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ABSTRACT

This study examined whether parents who lack numeracy, literacy, or writing skills transmit their difficulty to their children. The study also sought to determine whether other family or child characteristics relate to children's basic skills; if child outcomes or predictors display between-family variation; and if child outcomes display any differing variability as a function of child or family characteristics. The study used a multivariate multilevel analysis to evaluate intergenerational transmission of literacy and numeracy for a sample of 2,647 children (ages 5 to 17 years) born to 2,150 33-year-old cohort members of the fifth sweep of the National Child and Development Study conducted in 1991. Child level data were obtained from interviewing the child's mother and through the Mathematical Assessment and Reading Recognition subtests from the Peabody Individual Achievement Test. Results revealed a steady decrease in variance of mathematics and reading up to 11 years of age followed by an increase in variance. Even with age standardized scores, the effect of age on the outcomes must be considered. Substantive conclusions reflected the power of a multilevel approach to reveal variation in parameter estimates beyond a conventional regression approach. Parental qualifications and social class were influential determinants of children's achievement. Parent's difficulty in writing had a direct effect on child outcomes. There were a number of interactions within and between families involving preschooling, learning difficulties, age, and gender. (Contains 26 references.) (KDFB)

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analysis OF LARGE AND COMPLEX DATASETS

Intergenerational analysis of literacy and numeracy outcomes for children of NCDS cohort members

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SUMMARY: Findings are presented for a multilevel analysis of the interegenerational process in the transmission of skills in literacy and numeracy for a sample of 2647 children aged 5-17 years born to 2150 33-year old cohort members of the fifth sweep of the National Child and Development Study. The methodological issues of standardization and selection effects are considered. The results show that age standardization does not work by itself and age must be introduced into the models. Substantive conclusions reflect the power of a multilevel approach to reveal variation in parameter estimates beyond a conventional regression approach. From an intergenerational perspective parental qualifications and social class are influential determinants of children's attainment. A parent's difficulty with writing appears to have a direct effect on child outcomes. Interactions and variation both within and between families involving the effect of preschooling, learning difficulties, age and gender suggest a number of interesting research questions for closer observation.

KEYWORDS: National Child and Development Study, intergenerational transmission, literacy and numeracy, standardisation, selection effects, multivariate multilevel modelling.

1. INTRODUCTION

In June 1972 Sir Keith Joseph, then Secretary of State for Social Services, drew attention to the conspicuous persistence of deprivation and maladjustment in Britain. In particular, he drew attention to the idea that social problems tend to recur in successive generations of the same families to form a 'cycle of deprivation'. Subsequently, the, then Department of Health and Social Security and the, then, Social Science Research Council, funded a programme of research into the whole problem (Rutter and Madge (1976), Blaxter (1981), Coffield (1980), Brown and Madge (1982), , Blaxter and Paterson (1982), Mortimer and Blackstone (1982). The programme also required investigations to be made into the extent of disadvantage within one generation, Essen and Wedge (1982). A crucial aspect of their work was to explore the lives of children in disadvantaged circumstances, including both their present circumstances, their style of living and their likely future chances in life, as these could provide a clue to how transmission of disadvantage could occur. Using a multiple indicator of social disadvantage based on poor housing as indicated by either sharing or lacking hot water or overcrowding (more than 1.5 persons per room), recept of free school meals and/or supplementary benefit for a group of families described as atypical, those being single parents or with five or more children they explore using the National Child and Development Study (NCDS) the extent to which different children are disadvantaged at different stages of their childhood (age 11 and 16) and the relative impact of such disadvantage on their circumstances. In broad terms their study was a follow-up of the study of socially disadvantaged children reported in 'Born to fail' by Wedge and Prosser (1973).

The study reported here shares much in common with this early work on transmitted deprivation. The data source is the NCDS. NCDS is a longitudinal cohort study of all children born in one week in March 1958 with follow-ups on cohort members between birth and age 33 years (Shepherd, 1985). During the fifth sweep of NCDS in 1991 a sample of one third of the cohort members were selected. The sample consisted of all children aged between 5 and 17 years of age for the selected cohort member. This presented researchers with a unique opportunity to study the transmission of deprivation across generations. The substantive focus of the work reported here reflects current interest both in Britain and the United States on family literacy (Hannon (1995), Sticht and McDonald (1990)) and as such it represents only one small piece of further evidence regarding disadvantage. The concept of family literacy is increasingly accepted as an important factor in determining children's literacy abilities and their educational progress. The process of education may be impeded for children whose parents suffer from a lack of basic literacy and numeracy skills. The analysis reported here is an expansion of the work of the Adult Literacy and Basic Skills Unit (ALBSU) who provide the first objective evidence of the link between a parent's competence in basic skills (reading, writing and number) and the competence of their children (Montgomery and Bynner (ALBSU, 1993). The ALBSU Report examined the relationship between parents' literacy and numeracy difficulties and their children's abilities as measured by a maths test and a reading test. The report included other family characteristics and how they relate to basic skills. Their principal findings were based on multiway contingency tables relating child outcomes in reading and maths with self-reported problems from parents, parental educational qualification and income. Their results suggested that children from families where parents have basic literacy problems are likely to suffer from diminished opportunity to acquire literacy and numeracy skills. The disadvantage is compounded in families with low income or where parents achieved very low levels of educational attainment. The group reported to be most at risk of growing up with the lowest levels of basic skills are children from low income families where the parents have poor reading abilities (see annex for reference to ALBSU tables). A theme which fits neatly into the existence of a cycle of deprivation and earlier evidence on literacy and numeracy from NCDS (Simonite, 1983).

By conducting the analysis in the framework of multilevel modelling (Goldstein, 1995) it is possible to explore the combined effect of parental characteristics upon child outcomes whilst taking more into account about the child as individuals themselves. Any variation between families as described by cohort member characteristics can be modelled so that we are able to begin to understand why differences occur. Similarly and simultaneously it is possible to model within family variations in terms of child-level characteristics. The two child level outcomes in literacy and numeracy are modelled as bivariate outcomes in a single analysis. This provides an understanding of any association between these skills as well as identifying any differences in the part played by our explanatory variables. Furthermore there is no requirement for the design to have the same number of observations at any level. The facility to handle unbalancedness (Searle, 1987) routinely in multilevel modelling make it an appropriate procedure to handle any missing outcomes at the child-level. Formally, we have a population hierarchy of children grouped within families, where children are referred to as level 1 units clustered within families at level 2 in the data structure. The hierarchy is extended easily to handle the two test scores by nesting them at level 1 clustered within children at level 2 within families at level 3. Thus we have a 3-level multivariate multilevel analyses (also illustrated by Duncan, Jones and Moon, 1995). The analysis here is based on 2165 children nested within 1475 cohort members.

The main objectives of this analysis set out to answer the following questions:

-do parents who suffer from a basic lack of numeracy , literacy and writing skills impede their children's abilities in the same way?

-how do other family characteristics, notably the presence of a partner in the home, family size, parental education and income relate to the child's basic skills?

-how do other child characteristics, notably age, gender, birth order, learning difficulties and attendance at preschool relate to basic skills?

-are there any important interactions between and within family and child characteristics?

-do child outcomes and/or predictors display any between family variation?

-do child outcomes display any differing variability as some function of child or family characteristics?

2. SUBJECTS AND METHODS

2.1 Data

During the fifth sweep of NCDS, conducted in 1991 when cohort members were 33 years old (Ferri, 1993), approximately one third of cohort members with children were targeted for the very first sample of their children. Both female cohort members and the female partners of male cohort members were asked further questions about all of their children aged 4 years and above. The survey comprised an interview for cohort members which included questions about literacy and numeracy problems. Children also participated in educational assessments. To gain insight into aspects of intergenerational transmission this analysis focuses on those children for whom there was a response from the natural mother. Almost all of the eligible cohort members with children agreed to participate (see Ferri, 1993, table 1.1). Of the 2647 children identified, 2150 with complete data for the characteristics included in the analysis were included (81% of those eligible).

Characteristics are identified at the higher levels of the nesting hierarchy. Cohort member at level 3 and child at level 2. The child measures of literacy and numeracy are nested within each child at level 1. The following subsections 2.2, 2.3 and 2.4 provide more detail about the measures at each level beginning with level 1. Table 1 provides a complete summary of all of the measures described together with their acronym labels used in the tables of results referred to in section 3.

2.2 Measures of literacy and numeracy

The child level data was elicited by interview from the child's natural mother for all child variables except the measures of literacy and numeracy which act as our response variables. Child numeracy was measured using the Mathematical Assessment subtest from the Peabody Individual Achievement Test (PIAT) (Dunn and Markwardt, 1970). Literacy skills were tested using PIAT reading recognition assessment which involves reading words aloud and recognising words and letters in multiple choice questions administered by an interviewer. These scores were ***age based standardised*** using published norms. These norms were based on extensive testing developed in the United States (Dunn and Markwardt, 1970). Standardization attempts to ensure that a child's age does not confound their test score performance. Fortuitously, centring the "normed" results by subtracting the overall mean and dividing by the sample standard deviation produces a reasonably close approximation to a Standardized Normal Distribution.

