is to estimate the intra unit correlation, ρ, which tells us what portion of the total variance occurs between families. Values of 33.9%, 33.0% and 33.8% and 35.6%, 30.0% and 49.0% for reading, maths and behaviour from the NCDS and NLSY respectively tell us that there is significant clustering of test scores within family. This suggests that an OLS analysis of these data would likely yield misleading results.

The covariances between the residual terms allow us to assess the relationships between numeracy, literacy and behavioural problems at both the child and family levels. In particular, we see that at both family and child levels there is a strong positive covariance between maths and reading scores and a strong negative covariance between both maths and reading and behavioural problems.

Model 2 controls for the child's gender as well as family structure. Girls appear to be ahead of boys on reading attainment, and to be better behaviourally adjusted, in both countries. In the UK, however, girls have lower levels of maths attainment. In terms of family structure, Model 2 finds that in the NCDS three out of four sub-types of disrupted family showed children with significantly adverse outcomes on some but not all scores. Children with a lone mother at birth and interview scored significantly lower on reading, (5% less than those in intact families)

and significantly raised behaviour problems (8% on the borderline of significance). Children in step families following lone parenthood showed raised behavioural problems and lower maths scores than those with both their natural parents. Children of lone parents resulting from a couple breaking up showed significantly lower scores on all counts. Reconstituted two-parent families did not appear to be significantly different to intact two-parent families.

In the NLSY (Table 4), Model 2 shows more significant family structure parameters (eight out of twelve rather than six). Among reconstituted families in the NLSY there is an excess of behavioral problems (4%) (though maths borders on being significantly positive). In families that are fatherless at birth and interview, all three scores are significantly adversely affected.(by 5 or six points). In step families formed after single motherhood, there were significantly poorer reading and maths scores, (around half the magnitude of the single mothers who remain alone). For reading and maths these US families resembled their British counterparts. On behaviour, these US step families show non-significant association, in contrast with NCDS. Children whose mothers were currently alone, after a parental split had significantly lower reading scores and higher levels of behavioural problems than intact families.

It might be expected that the behaviour score would be more strongly with family disruption than reading or maths scores. The school test scores are generated in a structured classroom environment , while behaviour items are reported over a number of domains of the child's life. This is not wholly borne out in the estimates of Model 2. Neither the t statistics nor the coefficients are consistently stronger in the behaviour equation, though the coeffeicients are the highest for behaviour in all types of family disruption in the British data. The estimated effects on behaviour are certainly not consistently the weakest in either country. Furthermore, in neither country are the face value associations of family disruption and any of these scores particularly alarming. They are modest in magnitude and not generally or uniformly afflicting all types of non-intact family. The estimates of the variance components in Model 2 decrease in comparison to Model 1 but not greatly. This indicates that family status explains only a small proportion of the explainable variation in the scores within families. There are plenty of children doing well and poorly in these tests, or displaying unusually poor or good emotional adjustment quite unrelated to their family structure history, and what association there does appear to be is not enormous, and leaves an inevitable challenge to explanation.

Model 3 includes both child level and family level predictors in the model as well as the variables describing family disruption. In the NCDS only one family structure coefficient remains significant: that of children born to lone mothers who subsequently partnered in the models describing the child's maths and behavioural scores. Otherwise, the apparently damaging associations in Model 2 between family change and emotional and cognitive development are (statistically) accounted for by the set of child and parental characteristics included in Model 3. In the NLSY more coefficients implicating family change remain significant. For reading score both types of current lone mother family show significant, negative, but attenuated coefficients. For both maths, and behaviour problems, controlling for parental and child characteristics removes all the significant terms except those for children born to lone parents who remain unmarried. The estimated differences from intact families are also reduced. Curiously there is no consistent pattern in these still significant effects across countries. Step families formed after a birth to a lone mother have significantly raised behaviour problems in NCDS, but not in NLSY. In the families with a lone mother at both points, any significant disadvantage is accounted for by the controls included in Model 3 in Britain, but not in the USA.

