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ABSTRACT

The concern of this investigation lies with the development and estimation of models explaining children's intellectual variability. Specifically, attention is directed to: (a) the role of parental status attainments and family environments in the transmission of intellectual advantage-disadvantage across generations; (b) the possibility that children's abilities affect the nature of the environment to which they are exposed; and, (c) the dimensionality of family environment as a prerequisite to (a) and (b). Data on children's ability (males only), family environments, and parental status attainments from 100 families were provided by Dr. Harry Mosychuk, Director of Research with the Edmonton, Canada, Public School Board. Data collection for the present investigation involved contacting these families again and administering an intelligence test to both parents where possible. Visits were made with 72 of the original 100 families and usable parent ability data obtained for 69 of these. These comprised complete data for 55 families, and ability data on one parent only in another 14 families. Ability measures were the Wechsler Intelligence Scales for Children and Adults, respectively. The data provided general support for the existence of a triple advantage (disadvantage). It seems that children of intellectually advantaged parents are themselves advantaged in terms of genetic endowment (although this could not be shown in this investigation), the family environment in which they develop, and in the degree of control they have over this environment. (Author/JM)

ABILITIES, ENVIRONMENTS, AND ATTAINMENTS

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(b) the possibility that children's abilities affect the nature of the environment to which they are exposed; and,

(c) the dimensionality of family environment as a prerequisite to (a) and (b).

In order to quantify the arguments of (a) and (b) respectively, an attempt is made to develop models with the same basic configuration as Figures 1 and 2 below.

Figure 1. Inheritance of Abilities: Attainments and Environments as Intervening Variables.

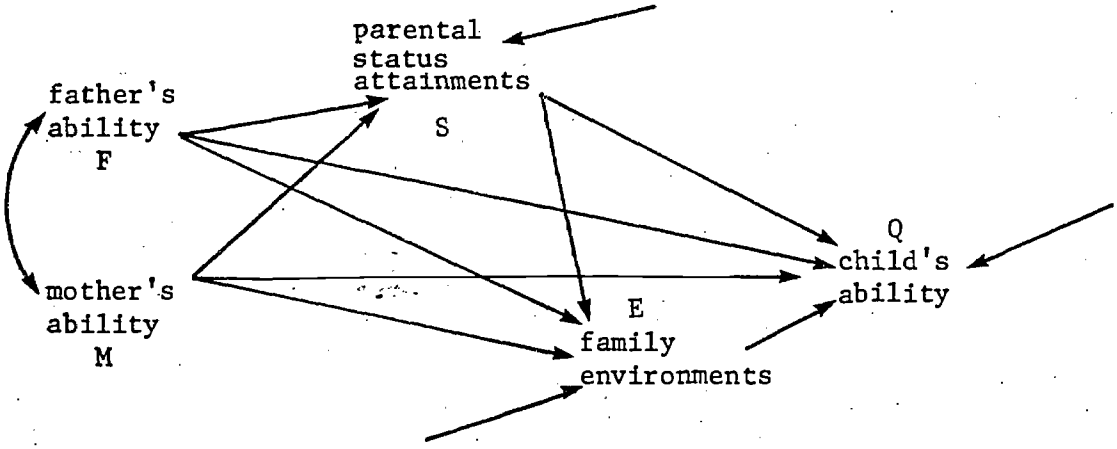
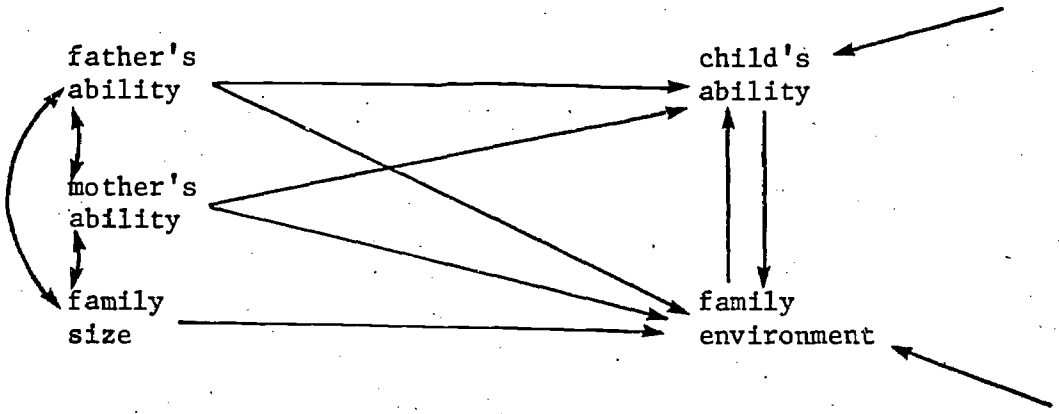