2.3 Child level characteristics

At the outset of our analysis it was decided to retain a child's age in the modelling as a simple check on the effectiveness of any standardization. This decision was confirmed by an initial comparison of unstandardised and standardised scores. What it revealed was possible evidence for a *selection effect* in our sample. This contrast is shown in table 2. The poorer performance of older children compared to the younger is clearly evident from column 4. What we are witnessing may well be a "selection effect" transmitted via the age of a child's mother at the birth of their offspring. Obviously in a single birth cohort older children are born to younger mothers. Thus, any age effect for the child could carry a residual element which describes possible social and cultural disadvantage relating to the children of young mothers rather than a weakness in the selection of norms for standardization. Subsequent analytical strategy will reflect this concern. Other characteristics include gender (51% of our sample were female), whether or not school attendance or learning had been affected by ill-health or other problems (6.8% and 3.1% reported so), birth order (67% were first-born) and whether or not *any* preschooling was received (79% had some).

2.4 Cohort member characteristics as proxies for the family setting

Characteristics of the cohort member are included but those of the other parent whether present or absent in the home are not directly considered. In the analysis undertaken, an assumption is made that the cohort member characteristics can act as a surrogate for those of any partner. Where this assumption is not justified then some of the unseen intergenerational effect will remain in the unexplained residual error.

Characteristics of the children's family setting then included sex of the cohort member as natural parent (36% were male) to describe any possible gender effect in reporting on a child's history and abilities, whether or not the child was in a single parent situation at the fifth sweep (10% were so), the number of children in the family (44.% were in only children families), parental educational achievement as measured by examination results (16% had no formal qualifications), net family income per person (x = £91.8, median = £63.2, σ = £530.6). At the time of analysis there was some concern about the quality of the social class coding. This led to a decision to use a simple manual non-manual dichotomy which produced an even break in the distribution.

Parental literacy and numeracy problems were identified using the following questions:

1. As you probably know, thousands of adults have difficulties with reading or writing at one time or another. It would help us if you could answer some questions about your own experience of reading and writing. Since leaving school, have you had any problems with reading?

2. And since leaving school, have you had any problems with writing or spelling?

3. Since leaving school have you had any problems with numbers or simple arithmetic?

The percentages reporting problems were small, 3.4%, 8.7% and 3.4% respectively.

2.5 Multivariate multilevel models

Multivariate multilevel models provide a way of modelling several responses as functions of explanatory variables. In our case there are two responses for a child's achievement in reading and mathematics (labelled, PIATREAD and PIATMATH). We treat the individual child as a level 2 unit and the 'within child' measurements as level 1 units. The basic explanatory variables are a set of dummy variables that indicate which response variable is present. Further explanatory variables are defined by multiplying these dummy variables by the child level variables, for example age.

The basic 2-level multivariate model is written as

$$y_{ij} = \beta_{01} z_{1ij} + \beta_{02} z_{2ij} + u_{1j} + u_{2j}$$

i = measure at level 1
j = child at level 2 *(1)*

$z_{1ij} =$ *1 if reading, 0 if number/maths*

$z_{2ij} = 1 - z_{1ij}$

$var(u_{1j}) = \sigma^2_{u1},\ var(u_{2j}) = \sigma^2_{u2}$

$cov(u_{1j}, u_{2j}) = \sigma_{u12}$

There are three important features of this model specification to consider- there is no level 1 variation specified because level 1 exists to define the multivariate structure,- the level 2 variances and covariance are the (residual) between-child variances and the multilevel estimates are statistically efficient even when some responses are missing (Goldstein, 1995).

Extending the model to include an explanatory variable for age we have:-

$$y_{ij} = \beta_{01} z_{1ij} + \beta_{02} z_{2ij} + \beta_{11} z_{1ij} x_j + \beta_{12} z_{2ij} x_j + u_{1j} + u_{2j} \qquad (2)$$

where $x_j =$ *age in years*

In the labelling convention that follows in tables 1, 3 and 4 the main effect of age on the reading score is represented algebraically by β_{11} and associated with the variable $z_{1ij}x_j$ and labelled 'RAGE'. Similarly, β_{12} associated with $z_{2j}x_j$ represents the main effect of age on the maths score and is labelled 'MAGE' . Additional explanatory variables are introduced and labelled in this manner.

The basic 3-level multivariate model is a natural extension of the 2-level model defined in equation (1). A third level is introduced for the cohort member or proxy for the family context. We have:

$$y_{ijk} = \beta_{01} z_{1ijk} + \beta_{02} z_{2ijk} + \nu_{1k} + \nu_{2k} + u_{1jk} + u_{2jk} \qquad (3)$$

with i = measure at level 1, j = child at level 2 and k = cohort member (as proxy for family context) at level 3.

Adding a fixed effect for age we have

$$y_{ijk} = \beta_{01} z_{1ijk} + \beta_{02} z_{2ijk} + \beta_{11} z_{1ijk} x_{jk} + \beta_{12} z_{2ijk} x_{jk}$$

$$\nu_{1k} + \nu_{2k} + u_{1jk} + u_{2jk} \qquad (4)$$

This model assumes that the slope for age is equal for all families in the population. It is possible to allow these slopes vary from family to family by writing β_{11} as $\beta_{11} + w_{1k}$ and likewise for β_{12}. This is equivalent to *random slopes regression* (Woodhouse et al., p.26). The resulting level-3 variance will now depend on the age of the child and is no longer constant. For reading, the variance term becomes:

$$\sigma^2_{v1} + 2\sigma_{1vw}(z_{1ijk} x_{jk}) + \sigma^2_{1w}(z_{1ijk} x_{jk})^2 \qquad (5)$$

The constant variance assumption at level-2 can also be relaxed. For instance the child level variance can be modelled as a function of age. The algebra is similar to the random slopes regression but the interpretation will be different. Now the variance term becomes

$$Var\,(u_{1jk} + f_{1jk} z_{1ijk} x_{jk})$$

$$= \sigma^2_{u1} + 2\,\sigma_{u1f1} x_j + \sigma^2_{f1} x^2_j \qquad (6)$$

Child level variance can also be modelled by the inclusion of dummy variables in the random part. For example say,

$$d_{1jk} = 1 \text{ if child has attended preschool}$$

$$= 0 \text{ otherwise}$$

then $z_{1ijk} d_{1jk}$ translates as 'RPRESCHD'

By re-expressing u_{1jk} as

$$u_{01jk} + u_{11jk}\, z_{1ijk}\, d_{1jk}$$

The variance becomes

$$\sigma^2_{u0} + 2\,\sigma_{01}$$

Thus we have effectively modelled a difference in the child level variance for those children who have attended pre-school compared to those who have not. As an illustration for the final model presented in table 4 the level 2 variance for a child who has attended preschool can be calculated as

$$0.2878 - 2 * 0.0328 * AGE + 0.017 * AGE^2$$

$$+ 2 * 0.0164$$

(see table 4).

2.6 Modelling strategy

Modelling was carried out in two distinct stages. Firstly it was important to check the quality of standardization for both outcomes and assess the evidence for the presence of any residual selection effect. An early inspection of the simple comparison of standardized versus unstandardized scores suggested that this may well be an issue. Subsequent second phase inclusion of explanatory variables would be in some sense an attempt to explain any selection effects. The first stage of modelling, then follows the description of the algebra in equations (4) through (6). Initially, age is included as a fixed effect. It is then modelled in the random part, both for evidence of between family differences and as a function of child-level variance. For convenience age is always entered as 'age minus 10'. Thus the relevant intercept can be interpreted as the achievement for a typical child aged 10 years.

The second stage of the modelling introduces explanatory variables into the model one at a time. Firstly, cohort member characteristics are included then, child level characteristics. Finally, evidence for any joint or interaction effects is assessed. All terms enter the model individually, first in the fixed part of the model and then in the random part. They only remain if their contribution is statistically significant when judged by the difference in the likelihood ratio statistic (Woodhouse et al., p.32, 1995).

3. RESULTS

Multilevel estimates are presented for three models. The null model as defined in equation (3), a 'baseline model' which demonstrates our evidence on the age effect described in equations (4) to (6) and thereby acts as a reference model to assess the final model which includes further explanatory variables. The results are in tables 3 and 4. The reader will find that studying these tables is rather like the simultaneous inspection of two univariate analyses combined as one with the added benefit of having information about the correlation between the outcomes. Admittedly, useful for comparative insight but sometimes challenging to disentangle. To maintain the comparative worth of the model if any terms are significant for one outcome but not the other the terms will be retained. Earlier univariate analyses reported in Wiggins and Wale (1996) also indicated that the explanatory variable for parental educational level (referred to as the National Vocational Qualification level or 'NVQ') when treated as a categorical measure had a monotonically increasing impact on the maths score as outcome. It was therefore felt acceptable to include this variable as an interval scaled measure.