The parental and child characteristics included in Model 3 which account for most variation in the test scores, (and also for the association between test scores and family status), are parental education, the variables which describe the families economic circumstances, the number of older siblings, 'race' in the US , and child's health for behaviour in UK. Parental education is strongly associated with higher test scores, particularly so for reading, but also maths, and fewer behavioural problems. One extra educational grade in the parent raises children's scores (and reduces their problem score) by around 2%. Note that the parent in question is invariably the mother in the the US sample, and mostly the mother in NCDS. The number of older siblings (birth order) has the opposite association, particularly in the case of reading in the UK. Table 2 shows that the number of older siblings is higher among lone mother families, so this term is contributing to the attenuation of family structure effects.

Table 2 also shows that family disruption is highly associated with the absence of any earning parent, social housing and parental education. Children in a family which lives in social housing (NCDS) tend to have lower test scores and more 'problems' than the more affluent families living in accommodation, and perhaps neighbourhoods, with better characteristics. Our other indicator for family poverty in Britain is the absence of any adult earner in the family. This is significantly associated with poor maths scores, and is nearly significantly associated with poor behavioural adjustment. In the US, family income shows a somewhat better determined association with each score. Children who are growing up in a low-income family in either country are clearly disadvantaged in their cognitive and emotional development.

It may be expected that parental separation has greatest disruptive effect on children at the time the separation takes place. In these analyses, however, we find no effect of the recency of parental separation on any of the British scores. In the US there is one significant finding: that behavioural problems were raised as the duration since partnership breakup increased. Apart from this, our NCDS findings resemble those for the previous generation by Kiernan (1992). But she found stronger adverse outcomes for step families. In that generation most step families would have started as two natural parent families in which case we find no association with test scores.

Comparing the random terms in Models 2 and 3 we find that the addition of child and parental characteristics significantly reduces the between family variance component (μ_{0k}). The predictors therefore help to explain part of the variation in maths and reading scores between families. There is still however substantial variation in maths and reading scores left unexplained. The t-statistic for the residual variance component for intercepts rejects the null that μ_{0k} is 0 in all models. The remaining random terms represent the covariance between the two random intercept terms at the child ($\sigma^1_{\mu 0}\sigma^2_{\mu 0}$) and family ($\sigma^1_{\mu 0k}\sigma^2_{\mu 0k}$) level, controlling for child and family characteristics. The correlation between the two intercepts for the two responses can be calculated as the ratio of their covariance to the square root of the product of their variances. At the level of the family this gives high positive correlations (0.76 in the NCDS and 0.86 in the NLSY) between the two response variables. This tells us that families with low reading scores are also families with low maths scores.and more behavioural problems.

Model 4 includes controls for the mother's age at first birth and the mother's labour market experience prior to the child attending school. This restricts our sample to the children whose mothers are NCDS cohort members. In both the UK and US, the fixed effects which are

common to Models 3 and 4 show little change in sign or statistical significance (except that the child's own health becomes significant in the UK). In the NCDS, if the mother's first job between child's birth and 4th birthday is negatively associated, other things being equal, with the child's reading score. This result needs further exploration, for example evaluation alongside terms which may offset it, such as the number of current earners and mother's education, and investigation of who these mothers are, but is not the main focus of this paper. Part time empoloyment when the child was younger seems to have no impact on the educational attainment, and a positive association with emotional adjustment. In the NLSY, families in which the mother started bearing children at young ages are associated with deficits in reading score. This probably reflects the background, experiences and characteristics of these women rather than a causal effect. The results for the fixed effects common to Models 3 and 4 are again largely unchanged except that the effect of repeated lone parenthood is again significant in Model 4. In neither model is the age at first birth term significant. The distinguishing characteristics of teenaged mothers seem to have been captured elsewhere. Neither does the inclusion of this term affect the estimated age coefficients, as it might have done, had the latter contained a strong age at parenthood element..