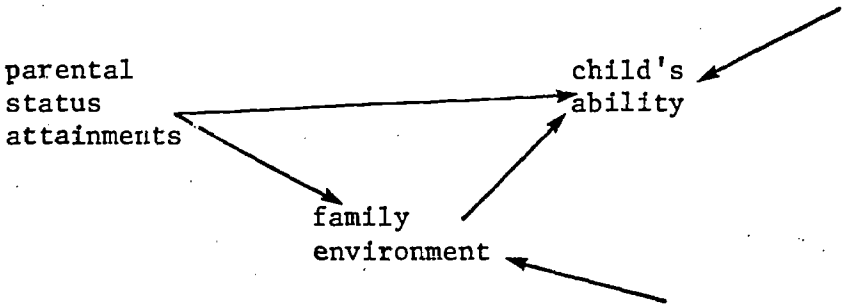
Figure 2. Inheritance of Abilities: Mutual Influence of Family Environment and Child's Ability



1. Background

For the most part, attempts to explain intellectual variability among children fall into two broad categories:
(a) "behavioral genetics" models utilizing naturally occurring controls over heredity and/or environment to estimate the proportions of phenotypic variability (variability in IQ scores) attributable to genetic variability (see, for example, Vandenberg, 1971); and, (b) "social science" models that conform to what Eckland (1971:66) calls "the standard deprivation model of social class and intelligence", and which link parental status attainments, family environments, and children's abilities in obvious ways (see, for example, Bernstein, 1961; Whiteman and Deutsch, 1968). The latter category of models are the specific concern of this investigation, and Figure 3 outlines the basic relationships involved.

Figure 3. The "Standard Deprivation Model of Social Class and Intelligence"



These "standard deprivation models" appear to be subject to a serious specification error. ("When one has mistakenly either omitted or included variables in an equation assumed to capture the true causal structure to Y, or when the functional form chosen to represent the variables is incorrect, we say one has made a specification error."; Bohrnstedt and Carter, 1971:128.) The error in question is of the first type and stems from the omission of parental abilities as antecedents to all variables in these models. (Errors of the second type are also a possibility -- e.g., the failure to consider multiplicative and/or higher order terms-- but are not a major concern of this investigation.)

Evidence from two sources supports this contention. First, there is a substantial behavioral genetics literature pointing to the direct effect of parental abilities on children's abilities via the biological mechanisms of inheritance. See, for example, Jensen's review (Jensen, 1969). Second, the literature on social stratification clearly implicates parental abilities as important causes of (parental) social and economic attainments. The work of Duncan et al. (1968) is a case in point. Less has been said about the effects of parental abilities on the nature of the family environment provided within the home, but what evidence there is suggests that the relationship is substantial. Burks (1928:286) reports parental ability/family environment correlations in the 0.6 to 0.7 range.

In terms of our understanding of those social processes contributing to children's intellectual variability, the consequences of this specification error are two-fold. First, models linking family SES, family environments, and children's abilities, but failing to include (control for) parental abilities as antecedent variables, probably overestimate the importance of between-family differences in SES and family environments as causes of the variation in children's cognitive abilities (cf. the classic spurious correlation argument: Lazarsfeld, 1955; Blalock 1964:83). Second, such models ignore: (i) the fact that intellectual advantage-disadvantage is transmitted from one generation to the next (Erlenmeyer-Kimling and Jarvik, 1963); and, (ii) the possibility that this occurs, at least in part, as a function of the variability in parental status attainments and family environments that accompanies parental intellectual variability. In other words, it seems likely that the parental ability -- SES -- family environment -- child's ability linkages (apart from the direct parent-child ability effect) serve as an important social mechanism by which ability differences in one generation are passed on to the next. It follows that an explication of these linkages would provide a more comprehensive explanation of the reasons for children's intellectual variability.