3.1 The influence of age beyond standardization

The null model suggests that there is substantial variation both between families and within families for both outcomes. The first column in table 3 illustrates that roughly similar proportions of variation are identified for both reading and maths. For the reading score 38% of the variance is between families and 62% is within families. For the maths score the percentages are 35% and 65% respectively. Whatismore multivariate multilevel modelling allows us to model the correlation between the outcomes; at the family level 0.86 and at the child level 0.41. Including age as a fixed effect suggests that age standardization had not been effective. Older children do less well for our sample. A typical child aged 10 or above will be achieving below average results in reading and maths. Modelling age in the random part suggests that there was no significant variation between families in the reading and maths scores but, the child level variance does appear to be a function of age. Following our labelling conventions this the *Level 2 Variance* would read as

(READDUM/READDUM)

+2 RAGE/READDUM(AGE)*

+ (RAGE/RAGE)(AGE)*^{2}

From table 3, column 2 this is equivalent to 0.4128 -2*0.0318*AGE + 0.0199*AGE. Figure 1 shows a steady decrease in variance up to the age of 11 years followed by a subsequent increase in later years. This might indicate the relatively beneficial impact of primary schooling in lessening the between child differences only to be masked by a regression in secondary school. The findings for maths are similar but less marked differences persist amongst older children (figure 2). The overall conclusion is that even with age standardised score the impact of age on the outcomes cannot be ignored. By including additional explanatory variables it may be possible to eliminate this age effect which would confirm its role as a proxy for selection effects.

3.2 Substantive findings

The final model is presented in table 4. We will deal first with the findings for the fixed part of the model, taking cohort member characteristics to begin with before turning our attention to the child level characteristics. We will then comment on the presence of any interesting interaction terms before concluding with an appraisal of the random part.

It would appear reasonable to ignore the impact of gender (CMSEX) and presence of partner (PARTNER) and net family income per head (FAMNET) for either outcome. Educational characteristics (NVQ) are very important with the children of well qualified parents doing well.. Being of non-manual social classification also looks to be influential for good MATHS attainment.

For cohort members who express reading, writing and number problems only writing problems persist in the final model and these are largely predictive via certain joint effects with other explanatory variables.

At the child level birth order (ORDER), learning difficulty (LERNDIF) gender (SEX) and preschooling (PRESCHD) are influential but, have to be interpreted in the context of their interaction effects. Problems attending school does not appear to have a significant effect on the outcomes. Age remains as an influential variable combining as it does with other explanatory variables in the model. Compared to the baseline model the fixed or residual effect for maths is negligible. This finding is not mirrored for reading score.

The model contains a number of interesting interactions or joint effects. We will review them in the order that the appear in table 4 and then summarize the interpretation in terms of three child level characteristics, age, gender and learning difficulties in the conclusion. Older children with 2 or more siblings are likely to do less well in maths. This is not the case for reading. Older children with learning difficulties will have lower than expected scores for both maths and reading. Young children in large families will have lower scores. This finding is more marked for maths than reading. Having a well qualified parent may be something of a disadvantage for boys. Where these parents send their children to preschool there might be problems for the child in maths understanding. Learning difficulties reverses any positive effect in preschooling for maths attainment. Wherever parents have an expressed learning difficulty with writing him/herself boys find maths achievement hardgoing. Though for some reason boys who attend preschool appear to have a relative advantage in maths. Parental difficulty with writing appears again-those attending preschool are less likely to do well at reading if the parent expresses this problem.

The random part of the model provides clear evidence to contradict the existence of simple variance components analysis with constant variance both between and within families. Child or level 2 variance is a function age as in our baseline model but also suggest that preschooling has a differential effect between families (see Figures 3 and 4). Furthermore, notice that the effect of learning difficulties is not constant between the sexes across families. At level 3 the variance between families will vary according to the educational qualifications of the parent and the presence or absence of a problem with writing. The substantive implications are hard to simplify. They read as follows: *the presence of an expressed writing problem will diminish the variance for reading but vice versa for maths, similarly the variance for reading decreases as the qualification level of a parent rises but again vice versa for* maths. Plots are shown for the reading outcome in figures 5-8.

4. CONCLUSION AND DISCUSSION

4.1 Standardization and selection effects

Multilevel modelling has provided a powerful framework to explore both methodological and substantive questions. Age standardization does not work in isolation. The main effects analysis (Table 4) would imply that "age" must be present in any modelling. Subsequent analyses which include age interaction effects suggest that any residual "selection" effect represented by age can be largely eliminated for maths attainment but *not* for reading. Age taken in conjunction with family size and expressed learning difficulties are the most important interactions. This suggests

that by tracing the life course for those older children in larger families where learning difficulties have been encountered might reveal some evidence as to why this interaction is prominent. It may well be that the parents of such children have very similar characteristics and experiences. It would also allow us to focus on the nature of any selection effects associated with age.
Another clear signal from the findings for the age effect is in the consideration of the very design of longitudinal cohort studies. It is well-known that cohort studies are subject to age and period effects (Goldstein, 1979). Additionally, this analysis is affected by an extra confounding effect which is itself an artefact of the design- children are not randomly drawn from their age group. As children are not of the same age their cohort member parent will be at different ages at the birth of the child. These cohort member differences in age at birth may well reflect differences in economic and social circumstances. For example, children who were aged fourteen years and over in March, 1991 were born to teenage cohort members. Teenage motherhood is typically associated with social impoverishment (Di Salvo, 1992). It would not be surprising, therefore, if overall scores obtained in various educational assessments were worse for the children of teenage cohort members than for their peers in the general population. Similarly, the younger children in the sample will be more likely to have been planned, are born to older parents and less likely to be deprived. Again, it would not be surprising if the improved circumstances of the younger children were reflected by better overall performances on the tests than would a more representative sample of their peers. As well as investigating these ideas it might be profoundly more useful to avoid the problem in future designs which allow for repeated observations for the children of cohort members. By phasing the selection of children at more regular intervals or sweeps of cohort member interviews it is possible to identify a spread of children of the same age but for varying ages of the natural parent. This would also provide for sound internal standardisation.

4.2 Substantive conclusions

From an intergenerational perspective parental educational background and social class are influential determinants of a child's attainment in literacy and numeracy and would appear to replace the family income effect reported by ALBSU. A parent's expressed difficulty with writing appears to have a direct effect on a child's attainment. Interestingly, parental problems with number have less explanatory power when considered alongside other characteristics and interactions between them. The presence of these interactions and the role of a number of characteristics in modelling the variance makes the substantive interpretation more challenging. From a child's perspective we are tempted to suggest that: having only one parent may not be so bad!, being in a large family may sometimes hold you back in reading and arithmetic, preschooling could be a mixed blessing, having a parent who did well at school may not always be a good thing; especially if you're a boy!, that your Mum and Dad's recognition that you have a learning difficulty could help us indicate that you are going to have problems with number and reading; but it is not always the case, we need to know more about exactly what your Mum or Dad mean when they say they have difficulty with writing? does it get in the way when they try and help you with your schoolwork?

Essen and Wedge (1982) drew a number of important conclusions which help place this study into a wider framework that may also suggest further investigation. In particular, the parents in our analysis who may have been identified as multiply disadvantaged at either age 11 or 16 would have been more likely to experience many other adversities in addition to their housing, familial and income difficulties. For example many of their parents were off work either through unemployment or sickness, and those in work were often in unskilled, badly paid jobs. Their mothers and fathers were more usually likely to be chronically ill. More of them than usual had been in the care of either a local authority or voluntary society (p.163). Socially disadvantaged children had poorer levels of attainment, less acceptable behaviour both at home and at school (and were shorter). From an intergenerational position the children of those children may well experience similar fortunes to their parents. For example, Bynner (1975) who was concerned specifically with attitudes to education noted that the proportions of working-class, but not middle-class, parents who hoped that their children would stay on at school after they were 18 fell drastically as they progressed through school. He attributed this to increasing alienation from school of the working-class, *probably due to the failure of so many working class parents to achieve their initial ambitions for their children.* However the fact that there are complex differences and variations in our analysis is in some sense comforting. Not all socially disadvantaged children as judged in terms of their parent's achievements and difficulties with writing will do less well. For example, only 14 per cent of disadvantaged 16-year olds scored above average on the reading test, and 11 per cent scored above average on the maths test. For a small group of socially disadvantaged who nevertheless had above average levels of attainment differed most strongly from other disadvantaged was that they had unusually positive attitudes to school work, good behaviour, and quite high aspirations for the future. Indeed, having a well-qualified parent may be disadvantageous. We obviously need more detail about the lives and circumstances of the children in our study in order to unravel some of the subtleties of intergenerational transmission. Tracing the family history of our NCDS children will be useful start but additional observational study will provide the insights that are going to be a necessary part of the development of hypotheses about how families influence the acquisition of basic skills for their offspring.