The random terms in Model 4 are still significant. Even with the additional controls variation at the family level persists, indicating that there is additional variation in our dependent variables that is not explained by the information included in the model. This finding may be interpreted as reason to believe that there are additional family level factors that might explain the variation in test scores. The estimates proved sensitive to the exclusion of a few outllying observations. The usual caution about estimates having margins of error applies in full force in all these models.

We have attempted to explore interactions between gender and family structure, and for the USA race, but have run into computational problems of non-convergence. Further work on the models proceeds. It may be that the small sample sizes of some disrupted groups makes it difficult to estimate different parameters by gender, or it may be that gender differences in reactions to family change are not as marked among children in this relatively young age range as have been found among adolescents in some of the other literature. The only significant interaction of gender and family structure which has so far been detected (in British data) was for behaviour and lone-lone mothers where girls 'performed' differently to boys. This will also attempt to introduce the 'confounder' variables in a temporally logical sequence.

CONCLUSIONS

In this paper we have examined the relationships between a child's experience of family disruption and later cognitive and behavioural outcomes using data collected from children born to a cohort of young parents in both the US and UK, controlling for some factors which may intervene in any causal mechanism at work.

The results for the two countries are similar in so far as differences in scores, of a generally similar magnitude, are apparent for the various non-intact family structures in both countries, when the only other control is age. They are also in general similar in that these differences can largely be explained by the inclusion of other variables, notably economic circumstances, which may themselves be the outcome of the disruption. Beyond that, the

countries differ as to the categories of disrupted families which are most affected, and in the degree to which some direct association remains after the controls. Lone mothers who were unmarried at the birth of the child are associated, in the US, with all scores significantly adversely affected even after adjustment, but none are in the British study. Children of lone mothers who form step families have significantly unfavourable scores on two different counts out of the three in each country, but only behaviour in Britain remains significantly affected after allowing for the other information. Broken families where the child stays with a mother on her own show similar reading and maths deficits, and similar levels of excess problems in both countries, all accounted for by additional regressors, except for reading in the US. Some of these differences between the countries may arise from the different definitions of approximately common variables, from the different definitions of the family structure in the two datasets, and from the underlying differences in demography that makes single motherhood more pervasive across individuals and across children's lifetimes in the USA. They also suggest that the precise routes through which children are affected vary from country to country. This could be explored further by separating the US ethnic groups. We can confirm the difficulty of drawing universal conclusions discovered by Cherlin et al (1991) in a similar analysis of the previous generation.

The results for the US find more significant associations of literacy and numeracy with family structure than did Cooksey (1997). A likely reason for this is the inclusion of children born after the first in the present study, who we find to be vulnerable. Another source of difference could be the different sample of mothers. This poor performance of children of single mothers concurs with most other previous US studies on educational outcomes that included information on family structure (Haveman and Wolfe 1995). Our results suggest that in the NLSY the average effect of living with a step-parent after a divorce on child test scores could be positive.

For NCDS children our results confirm those of Wiggins and Wale (1996), who found no association of single parenthood with reading and maths in the same data, even though they took no account of the route to the lone parent situation and included some different controls. Our results for step families contrast with studies made of the previous NCDS generation (Kiernan 1992, Elliott and Richards 1991), where, at older ages than those examined here, the presence of a step-parent after divorce did not seem on average to ameliorate various negative outcomes. In this case the only step families where children appear to have poor scores(on maths and behaviour) are those where the mother was unpartnered at the child's birth - a minority of the step families here and an even more rare occurrence in the previous generation. This points towards a conclusion that the later generation has adjusted better to some sorts of family form. Although passing school tests around age ten may not be the most telling challenge these children will have to face, the failure to discern a deficit on the behaviour score, of being in a reconstituted family suggests that on the whole most children and most families were coping as well as their circumstances would allow. It is possible, though unlikely, that the well validated Rutter scale may not be appropriate to capture the ways in which children may be psychologically damaged by a 'broken home'. The legacy of family change may be yet to come. It may also have affected the few families who had experienced multiple re-partnering, as in the Exeter Study (Cockett and Tripp (1994), who were not sufficiently numerous in our data to treat separately, but who may have been among our outliers. A step-parent may bring extra resources or extra stresses, or both, to a child's life, for which our quantitative data is only the most superficial indicator.