The major concern of this investigation is the inheritance of ability via the latter set of biosocial (Heise, 1973:xiii) mechanisms, that is, the way in which intellectual advantage-disadvantage in the parental generation is transmitted to children via parental attainments and family environments. In terms of the relationships shown in Figure 1, these mechanisms are contained with the pattern of indirect effects of F and M on Q via S and E.

Such concerns amount to an examination of some of the mechanisms contributing to the covariance of heredity and environment. Basically, the covariance argument is that more intelligent parents provide their children with "better" genes for intelligence -- hence, greater intellectual potential-- and "better" environments for the development of this potential, with the result that these children are doubly advantaged (Jensen, 1969:38; Jencks 1972:69). The second aspect of this double advantage (or double disadvantage) -- the way in which parental abilities contribute to environments and these to children's abilities -- is the issue in question here.

However, there is more to the covariance argument than this. It is conceivable that doubly advantaged children have a greater capability to affect the environment to their own cognitive advantage than do doubly disadvantaged children (Jensen, 1969:38). As a result, children of intellectually advantaged parents may have a triple advantage in the sense of "better" genes, "better" environments, and "better" control over the environments to which they are exposed. In this investigation, models are developed to test the latter proposition by allowing children's abilities and family environments to be mutually determined. Such a situation is shown in Figure 2 where the child's ability affects, and is affected by, the family environment.

Over and above these issues, it seems that models of this sort suffer from a further handicap. Our understanding of the specific mechanisms by which family environments affect children's cognitive development is rather limited. Schulman (1970:374) comments on this point — "Social scientists are dramatically impotent in their ability to characterize environments" — and points to the need to move away from unidimensional deprived/enriched conceptions of environments toward a multidimensional view: "characterizing the educationally-relevant facets of environments should be one of the major goals of educational research."

Attempts at a detailed behavioral characterization of family environments do exist, and have for some time (for example, Van Alstyne, 1929). Among the more recent of these are a number organized around the notion of "environmental presses" (cf. Murray, 1938) for certain categories of behavior (Dave, 1963; Wolf, 1964; Dyer, 1967; Mosychuk, 1969; Weiss, 1969; Marjoribanks, 1970). Although these measures produce a multidimensional picture of family environments, the dimensions of parental behavior hypothesized -- the "environmental presses" -- have little empirical support. Moreover, when

factored they invariably produce a single environment dimension which, given the apparent complexities of family environments, seems odd, and apparently little removed from the unidimensional deprived/enriched characterization that Gerwirtz (1969:61) describes as "essentially useless for understanding human social development....".

An alternative conceptualization of family environments is offered here, one organized around the basic concepts of social learning theory. Parents hold out expectations for intellectually relevant (i.e., school-related) behaviors on the part of their children, provide models as one means by which these behaviors can be learned, provide opportunities for the learning and practice of the behaviors, and reinforce performance on these behaviors (see Bijou, 1971). It is argued that families vary, not in "presses" for specific behaviors, but in their expectations, in the nature of the models and opportunities they provide, and in the way in which they reinforce, all behaviors. If this is true then the single environment factor produced in (most of) the studies cited above is a function of the way in which the "press" variables cut across these dimensions. The result of cross-cutting weakly related expectation, model, opportunity, and reinforcement dimensions is to produce a set of highly related press variables and, hence, an artifactual single environment factor. (This argument is developed more completely in Williams, 1973.)