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Table 1: Variables used in the analysis- a key to the acronyms and coding

LEVEL 3- COHORT MEMBER AS PROXY FOR THE FAMILY CONTEXT

CMSEX	*Gender (1=male, 0=female)*
PARTNER	*Partner present in the home (1=yes, 0=otherwise)*
QUALS	*Qualifiaction level defined in terms of NVQ equivalents (1-6)*
WRIT	*Writing problems (1=yes, 0=no)*
NUMPROB	*Number problems (1=yes, 0=no)*
READPROB	*Reading problems (1=yes, 0=no)*
FAMNET	*Net family income per head*
SOCCL	*Social class (1=nonmanual, 0=other)*
NKIDS	*Number of children in the family*

LEVEL 2- THE CHILD

AGE	*Age of child minus 10 years*
ORDER	*Birth order*
SEX	*Gender (1=boy, 0=girl)*
ATTEND	*Problems attending school.. illness or (1=yes, 0=no)*
LERNDIF	*Problems with learning..illness or (1=yes, 0=no)*
PRESCHD	*Preschooling (1=some, 0=none)*

LEVEL 1- THE OUTCOME

READ	*PIAT Reading score*
MATH	*PIAT Maths score*
READDUM	*Dummy for presence of a reading score*
MATHDUM	*Dummy for presence of a maths score*

FURTHER LABELLING CONVENTIONS

*ACRONYM always prefixed by an 'R' or an 'M' depending on which outcome score they are associated with- thus READDUM*AGE indicates an age for a child associated with a particular reading outcome and will be labelled 'RAGE'.*

Interaction terms will be slightly shortened but hopefully decipherable! e.g. RAGEORD, RQUALSEX, RQUALPRE, RLERNSOC.

Table 2: Standardised compared to unstandardised scores for reading and maths

A. Tabulation (by age) of the mean and standard deviation for the raw, "normed" and standardized "normed" PIAT maths scores

Age of children	Raw Score Means	Raw Score S.D.	Normed Means	Normed S.D.	Standard-ized Normed Means	Standard-ized Normed S.D.	Number of children
Five	16.2	5.08	0.78	1.24	0.25	1.143	297
Six	23.6	7.57	0.79	1.201	0.27	1.108	303
Seven	32.6	8.69	0.69	0.896	0.17	0.826	256
Eight	39.6	8.97	0.52	0.906	0.01	0.835	256
Nine	45.1	9.50	0.60	1.032	0.09	0.952	244
Ten	48.5	9.33	0.29	1.085	-0.20	1.000	200
Eleven	50.9	10.99	0.25	1.181	-0.24	1.089	197
Twelve	54.0	9.65	0.21	0.893	-0.27	0.823	142
Thirteen	55.3	10.16	0.05	0.958	-0.42	0.884	110
Fourteen	58.5	8.76	0.11	0.811	-0.36	0.748	71
Fifteen	59.8	10.74	0.05	0.968	-0.42	0.892	57
Sixteen	64.9	7.72	0.33	0.628	-0.16	0.579	14
Seventeen	63.3	4.51	0.06	0.382	-0.41	0.352	3
TOTAL	38.9	16.43	0.5	1.085	0	1.000	2150

B: Tabulation (by age) of the mean and standard deviation for the raw, "normed" and standardized "normed" PIAT reading recognition score

Age of children	*Raw Score Means*	*Raw Score S.D.*	*Normed Means*	*Normed S.D.*	*Standard-ized Normed Means*	*Standard-ized Normed S.D.*	*Number of children*
Five	*15.9*	*7.14*	*0.96*	*1.74*	*0.17*	*1.237*	*297*
Six	*24.5*	*10.59*	*0.86*	*1.65*	*0.09*	*1.176*	*303*
Seven	*35.0*	*11.40*	*1.21*	*1.56*	*0.34*	*1.110*	*256*
Eight	*41.4*	*12.24*	*0.70*	*1.24*	*-0.02*	*0.879*	*256*
Nine	*47.2*	*12.83*	*0.82*	*1.26*	*0.06*	*0.894*	*244*
Ten	*51.7*	*12.63*	*0.52*	*1.09*	*-0.15*	*0.774*	*200*
Eleven	*55.6*	*14.52*	*0.47*	*1.29*	*-0.19*	*0.913*	*197*
Twelve	*59.2*	*12.60*	*0.33*	*0.93*	*-0.28*	*0.658*	*142*
Thirteen	*61.0*	*14.50*	*0.31*	*1.12*	*-0.30*	*0.799*	*110*
Fourteen	*66.4*	*11.24*	*0.56*	*0.85*	*-0.12*	*0.605*	*71*
Fifteen	*65.9*	*14.95*	*0.21*	*1.24*	*-0.36*	*0.878*	*57*
Sixteen	*71.4*	*14.12*	*0.40*	*1.13*	*-0.24*	*0.803*	*14*
Seventeen	*73.3*	*3.21*	*0.43*	*0.28*	*-0.21*	*0.197*	*3*
TOTAL	*41.6*	*19.80*	*0.73*	*1.41*	*0*	*1.000*	*2150*

Table 3: Null, baseline and final models compared for 3-level analysis of bivariate outcomes in literacy and numeracy

RANDOM PART

LEVEL 3- The family

PARAMETER	ESTIMATE (S.ERROR) NULL	BASELINE	FINAL MODEL
READDUM /READDUM	0.3842	0.2719	0.2292
	(0.037)	(0.036)	(0.045)
MATHDUM /READDUM	0.3156	0.2412	0.1417
	(0.030)	(0.027)	(0.022)
MATHDUM /MATHDUM	0.3543	0.2931	0.1181
	(0.037)	(0.034)	(0.051)
Further terms for final model			see table 4

LEVEL 2-The child

PARAMETER	NULL	BASELINE	FINAL MODEL
READDUM /READDUM	0.6248	0.4128	0.2878
	(0.032)	(0.028)	(0.037)
MATHDUM /READDUM	0.2588	0.1939	0.1026
	(0.025)	(0.028)	(0.024)
MATHDUM /MATHDUM	0.6474	0.5788	0.4096
	(0.033)	(0.039)	(0.047)
RAGE /READDUM	-	-0.0318	-0.0328
		(0.003)	(0.003)
RAGE /RAGE	-	0.0199	0.0170
		(0.003)	(0.003)
MAGE /MATHDUM	-	-0.0104	-0.0078
		(0.003)	(0.003)
MAGE /RAGE	-	0.0087	0.0090
		(0.002)	(.0002)
MAGE /MAGE	-	0.0048	0.0084
		(0.003)	(0.003)

Table 3 continued...

FIXED PART

		ESTIMATE (S.ERROR)	
	NULL	*BASELINE*	*FINAL MODEL*
READDUM	-0.0324	-0.0446	-0.4956
	(0.024)	(0.023)	(0.164)
MATHDUM	-0.0242	-0.0743	-0.8375
	(0.024)	(0.024)	(0.168)
RAGE	-	-0.0485	-0.0371
		(0.007)	(0.017)
MAGE	-	-0.0685	-0.0173
		(0.007)	(0.017)
Further terms for final model			see table 4
*LIKELIHOOD (-2*LOG(lh))*	11249.7	10963.4	10498.7

Table 4: Final 3-level analysis for bivariate outcomes in literacy and numeracy

RANDOM PART

LEVEL 3- The family

PARAMETER	ESTIMATE (S. ERROR)
READDUM /READDUM	0.2292 (0.045)
MATHDUM /READDUM	0.1417 (0.022)
MATHDUM /MATHDUM	0.1184 (0.051)

Additional terms compared to baseline model

RSEX /READDUM	-0.0044 (0.034)
RSEX /RSEX	0.2055 (0.069)
MSEX /MATHDUM	0.0476 (0.039)
MSEX /RSEX	0.1563 (0.034)
MSEX /MSEX	0.0612 (0.078)
RWRIT /READDUM	-0.0503 (0.020)
MWRIT /MATHDUM	0.0816 (0.035)
RLERNDIF /READDUM	-0.0723 (0.084)
RLERNDIF /RLERNDIF	0.3465 (0.215)
MLERNDIF /MATHDUM	0.0460 (0.133)
MLERNDIF /RLERNDIF	0.3425 (0.173)
MLERNDIF /MLERNDIF	0.8021 (0.366)
RQUALS /READDUM	-0.0089 (0.005)
MQUALS /MATHDUM	0.0058 (0.006)