Note that two other forms of disrupted family were not associated with significant adjusted parameters in NCDS: living with a lone mother who had been unpartnered at birth, and those in two parent families at birth and at interview where there had been a change of partner. For the UK, the puzzle is why some non-conventional families do not present problems, despite their material disadvantages. Perhaps this is evidence that some children cope with at least those non-intact family forms where there is less change. It is also possible that other outcomes, eg, achievements at later ages or in the labour market, could vary across all types of family, but this paper finds that contemporary behaviour is not much more disrupted than the cognitive scores. It is also possible that the reference group of intact families are not free of conflict and instability. In further tests reported by McCulloch (1998), there was no significant difference in these childscores between those intact families where the relationship was described as happy, and those reported to be less than happy. We have no information on how people outside the family react to changes in its personnel. The growing prevalence of family fission may have reduced the stigma of single parenthood since the parents in these studies were themselves growing up. Although it is still too soon to tell, these children have to face a number of more taxing hurdles than literacy and numeracy tests on their route into adulthood. Furthermore comparison with the US, where family fission has become even more familiar does not suggest that adaptation has followed, at least completely in its wake.

We did not replicate in the US any negative association between mother's employment and child outcomes, as was reported by Haverman and Wolfe (1995). Neither did we in the UK as concerns mothers whose first job while the child was under 4 was part-time. We did find a significant negative association, holding other variables constant, of a mother having had a full-time job in the first four years of the child's life, with the child's maths score. This factor may dampen the strong positive effect we have fitted for maternal education in the two countries. This adds to the importance of women's education for their role in social reproduction, and the transmission of social capital, which is apparent in the demography of rich and poor countries alike.

There are additional important research findings that result from our use of a hierarchical statistical model. We are able to assess the relationship between a child's scores at both the child and family level. This shows a strong positive correlation between a child's test scores at both the individual and family level. The models have been more successful at explaining variances and covariances at the family level than that of the child him/herself.

It should be borne in mind that, while this study has controlled for a relatively large number of potentially confounding factors, the possibility remains that the relationships between the explanatory variables and child outcomes are non causal and arises from various sources of confounding, at the child, family and community level, not adequately controlled for by this analysis. The statistical significance of the random terms included in our model indicate substantial individual and family specific differences in the level of attainment achieved by the children in both the NLSY and NCDS. Family disruption is only one part of a general social, economic and family context where a large number of factors which may act to put children at a disadvantage.

This is an early attempt to analyse these data. Much remains to be explored, for example separate models for the Black and White Americans, and the inclusion of information in the NCDS on geographical mobility. We also intend to extend the multi-level modelling to a random

element in the coefficients. In due course further collection of data from these children could address the issue of causation, or at least temporal sequence, of poor test performance and family change, and explore the consequences of parental conflict, recorded in 1991 for NCDS members who had partners. With data both before and after a change in family structure it is possible to make some allowance for pre-existing conditions, and to improve the causal interpretation of associations. There would still be the problem of disentangling those antecedents which were independent, causal or anticipatory of family change. Tests by McCulloch (1998) on the snapshot data used here could not reject the hypotheses of positive, negative, or no causal effect from family structure to child's maths and reading, so caution is in order about causation. If we found large significant parameters, one would be wary of calling them effects of family disruption. As we find few significant adjusted parameters, can we conclude less cautiously that there is little causation? It looks as though any effects there are involve those of the regressors which are consequent upon the family disruption, but this depends upon assumptions we have not been able to test. Those we have found significant here mostly involve material resources. (though other parental inputs also matter, witness our earlier British evidence about mothers involvement in schooling).