2. Data

a. Sample. Data on children's ability (males only), family environments, and parental status attainments from 100 families were provided by Dr. Harry Mosychuk, Director of Research with the Edmonton Public School Board. His assistance throughout the whole investigation is gratefully acknowledged. Data collection for the present investigation involved contacting these families again and administering an intelligence test to both parents where possible. Visits were made with 72 of the original 100 families and usable parent ability data obtained for 69 of these. This comprised complete data for 55 families, and ability data on one parent only in another 14 families.

b. Measurement. Ability measures were the WISC and WAIS (Wechsler 1949; 1955) for children and parents respectively. Parental status attainments were obtained from mother's reports of parental education and occupation, and from parent reports on income for the previous year. Family environment data took

the form of a detailed interview with the mother in each family in which some 200 separate ratings of reported parental behaviors were made. The family environment instrument was in the tradition of these cited earlier. See Mosychuk (1969) for details.

3. Preliminary Analyses: the Structure of Variables

In these analyses the raw parent and child ability data, and family environment data are reduced to theoretically more meaningful and parsimonious dimensions. The principal technique is factor analysis.

a. Family environment. In view of what has been said about existing characterizations of family environments, the environmental model developed in this investigation will be multidimensional. The dimensions hypothesized are dictated by the argument that family environments can be seen more profitably from a social learning theory perspective with major dimensions involving expectations, opportunities, models, and reinforcements as the broad categories of behaviors that vary between families.

To test this argument the raw environment data provided by Mosychuk (1969) was reorganized through some preliminary aggregations of items considered to measure the same aspect of parental behavior. Subsequently, a number of factor analyses were carried out in an attempt to clean up the factor matrix (i.e., eliminate singletons and obvious irrelevancies). As a result, the 59 original family environment items used by Mosychuk (1969) were reduced to a more manageable 26. The correlations among these 26 items are shown in Table 1.

Table 1 about here

A principal factor solution of this matrix was rotated obliquely and the resultant factor pattern is shown in Table 2.

Table 2 about here

The four factors extracted were interpreted as follows:
(i) the extent to which parents specifically structure opportunities for the child to interact with both people and things in his environment;
(ii) the extent of father (same-sex model) involvement in child-rearing;
(iii) the nature of reinforcement practices used (on a physical punishment -- non-physical punishment dimension); and
(iv) the nature of parental expectations and encouragement for the child's academic performance. In other words, the data offer support for the dimensionality of family environments proposed earlier, namely that which argued these environments would be most fruitfully conceptualized in terms of the expectations, models, reinforcements, and opportunities provided by parents in connection with the child's behavior.

b. Parent and child abilities. In each case these abilities were measured with the respective Wechsler intelligence scales. Conventional treatment of the data provides eleven sub-test scores for the WAIS and twelve for the WISC, along with aggregates of these as "verbal" and "performance" IQ, and a grand aggregate"total" IQ.

The treatment of these data in the present investigation differs from this and is guided by existing notions about the hierarchical structure of intelligence (see Cattell, 1971). That is, the Wechsler sub-test scores are seen as indicators of more fundamental underlying abilities (cf. primary mental abilities) which themselves are indicators of a still more fundamental general intelligence. Clearly, this is a second-order factor model, and the data here are treated accordingly.

Table 3 contains the correlations among the Wechsler scale sub-tests for both parents and children.

Table 3 about here

With the exception of the "mazes" sub-test in the WISC, the Wechsler child and adult scales appear to have eleven comparable sub-tests. Separate principal factor solutions of these eleven sub-test correlation matrices were

obtained and the first two factors rotated obliquely. The resultant pattern matrices are shown in Table 4.

Table 4 about here

The factors look similar in both groups and approximate those generally found (Cohen, 1959; Wechsler, 1958; Guertin et al., 1966). Factor I is the verbal comprehension factor that always emerges, and Factor II is the commonly found non-verbal ("perceptual organization") dimension to the Wechsler scales.

To evaluate the apparent similarity of these factorial structures rotations to congruence were attempted (Evans, 1970). Rotating the WISC and WAIS structures in this way showed them to be exceedingly congruent in their overall structure, meaning that they measure the same underlying ability dimensions in both parents and children.