Level 2- The child

PARAMETER	ESTIMATE (S. ERROR)
READDUM /READDUM	0.2878 (0.037)
MATHDUM /READDUM	0.1026 (0.024)
MATHDUM /MATHDUM	0.4096 (0.047)
RAGE /READDUM	-0.0328 (0.003)
RAGE /RAGE	0.017 (0.003)
MAGE /MATHDUM	-0.0078 (0.003)
MAGE /RAGE	0.0090 (0.002)
MAGE /MAGE	0.0084 (0.003)

Additional terms compared to baseline model

RPRESSCHD/READDUM	0.0164 (0.016)
RPRESCHD /MATHDUM	0.0422 (0.019)

FIXED PART PARAMETER	*ESTIMATE (S.ERROR)*
READDUM	*-0.4956 (0.164)*
MATHDUM	*-0.8375 (0.168)*
RAGE	*-0.0371 (0.017)*
MAGE	*-0.0173 (0.017)*

Additional terms added to baseline model

RSEX	*0.0435 (0.105)*
MSEX	*0.0703 (0.109)*
RWRIT	*-0.1078 (0.144)*
MWRIT	*-0.0849 (0.182)*
RNKIDS	*0.0367 (0.045)*
MNKIDS	*0.0742 (0.045)*
RORDER	*-0.0407 (0.099)*
MORDER	*0.0583 (0.099)*
RLERNDIF	*-0.4364 (0.226)*
MLERNDIF	*0.0468 (0.310)*
RSOCCL	*0.0100 (0.043)*
MSOCCL	*0.1649 (0.045)*
RQUALS	*0.2126 (0.034)*
MQUALS	*0.2310 (0.036)*
RPRESCHD	*0.2798 (0.119)*
MPRESCHD	*0.3339 (0.124)*

Interaction terms

RAGENKID	*-0.0034 (0.008)*
MAGENKID	*-0.0214 (0.008)*
RAGELERN	*-0.1121 (0.042)*
MAGELERN	*-0.1493 (0.053)*
RNKIDORD	*-0.0573 (0.032)*
MNKIDORD	*-0.0769 (0.032)*
RQUALSEX	*-0.0498 (0.028)*
MQUALSEX	*-0.0495 (0.028)*
RQUALPRE	*-0.0820 (0.035)*
MQUALPRE	*-0.1128 (0.037)*
RLERNPRE	*-0.4908 (0.266)*
MLERNPRE	*-0.9618 (0.370)*
RSEXWRIT	*-0.0201 (0.125)*
MSEXWRIT	*-0.2781 (0.144)*
RSEXPRES	*-0.0167 (0.087)*
MSEXPRES	*0.1837 (0.090)*
RWRITPRE	*-0.2515 (0.154)*
MWRITPRE	*0.0593 (0.193)*

FIGURES- these follow on after the references

Figure 1 Child level variance for reading as a function of age (RSS 17/1)

Figure 2 Child level variance for maths as a function of age (RSS 17/2)

Figure 3 Child level variance for reading as a function of age by preschooling (RSS 24/1)

Figure 4 Child level variance for maths as a function of age by preschooling (RSS 24/2)

Figure 5 Family level variance for reading as a function of educational qualification by gender for parents with no writing problem and children with no learning difficulty (RSS 27/3)

Figure 6 Family level variance for reading as a function of educational qualification by gender for parents with no writing problem and children with a learning difficulty (RSS 27/4)

Figure 7 Family level variance for reading as a function of educational qualification by gender for parents with a writing problem and children with no learning difficulty (RSS 27/5)

Figure 8 Family level variance for reading as a function of educational qualification by gender for parents with no writing problem and children with a learning difficulty (RSS 27/6)

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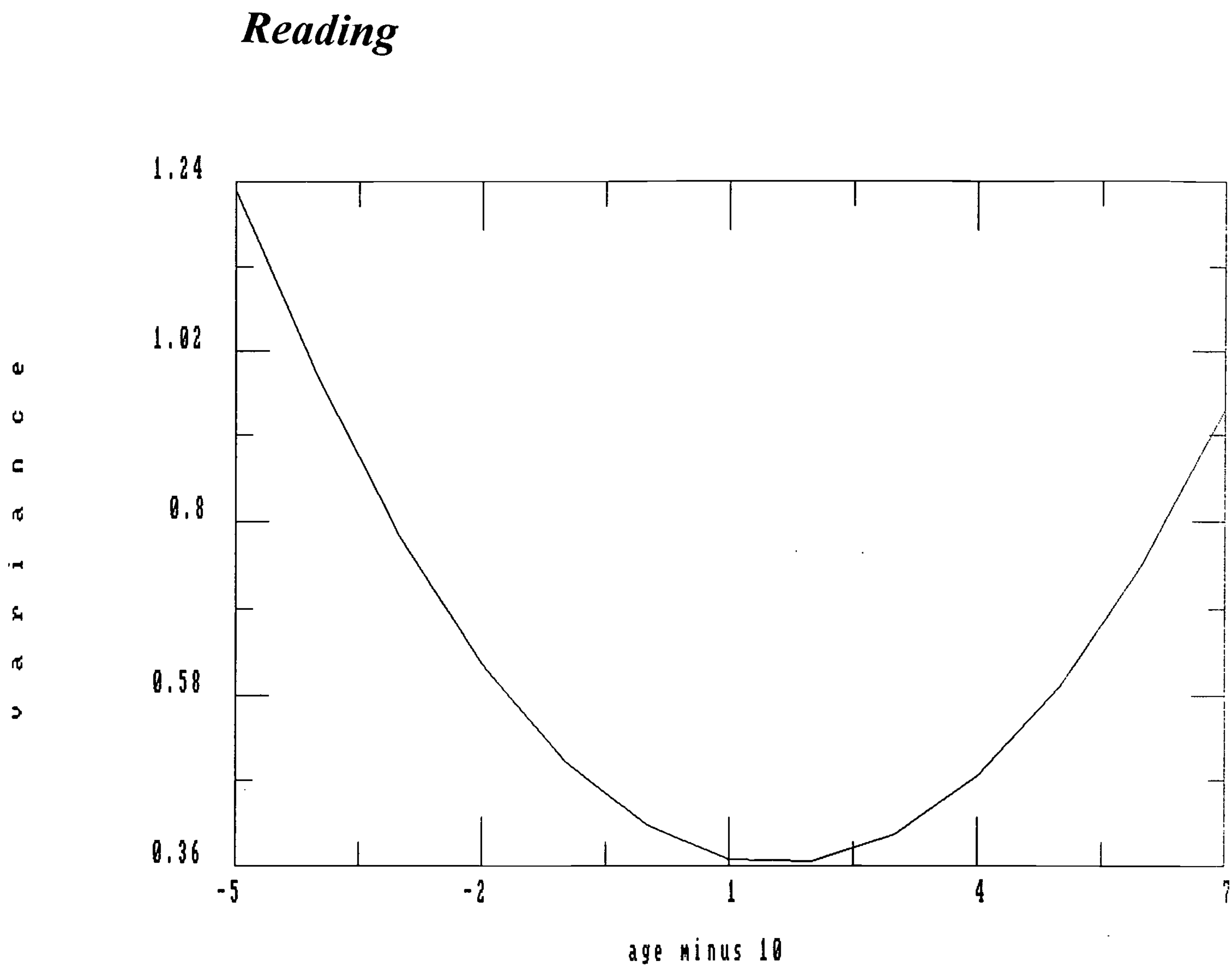
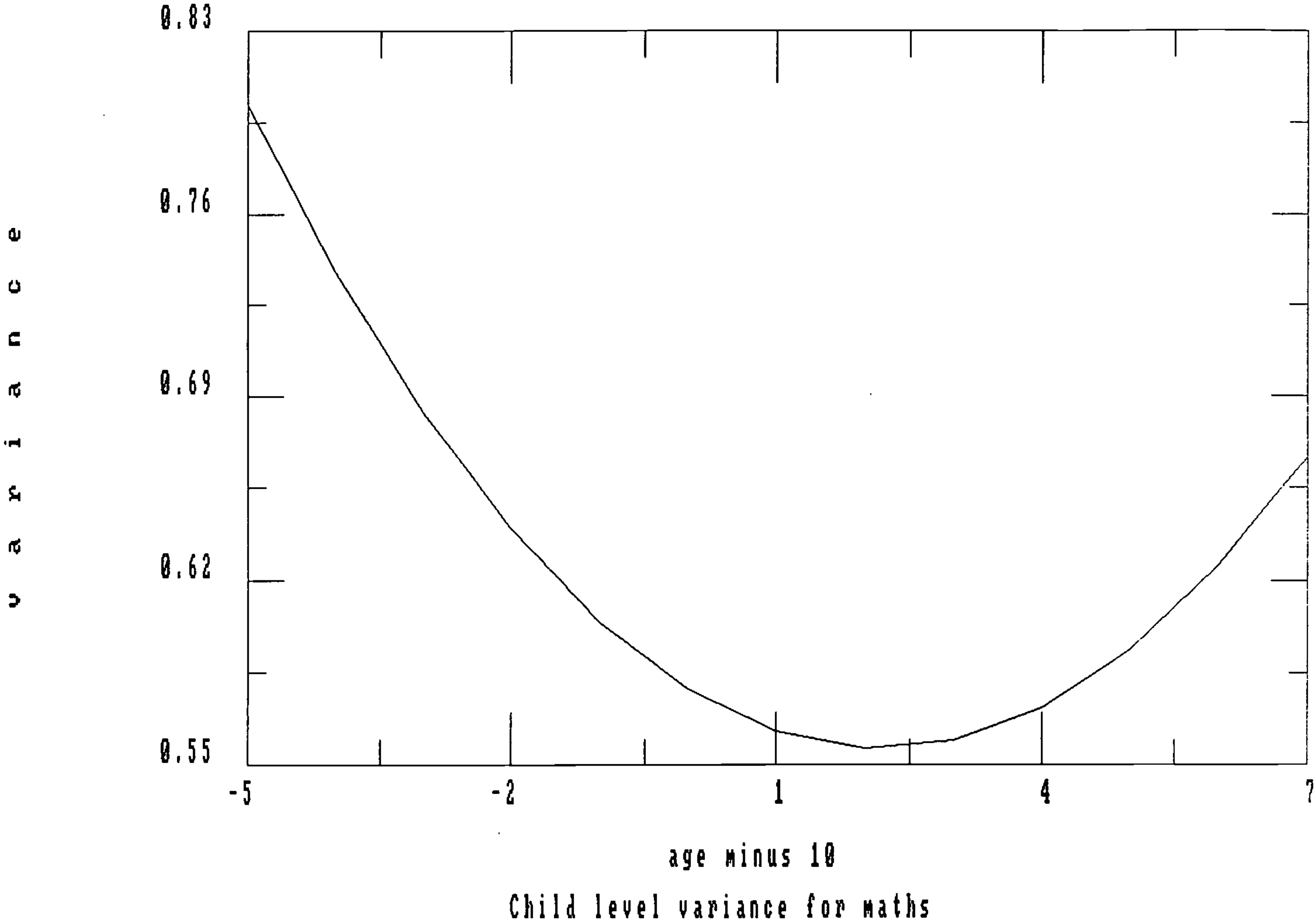
Figure 1 Child level variance for reading as a function of age (RSS 17/1)