What can we conclude from this analysis about the effects of family change on children's educational attainment ? There are both hopeful and pessimistic signs. The pessimistic signs are that, as far as these outcomes are concerned, it would appear that most kinds of non-intact family are associated with lower levels of school test performance or behavioural adjustment in children. More optimistically, the model suggests (but does not prove) that children's well-being may be protected from adverse consequences of family change by adequate inputs of parental resources. But even where this is difficult, negative outcomes are far from inevitable. The relatively large portion of unexplained variance in maths, reading, and behaviour scores gives some weight to the 'Law of Random Results' propounded by the journalist Katherine Whitehorn about child-rearing. From the parent's point of view this means that whatever they do, some children will succeed and some will fail on conventional targets. From the child's point of view, it means that their attainments are not pre-ordained by who their parents are, what they do and whether they stay together. What the fixed part of our model suggests the assignment of maths, reading and behaviour scores is not a total lottery, that the dice are differentially loaded against some children. This offers them a challenge rather than an excuse.

This is a preliminary report of our project, using data which has since been subjected to apparently minor revisions in the case of NCDS. Further refinement of our models is in train, and comments will be welcomed.

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[1] Custody of children at divorce is generally awarded to mothers (Maclean & Eekelaar 1997, Haskey 1996) and children born outside of a partnership nearly always remain in the care of their mothers (Clarke et al. 1997).

Table 1: Defintions of variables included in analyses.

NAME	DEFINITION	LEVEL[1]	COUNTRY[2]
read	PIAT reading recognition test score (divided by maximum = 84)	C	B
math	PIAT mathematics test score (divided by maximum = 84)	C	B
problems	Emotional adjustment score (sum of individual items divided by maximum = 18 for Rutter Scale and 32 for BPI).	C	B
age	age of child in months	C	B
age2	square of age / 100	C	B
girl	sex of child, 1 = female	C	B
lone - lone	lone parent at birth and interview	C	B
lone - step	step family, lone at birth	C	B
joint - step	step family, natural parents together at birth	C	B
joint - lone	lone parent, natural parents split	C	B
duration	months since most recent partnership breakup expressed as a proportion of the child's age	C	B
non-white	dummy = 1 if either Hispanic or Black	C	US
tenure	dummy = 1 if family rents housing from local authority or housing association	F	UK
noearner	dummy = 1 if neither mother nor resident father in employment	F	UK
netinc	log (total family income divided by family size)	F	US
qual	cohort member's highest educational qualification, scale 0 to 5 where 5 =degree, 0 = none	F	UK
	mother's educational attainment, scale 0 to 4 where 4 = more than BA, 0 = less than high school	F	US
birth order	number of older siblings - 1	C	B
health	child's school attendance affected by poor health	C	UK
earlyft	dummy = 1 if mother's first job before child aged 4, if any, was full-time	C	UK
earlypt	dummy = 1 if mother's first job before child aged 4, if any, was part-time	C	UK
work5	if mother had any paid work before child aged 5	C	US
first birth	age of mother at her first child (years)	F	B

[1] level of model at which variable is defined (C = child level, F = family level).

[2] country for which variable can be constructed (US = United States, UK = United Kingdom, B = both).

Table 2: Means of variables included in analyses.