The two abilities in parents and children were considered as first-level abilities and potential indicators of a more general underlying ability whose structure is to be developed later. Measures of these first-level abilities were estimated as factor scores in the way outlined in Harman (1967: 350).

4. Estimation of Model Parameters

In this section variables with the structures derived above are incorporated into the conceptual frameworks shown in Figures 1 and 2. Using the correlations among these variables, model parameters are estimated via the methods of path analysis. (Path analysis is a generalization of multiple linear regression procedures to systems of causally related variables. Blalock, 1971, provides basic references.)

Models of the type proposed in this investigation make almost mandatory an attempt to correct the obtained correlations for attenuation due to measurement error. Established ability measures of the sort used here are among the most valid and reliable measures of human behavior that exist. They are contrasted with family environment measures whose validity and reliability are

almost certainly of a lower order. Hence, as a function of these differences in measurement precision, ability-ability correlations most likely are nearer their "true" values than any correlation involving an environment dimension. Thus, in assigning meaning to parameters derived from uncorrected correlations one runs the risk of attributing substance to effects -- and differences in effects -- that may result from differential measurement error. In the case of the models in question, this could mean placing family environments at an explanatory disadvantage when environment measures are used with parental abilities to predict children's abilities.

Corrections for attenuation were undertaken by estimating the correlations among unmeasured variables from the correlations among their (multiple) indicators (Hauser and Goldberger, 1970; Werts et al., 1973). Where the ability measures are concerned, the two first-level abilities were taken as indicators of a unmeasured general cognitive ability in fathers, mothers, and children. Each of the four family environment dimensions was treated as an unmeasured variable with three indicators, the three family environment items with the highest loading on each factor. Parental occupational, educational, and economic attainments had single indicators only, and corrections for attenuation were attempted using a slightly different procedure which is to be explained below.

The basic data for these procedures are the correlations among the two first-level abilities (factor scores) in fathers, mothers and children, the twelve family environment items (three for each of four factors), and the four parental attainment measures, along with family size which is used in the reciprocal effects model (Figure 2). Table 5 contains these correlations and the case base for each.

Table 5 about here

Estimation of the "true" correlations among the unmeasured variables was undertaken as follows. (See Jöreskog, 1970, for the mathematical basis of the procedures used, and Jöreskog et al., 1970 for the computer program.) A factor model was specified in which the indicators of each unmeasured variable loaded on that variable (factor) and no other. F_1 and F_2 loaded on F (father's ability), M_1 and M_2 loaded on M (mother's ability), Q_1 and Q_2

loaded on Q (child's ability), E_1, E_3 and E_{10} defined E_1 (the opportunities dimension of family environments), E_5, E_{13}, and E_{14} defined E_2 (the model dimensions), E_7, E_{17}, and E_{24} loaded on E_3 (reinforcement), and E_2, E_{21}, and E_{26} loaded on E_4 (expectations).

The parental attainment indicators, the S_i, each defined a single factor. To allow for measurement error in this instance, the loading of each S_i on its respective factor was constrained to an estimate of the validity of the indicator (i.e., the correlation of the indicator with the factor). These estimates were obtained as the square root of the reliability coefficients (Heise and Bohrnstedt, 1970:123) reported by Siegel and Hodge (1968:37) for U.S. census data.

This factor model is shown in Table 6.

Table 6 about here

Maximum-likelihood estimates of the correlations among these factors are taken as estimates of the true correlations among the ability, environment, and attainment variables, the F, M, Q, E_i, and S_i.

Unfortunately, the correlations among the parental ability and attainment variables (for this sample at least) are so high that their excessive collinearity makes estimates of their separate effects (as partial regression coefficients) on environments and the child's ability meaningless. There is virtually no acceptable way around this problem (Farrar and Glauber, 1967) and, as a result, the parental status attainment measures were excluded from further analyses.