Child level variance for reading

Figure 2 Child level variance for maths as a function of age (RSS 17/2)

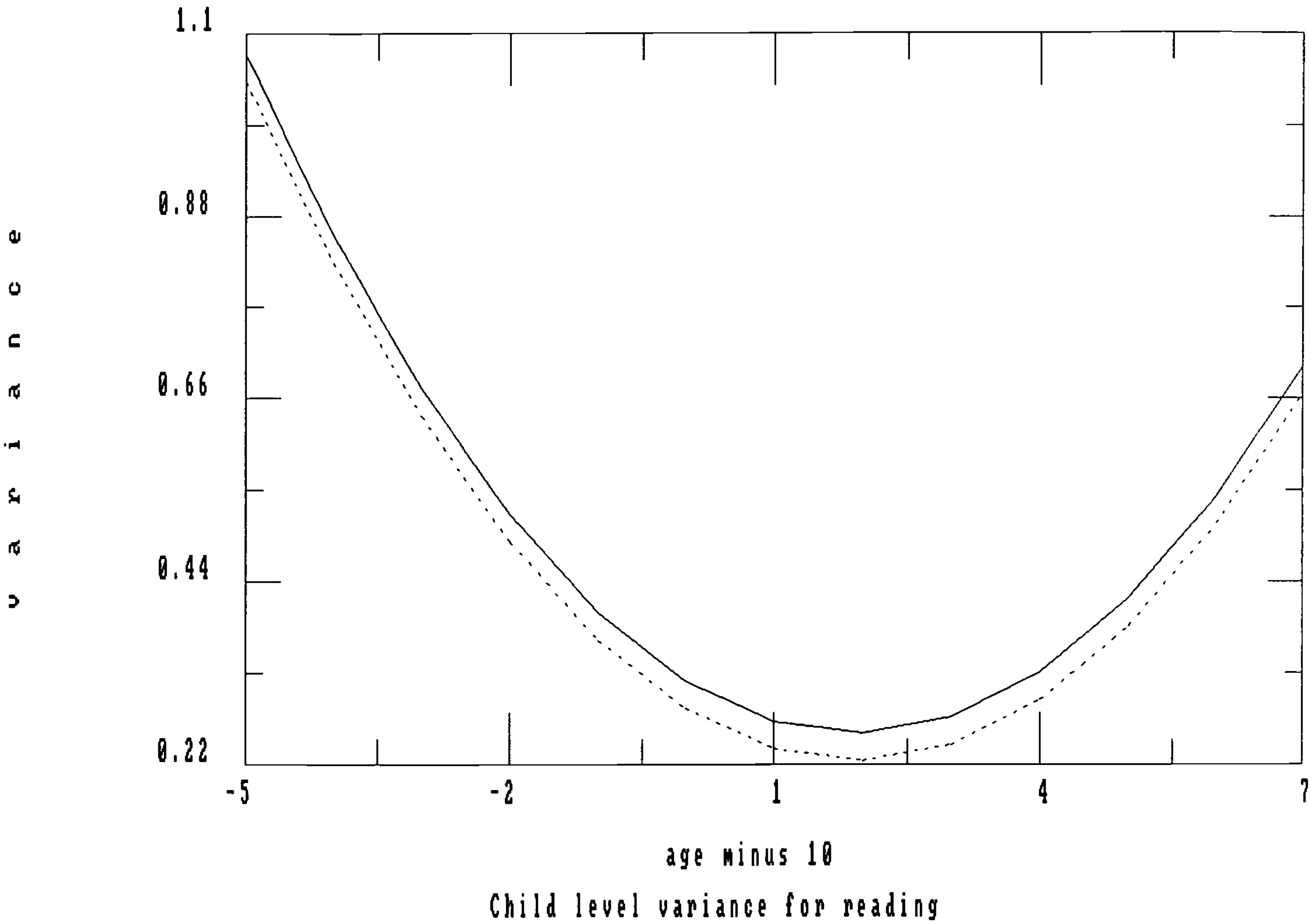
Maths



17/2

Figure 3 Child level variance for reading as a function of age by preschooling (RSS 24/1)

Reading



——————— *Attended preschool*

-------------- *Didn't attend preschool*

Figure 4 Child level variance for maths as a function of age by preschooling (RSS 24/2)