	FULL SAMPLE		FAMILY HISTORY				
	Mean	Standard Deviation	Lone-Lone	Lone-Step	Joint-Step	Joint-Lone	Intact
NCDS							
read	0.50	0.22	0.42	0.61	0.60	0.53	0.46
math	0.46	0.19	0.43	0.56	0.56	0.50	0.43
problems	0.34	0.22	0.43	0.43	0.38	0.40	0.32
(n=1982)							
age	108.8	33.9	113.4	146.1	134.7	123.8	103.9
girl	0.52		0.40	0.45	0.54	0.53	0.51
duration	0.07	0.20			0.52	0.46	
tenure	0.27		0.53	0.50	0.42	0.57	0.22
noearner	0.10		0.36	0.26	0.12	0.47	0.06
qual	2.01	1.37	1.46	1.54	1.62	1.63	2.10
birth order	1.59	0.85	1.73	1.32	1.61	1.72	1.58
health	0.06		0.03	0.06	0.06	0.06	0.06
earlypt			0.21	0.20	0.30	0.27	0.25
earlyft			0.32	0.52	0.26	0.21	0.38
first birth			21.82	20.17	20.65	21.25	23.01
No. cases	2307		30	46	191	155	1885
NLSY							
read	0.50	0.22	0.49	0.57	0.51	0.59	0.46
math	0.46	0.19	0.45	0.51	0.47	0.31	0.42
problems	0.31	0.19	0.34	0.30	0.34	0.55	0.28
age	122.0	37.0	131.6	140.7	125.4	133.4	111.3
girl	0.50		0.52	0.49	0.53	0.53	0.48
duration	0.08	0.19			0.40	0.39	
non-white	0.54		0.87	0.78	0.55	0.36	0.42
netinc	8.83	0.87	8.25	8.67	8.65	8.93	8.93
qual	2.22		1.93	2.09	2.21	2.18	2.30
birth order	1.70		1.75	1.47	1.67	1.61	1.76
health	0.01		0.01	0.01	0.02	0	0.01
work5			0.69	0.87	0.86	0.91	0.86
first birth	20.48	3.07	19.21	19.24	20.11	19.66	21.17
No. cases	2251		425	289	276	149	1114

Table 3: Multivariate model estimates for literacy, numeracy and behaviour: NCDS Children.

		Model 1						Model 2					
Fixed		Reading		Maths		Problems		Reading		Maths		Problems	
effects:		β*	t	β	t	β	t	β	t	β	t	β	t
constant		-5.935	-21.5	-5.062	-24.0	-0.545	-1.1	-5.995	-21.6	-4.956	-23.31	-0.537	-1.1
age		0.145	29.2	0.13	34.2	0.065	1.36	0.144	29.1	0.129	33.9	0.067	1.6
age2		-5.519	-18.3	-4.97	-21.6	-3.47	-0.4	-5.442	-18.0	-4.875	-21.12	-3.684	-0.8
lone - lone								-0.516	-2.1	-0.171	-1.0	0.812	1.9
lone -step								-0.315	-1.6	-0.366	-2.4	0.885	2.6
split - step								-0.172	-1.6	-0.113	-1.4	0.263	1.4
split - lone								-0.371	-3.1	-0.222	-2.4	0.621	2.9
girl								0.18	3.428	-0.092	-2.3	-0.215	-2.3
health													
birth order													
duration													
qual													
tenure													
noearner													
earlyft													
earlypt													
first birth													
Random Effects:													
Family Level	R	0.059	9.454	0.037	9.675	-0.028	-3.608	0.057	9.414	0.036	9.526	-0.025	-3.239
	M			0.033	9.127	-0.018	-3.001			0.032	9.035	-0.016	-2.679
	P					0.158	8.517					0.155	8.533
Child Level	R	0.115	20.424	0.036	10.865	-0.022	-3.082	0.114	20.286	0.036	10.959	-0.022	-3.008
	M			0.067	20.508	-0.016	-2.886			0.067	20.308	-0.017	-3.032
	P					0.309	18.447					0.306	17.905
-2 log-like		-8478						-8548.7					
N		2307						2307					