The investigation is now reduced to models linking parent and child abilities directly, and indirectly via family environments; in other words, Figures 1 and 2 with the parental status attainments deleted. In this form, the models represent something of a replication -- the only one (Vandenberg, 1971:189) -- of the Burks (1928) study. (It is of some interest to note that Burks' work appears to contain the first application of path analysis to social science data. The technique was resurrected by Duncan, 1966, some 38 years later.)

Table 7 indicates the hypothetical factor structure specified for the ability-environment-ability model that is now central to the investigation, together with the results of quantifying this structure using the correlational data of Table 5.

Table 7 about here

The factor correlations shown were used subsequently to estimate the parameters of the model shown in Figure 4 via standard path analytic methods.

Figure 4 about here

(In the interests of simplicity the factor structure of each unmeasured variable is not shown in the figure. One can do this quite easily though, using the information contained in Table 7. For example, the factor loading of F_1 on F can be taken as the path coefficient p_{F_1F}, the effect of F, the unmeasured variable, on its indicator F_1. The relationships of the remaining indicators to their factors are analogous to this situation.)

The interpretation of the environment dimensions in this model differs somewhat from that for the dimensions shown in Table 2. All factor loadings for the E_i in Table 7 are positive (cf. Table 2) with the result that E_1 is interpreted as an opportunities dimension as before, E_2 now measures the extent of father's non-involvement in child-rearing (i.e., mother dominance in child-rearing), E_3 now indicates the degree to which reinforcement tends to be in the form of physical punishment, and E_4 indicates high expectations on the part of parents, as it did in Table 2.

A detailed discussion of this model is undertaken in the following section of this paper but two matters arising from the model deserve comment at this point. First, the overall influence of father's ability on that of the child appears to be mostly direct (compare r_{QF} with p_{QF}) while that of mother's ability appears to be mostly indirect. Second,

two aspects of family environment influence run counter to intuition. Physical punishment appears as a mildly beneficial means of reinforcement ($p_{QE_3} = .16$) and high parental expectations appear to inhibit cognitive performance ($p_{QE_4} = -.51$).

Among investigations in this tradition it is fairly common to find parental abilities considered as a composite like, for example, mid-parent intelligence (Eckland, 1971:68). Something approaching this is possible in the present investigation by defining a single parental ability P with four indicators, F_1, F_2, M_1, M_2, the two first-level abilities of mothers and fathers respectively. The results of estimating a factor model defined in this way are shown in Table 8.

Table 8 about here

The factor correlations estimated under these conditions were used to calculate the parameters of Figure 5 below, the analogue of Figure 4 but with a single <u>parental</u> ability rather than separate abilities for each parent. Discussion of the model is reserved until later in the paper.

Figure 5 about here

Both of the preceeding models consider that part of the covariance argument that says intellectually advantaged parents provide better environments for the development of their (genetically advantaged) children, with respect to this trait. The two models that follow consider a further aspect of the covariance argument, namely, that children doubly advantaged (disadvantaged) in this way have, in fact, a <u>triple</u> advantage (disadvantage) as a function of their varying capability to influence the environment to their own cognitive advantage.

In these models only one aspect of family environments -- the major dimension here, the <u>opportunities</u> parents provide for interaction with e and things in the environment-- is considered. It is argued to t, and be affected by, the child's ability in a mutual influence

relationship (see Figure 2) and both variables are seen to be affected by parental abilities. Family size (N) is also included as an instrumental variable (Fisher, 1971) assumed to affect E_1 but not to affect Q, the child's ability, directly. This assumption, and the assumption that the disturbance terms for E_1 and Q are uncorrelated, are necessary to render the system just-identified and, hence, capable of providing unique parameter estimates.

Table 9 presents the results of quantifying a hypothetical factor model incorporating F, M, Q, E_1, and N. Note that family size is a single indicator construct and that, for the purposes of this investigation, the measure was assumed perfectly valid with its factor loading constrained to 1.0.

Table 9 about here

Parameters for the model shown in Figure 6 below were estimated from the factor correlations of Table 9 by the method of indirect least squares (Duncan et al., 1968). A quick look at the model indicates support for the argument that children's abilities affect the environment to which they are exposed. The model also points out the often documented negative effect of family size on ability, albeit an indirect effect here.