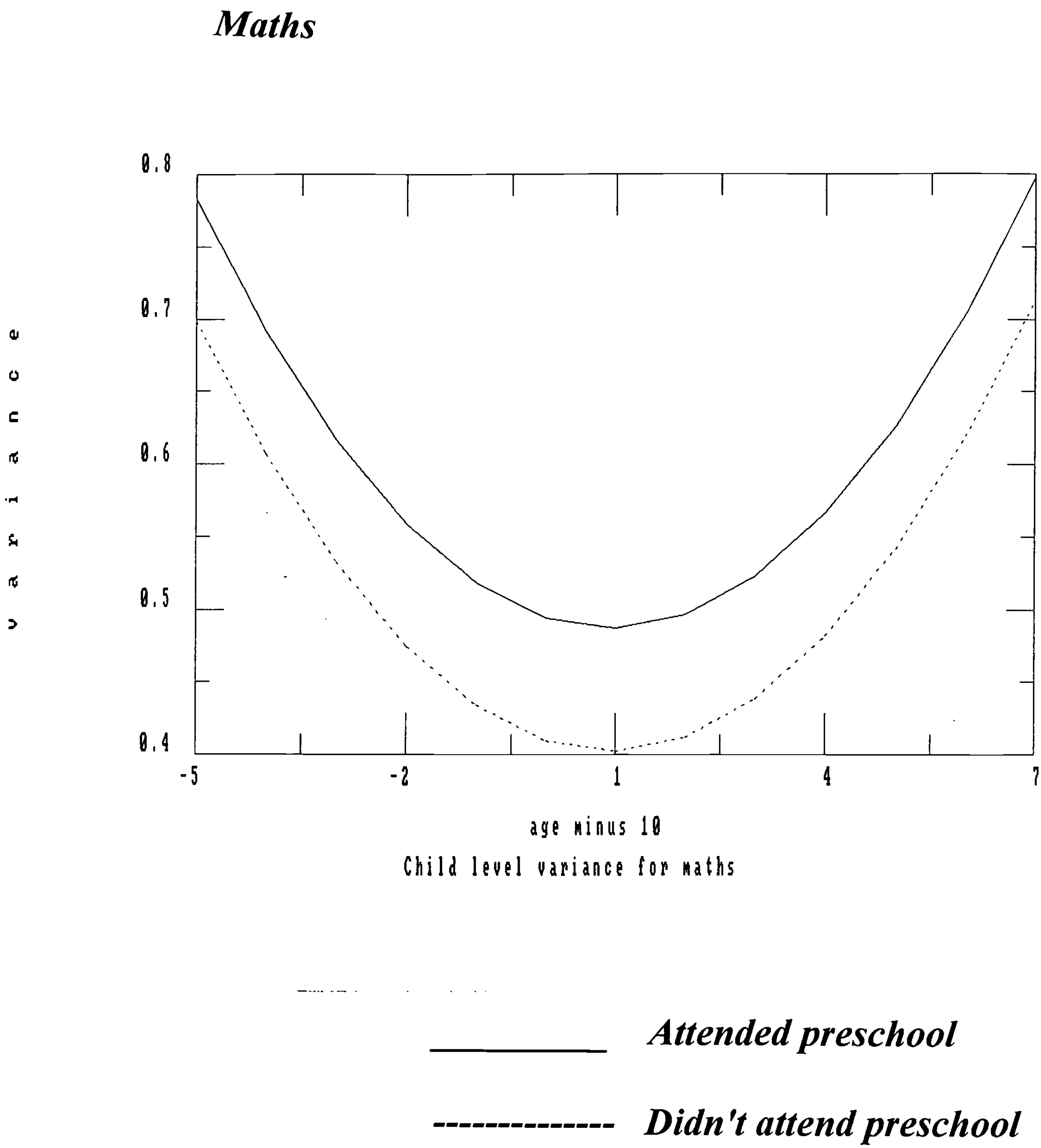


Figure 5 Family level variance for reading as a function of educational qualification by gender for parents with no writing problem and children with no learning difficulty (RSS 27/3)

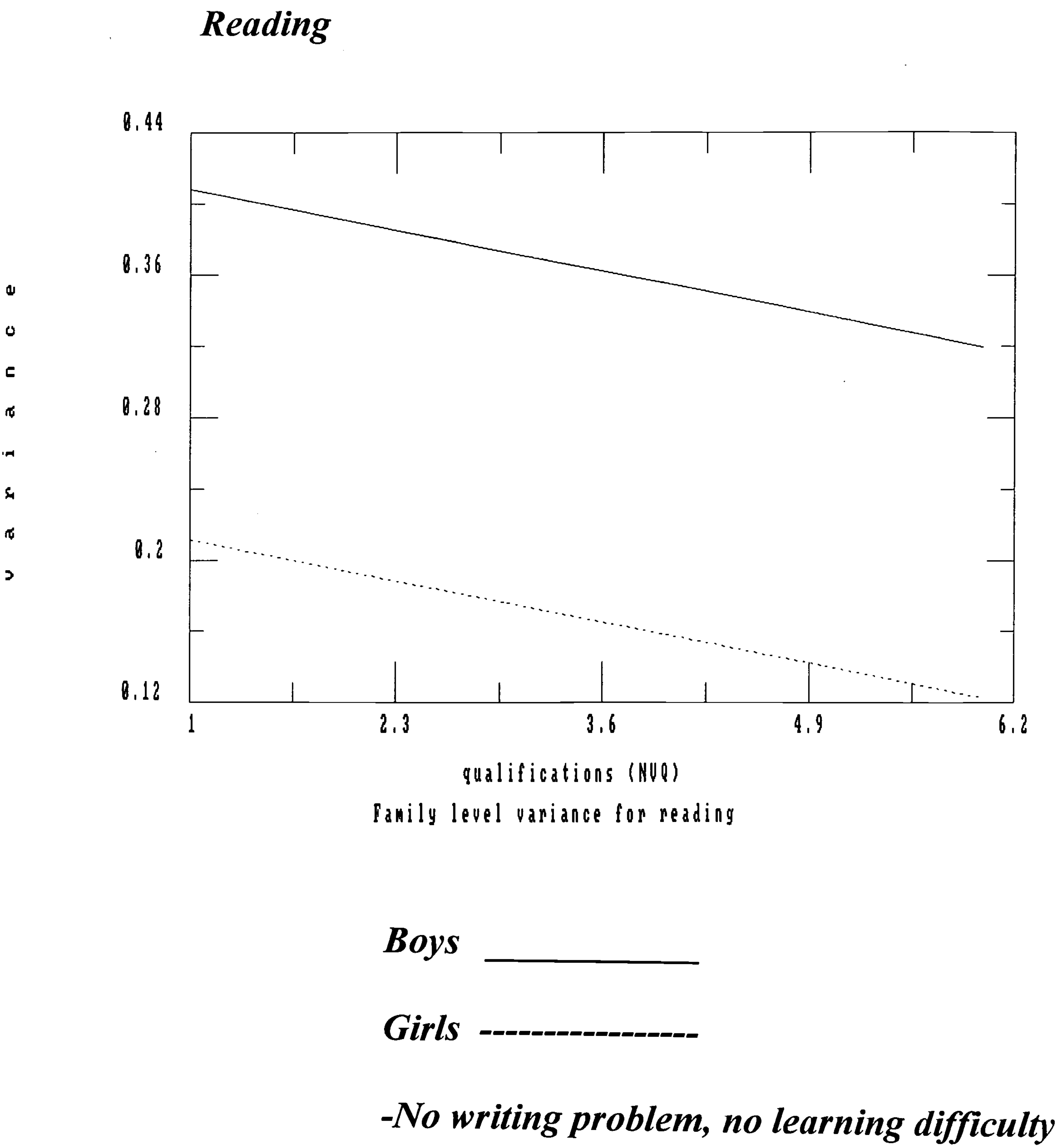


Figure 6 Family level variance for reading as a function of educational qualification by gender for parents with no writing problem and children with a learning difficulty (RSS 27/4)

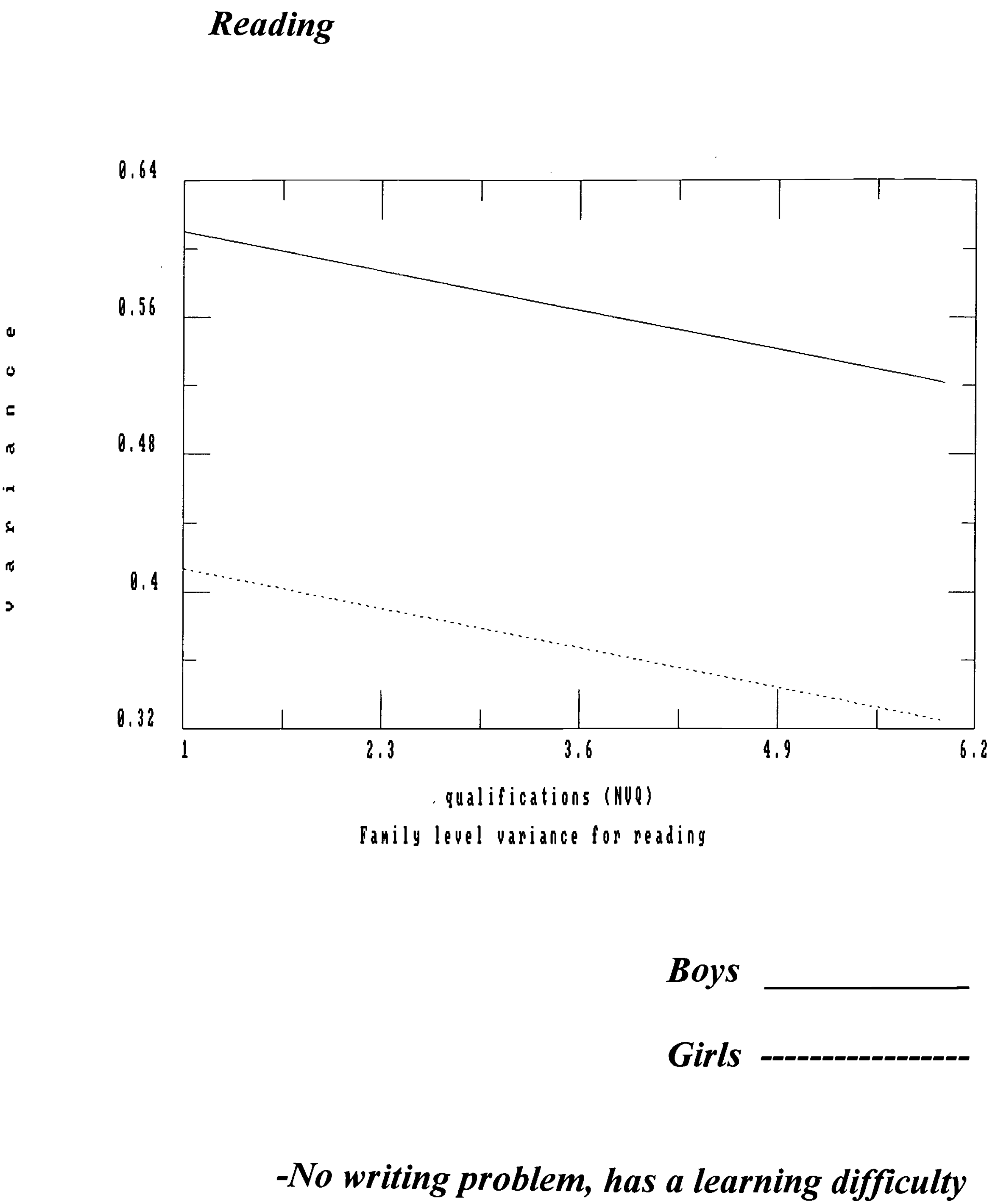


Figure 7 Family level variance for reading as a function of educational qualification by gender for parents with a writing problem and children with no learning difficulty (RSS 27/5)