coefficients are reported × 10

Table 3 continued NCDS

		Model 3						Model 4					
Fixed		Reading		Maths		Problems		Reading		Maths		Problems	
Effects:		β	t	β	t	β	t	β	t	β	t	β	t
constant		-6.059	-20.665	-5.259	-23.342	-0.353	-0.663	-6.764	-8.866	-5.362	-9.121	1.759	1.278
age		0.144	30.008	0.129	34.965	0.066	1.51	0.146	26.436	0.130	30.334	0.059	0.869
age2		-5.409	-18.543	-4.846	-21.615	-3.727	-0.917	-5.419	-16.876	-4.859	-19.577	-3.54	-1.007
lone - lone		-0.264	-1.131	0.019	0.104	0.523	1.212	-0.293	-1.212	0.073	0.393	0.53	1.19
lone -step		-0.251	-1.318	-0.313	-2.147	0.783	2.307	-0.126	-0.623	-0.135	-0.863	0.759	2.081
split - step		0.019	0.11	0.068	0.496	-0.395	-1.17	-0.084	-0.47	0.060	0.432	-0.298	-0.859
split - lone		-0.043	-0.248	0.076	0.57	-0.213	-0.628	-0.097	-0.546	0.078	0.715	-0.079	-0.226
girl		0.174	3.445	-0.098	-2.52	-0.21	-2.271	0.184	3.214	-0.093	-2.094	-0.185	-1.763
health		-0.108	-0.98	-0.134	-1.588	0.343	1.667	-0.286	-2.212	-0.291	-2.921	0.54	2.255
birth order		-0.186	-5.697	-0.057	-2.274	0.069	1.151	-0.137	-2.75	-0.055	-1.428	0.015	0.166
duration		-0.126	-0.469	-0.206	-1.001	0.982	1.941	-0.012	-0.046	-0.127	-0.608	0.803	1.551
qual		0.199	8.973	0.17	9.971	-0.147	-3.642	0.205	8.124	0.168	8.657	-0.145	-3.149
tenure		-0.394	-5.551	-0.211	-3.884	0.414	3.123	-0.428	-5.374	-0.244	-3.995	0.379	2.519
noearner		-0.075	-0.711	-0.172	-2.132	0.377	1.867	0.048	0.402	-0.171	-1.877	0.383	1.681
earlyft								-0.188	-2.584	-5.016	0.294	0.151	1.122
earlypt								-0.05	-0.646	0.023	0.391	-0.327	-2.268
first birth								0.023	1.073	-0.003	0.158	-0.062	-1.628
Random Effects:													
Family	R	0.043	7.719	0.026	7.652	-0.012	-1.719	0.041	6.532	0.025	6.561	-0.011	-1.396
Level	M			0.024	7.537	-0.007	-1.271			0.023	6.111	-0.001	-0.198
	P					0.14	7.891					0.147	7.21
Child	R	0.112	20.64	0.035	10.967	-0.021	-2.956	0.112	18.144	0.035	9.565	-0.023	-2.94
Level	M			0.066	20.672	-0.016	-2.941			0.068	18.255	-0.022	-3.615
	P					0.307	18.367					0.305	16.144
-2 log-like		-8831.80						-6911.27					
N		2307						1806					

coefficients are reported × 10

Table 4: Multivariate model estimates of literacy, numeracy and behaviour: NLSY Children

		Model 1						Model 2					
Fixed		Reading		Maths		Problems		Reading		Maths		Problems	
Effects:		β	t	β	t	β	t	β	t	β	t	β	t
constant		-5.777	-18.848	-5.84	-23.482	2.663	6.443	-6.11	-19.59	-5.727	-22.485	3.049	7.183
age		0.135	26.393	0.135	32.594	0.005	0.79	0.134	26.647	0.134	32.517	0.004	0.543
age2		-4.93	-17.148	-5.347	-22.782	-0.228	-0.592	-4.854	-17.092	-5.247	-22.519	-0.186	-0.485
lone - lone								-0.648	-7.271	-0.505	-7.118	0.587	4.424
lone - step								-0.319	-3.147	-0.247	-3.036	0.177	1.167
split - step								0.065	0.501	0.2	1.931	0.41	2.109
split - lone								-0.323	-3.086	-0.157	-1.882	0.565	3.69
girl								0.318	5.817	0.022	0.482	-0.306	-4.051
non-white													
health													
birth order													
duration													
qual													
netinc													
work5													
first birth													
Random Effects:													
Family	R	0.063	9.714	0.039	9.092	-0.032	-4.557	0.057	9.173	0.035	8.49	-0.024	-3.649
Level	M			0.035	8.304	-0.024	-4.264			0.031	7.726	-0.02	-3.666
	P					0.182	13.304					0.174	13.073
Child	R	0.114	19.868	0.043	11.568	-0.023	-4.042	0.112	19.95	0.042	11.571	-0.021	-3.905
Level	M			0.081	20.383	-0.016	-3.438			0.081	20.468	-0.016	-3.409
	P					0.187	19.244					0.186	19.27
-2 log-like		-						-					
N		2251						2251					