Figure 6 about here

Table 10 and Figure 7 are the analogues of the table and figure just presented, with the exception that father's and mother's ability are combined into a single parental ability as was done with the recursive models estimated above (Figures 4 and 5).

Table 10 about here

Figure 7 about here

5. Discussion

The discussion follows the pattern of the preceding analyses. Consideration is given first, to the way in which arguments about the structure of the ability and environment variables are supported by the data; and second, to the meaning of the estimated models for the heredity/environment covariance argument,-- the idea of a triple advantage or disadvantage -- advanced earlier.

1. The Structure of Variables.

(a) Ability. Two clear and comparable ability dimensions appear to account for much of the covariation among the Wechsler scale sub-tests in adults and children. The first of these is a verbal dimension identified by the predominantly verbal sub-tests (vocabulary, information, etc.), and the second is a non-verbal dimension on which such non-verbal tests as "block design" and "object assembly" load. This dimension is variously named "performance", "non-verbal", "space and visual motor organization", "perceptual organization", and sometimes "g". The term "non-verbal" ability is adopted here. (Other dimensions sometimes derived as factors III and IV in the Wechsler scales and identified respectively by the digit span and digit symbol sub-tests were considered in this investigation. However, because these two factors have consistently presented problems in interpretation when found, and because they are not always found -- Cohen, 1959-- they were abandoned for the purposes of this investigation.)

An evaluation of the apparent similarity of these two two-factor solutions--by rotating them to maximally congruent structures--indicated that they were, in fact, comparable dimensions in parents and children. The point of this, of course, was to ensure that the subsequent analyses were examining the transmission of the same abilities across generations and not, for example, the effect of verbal abilities in parents on non-verbal abilities in children.

The theoretical considerations that guided these analyses argued for a hierarchical structure to intellectual abilities. In this sense, the two first-level abilities identified in parents and children--verbal and non-verbal --were seen as explaining the covariation among the respective Wechsler scale

sub-tests. Subsequently, a higher order general ability (an unmeasured variable) was postulated as a cause of the covariation among these two abilities (its indicators).

(b) Family Environment. Four major dimensions to family environments were postulated, with the overall theoretical orientation to these environments being that of social learning theory. These dimensions were supported by the data and suggested the following interpretation.

(i) An opportunities dimension (E_1), defined by items measuring the extent to which parents specifically structured opportunities for their child to interact with things and people in his environment. The quality and quantity of the learning experiences provided by these things (for example, items 3, 4, 20 and 22 in Table 2) together with the quantity and the quality of exposure to adult models (for example, items 10, 11, 15 and 25 in Table 2) proved to be major components of this dimension.

(ii) A dimension (E_2) concerned with the degree of father involvement in child-rearing. This is not strictly a social learning theory dimension but appears in these data because family environment instruments in the tradition of Mosychuk's (1969) typically show some concern with father/mother dominance (see, for example, Marjoribanks, 1970). The dimension developed here has been called a model dimension in the sense that it refers to the presence of a same-sex adult model.

(iii) The reinforcement dimension (E_3) is somewhat limited in that it refers to the overall nature of the sanctions used by parents along a scale ranging from non-physical to physical punishment. Although this is a "social learning theory" dimension its specific nature in this investigation is defined by the Mosychuk (1969) data. Obviously, much of the complexity that surrounds notions of the role of reinforcement in social learning theory is absent here.

(iv) The expectations dimension (E_4) is the weakest of the four dimensions having a really substantial loading only on item 2 in Table 2, the "parental encouragement" item. Again this is partly a function of forcing data gathered to satisfy one conceptual framework to fit another.

2. Estimation of the Models.

The focus of the models was on two aspects of the covariance argument, the parental abilities--environment--child's abilities linkages, following the notion of a double advantage (disadvantage), and the reciprocal influence of child abilities and environment, extending this notion to that of a triple ntage (disadvantage). The models are discussed in this order.