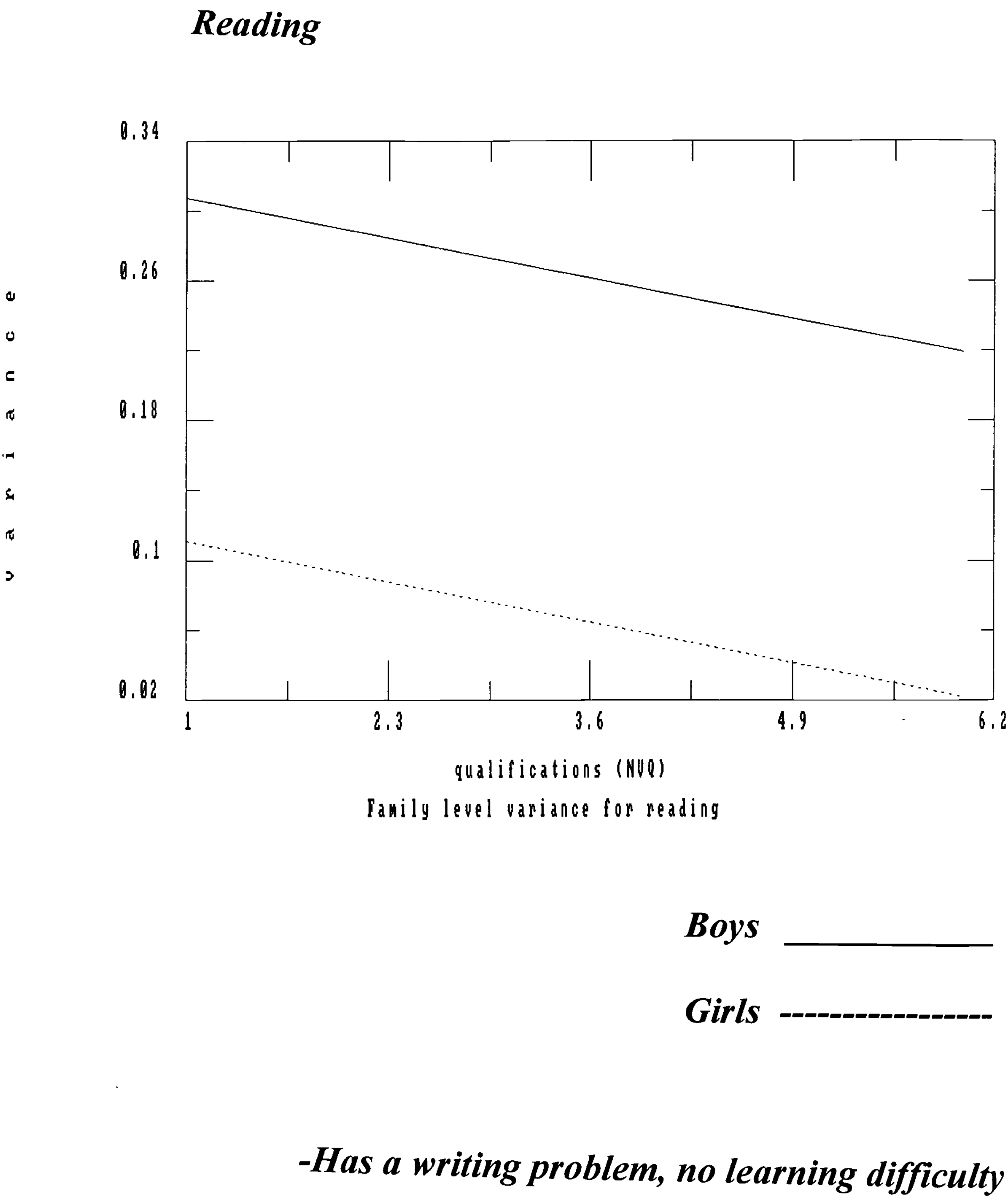


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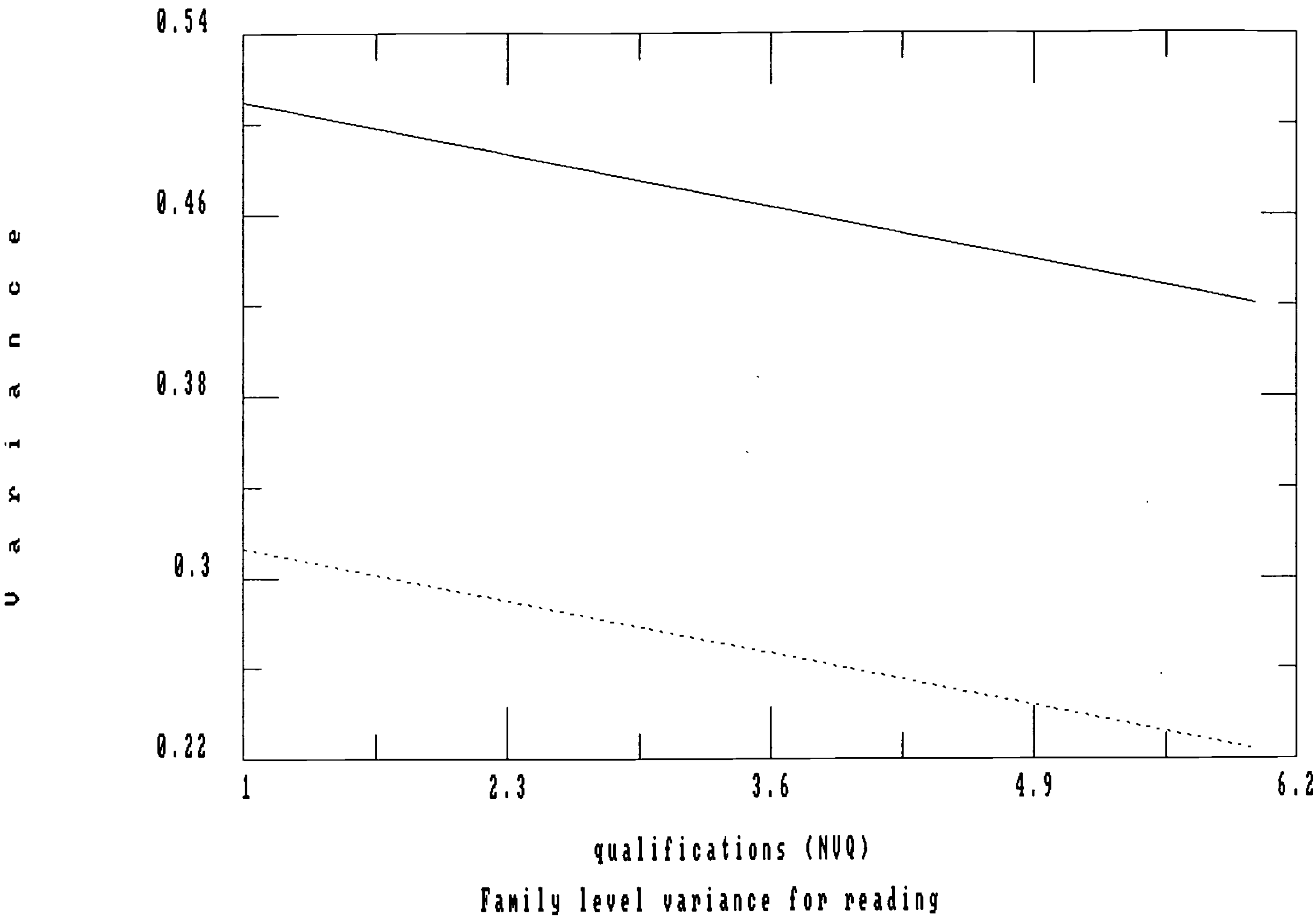
Figure 8 Family level variance for reading as a function of educational qualification by gender for parents with no writing problem and children with a learning difficulty (RSS 27/6)

Reading



Boys ________________

Girls ----------------

-Has a writing difficulty, has a learning difficulty

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