coefficients are reported × 10

Table 4 continued NLSY

		Model 3						Model 4					
Fixed		Reading		Maths		Problems		Reading		Maths		Problems	
Effects		β	t	β	t	β	t	β	t	β	t	β	t
constant		-8.474	-17.592	-7.311	-18.799	6.506	9.181	-7.87	-11.025	-7.719	-13.413	5.745	5.285
age		0.138	27.787	0.136	33.738	0	-0.064	0.134	19.576	0.146	26.456	0.007	0.713
age2		-5.038	-18.096	-5.346	-23.468	-0.114	-0.299	-4.851	-11.6	-6.014	-17.735	-0.543	-0.907
lone - lone		-0.348	-3.825	-0.178	-2.47	0.35	2.492	-0.37	-4.031	-0.185	-2.522	0.37	2.511
lone - step		-0.187	-1.897	-0.057	-0.722	0.084	0.553	-0.182	-1.791	-0.093	-1.131	-0.021	-0.13
split - step		0.006	0.04	0.158	1.336	0.147	0.636	0.139	0.931	0.305	2.524	0.082	0.336
split - lone		-0.307	-2.297	-0.091	-0.86	0.197	0.965	-0.368	-2.734	-0.053	-0.492	0.219	1.022
girl		0.293	5.494	0.001	0.023	-0.289	-3.862	0.285	5.33	-0.006	-0.148	-0.335	-4.26
non-white		-0.201	-2.98	-0.416	-7.76	0.017	0.162	-0.16	-2.395	-0.357	-6.644	0.032	0.298
health		0.164	0.622	-0.13	-0.603	0.637	1.92	0.213	0.799	-0.198	-0.909	0.848	2.387
birth order		-0.109	-3.148	-0.043	-1.534	-0.106	-2.152	-0.117	-2.6	-0.044	-1.201	-0.086	-1.276
duration		0.176	0.819	0.075	0.433	0.71	2.164	0.27	1.21	0.012	0.066	0.597	1.679
edqual		0.235	6.07	0.149	4.828	-0.266	-4.421	0.225	5.749	0.138	4.362	-0.284	-4.505
netinc		0.213	5.731	0.151	5.076	-0.257	-4.405	0.185	4.927	0.131	4.328	-0.246	-4.008
work5								0.11	1.35	0.095	1.444	0.177	1.427
first birth								-0.009	-0.552	0	0.033	0.008	0.328
Random Effects:													
Family	R	0.04	7.103	0.022	6.134	-0.012	-1.991	0.037	6.764	0.022	6.19	-0.012	-1.823
Level	M			0.02	5.635	-0.01	-2.077			0.022	6.128	-0.009	-1.843
	P					0.162	12.548					0.163	11.972
Child	R	0.114	20.337	0.044	11.963	-0.022	-4.09	0.101	18.636	0.036	10.439	-0.022	-4.015
Level	M			0.081	20.907	-0.017	-3.666			0.07	19.038	-0.017	-3.86
	P					0.184	19.567					0.177	17.775
-2 log-like		-						-					
N		2251						2019					

coefficients are reported × 10