(a) Double advantage (disadvantage). The models provide evidence on the two links in this argument; first, that family environments affect children's abilities (and the manner of their influence); and second, that parental abilities contribute to this environmental variability and, hence, to children's intellectual variablity indirectly.

Of the four dimensions to family environments, the opportunities and expectations dimensions exert the greatest influence on children's abilities. The effect due to opportunities (p_{QE_1} = .78 in Figure 4 and .74 in Figure 5) is considerable, a one standard-deviation change in E_1 (the metric of E_1 is unknown) resulting in a change of some 12 points in child's ability, assuming the common 15 point standard deviation for IQ. On the other hand, the substantial negative effect of the expectations dimension (p_{QE_4} = -.51 in Figure 4 and -.37 in Figure 5) means that the higher the expectations that parents hold for their child's cognitive performance, the lower that performance. The effects of the other two dimensions are relatively minor. Female dominance in child rearing has a minor negative effect on boy's abilities (p_{QE_2} = -.16 in Figure 4 and -.28 in Figure 5), and the use of physical punishment (vs. psychological) has a minor positive effect (p_{QE_3} = .16 in Figure 4 and .10 in Figure 5). The latter is to some extent at odds with the middle-class child-rearing model that sees love-oriented techniques of discipline (i.e., involving withdrawal of love) as a more appropriate means of punishment.

A further point should be noted. There is substantial covariation between E_1 and E_2 ($r_{E_1E_2}$ = .59 in Table 5) suggesting that families tend to be either high or low on both of these dimensions together. Assuming that middle-class families tend to be high on both and working-class families tend to be low on both, then one would have to conclude that the middle-class child-rearing model is not without liabilities with respect to promoting children's cognitive development. It seems that high expectations on the part of parents actually may inhibit children's cognitive performance. There are explanations of this sort of phenomenon, explanations based on notions of test anxiety (for example, Bronfenbrenner, 1961; Smith, 1969:232). Moreover, given what is known about the antecedents of achievement motivation (e.g., Rosen and D'Andrade, 1959), then it seems as if those environments

most conducive to development of the motivation to achieve are not necessarily those best suited to the development of the abilities necessary for success (and vice versa).

The simplest model of parental influence on family environments is that of Figure 5 where a single parental ability is used. Families characterized by high ability parents provide opportunities for their children to interact with the environment ($p_{E_1P} = .41$), are high on female dominance in child-rearing ($p_{E_2P} = .36$), use non-physical sanctions ($p_{E_3P} = -.30$), and hold out high expectations for their children's performances ($p_{E_4P} = .28$); all in all, the middle class model.

Figure 4 presents the analogous model with separate parental abilities. High ability fathers appear to provide opportunities for their sons to interact with the environment ($p_{E_1F} = .31$), are involved in child-rearing ($p_{E_2F} = -.36$), tend to non-physical modes of sanctioning ($p_{E_3F} = -.41$), and hold out high expectations for their son's performance ($p_{E_4F} = .72$). High ability mothers, it appears, provide opportunities for environmental interaction ($p_{E_1M} = .26$), tend to play an active role in child-rearing ($p_{E_2M} = .57$) but differ little from low ability mothers in terms of the use of physical punishment as a sanction ($p_{E_3M} = .02$), or in terms of the expectations they hold for their child's performance ($p_{E_4M} = -.19$).

What appears to be happening as far as the covariance argument is concerned is that parental abilities exert substantial effects on these dimensions of the family environment, and at least two of these in turn exert substantial effects on children's abilities. However, the matter is complicated by the fact that these quite sizeable indirect effects tend to be opposing effects whose aggregate influence is relatively minor. For example, in Figure 5 the indirect effect of P on Q via E_1 amounts to .31 ($p_{E_1P} \cdot p_{QE_1}$), however, when the other indirect effects are taken into account the total effect of P on Q via the E_i amounts to .08, some 18 per cent of the total effect of .44 (r_{PQ}). This also appears to be true for the separate parental ability model shown in Figure 4 where each parental ability has patterns of opposing indirect effects on the child's ability via the four environment dimensions. The overall result is to make to total indirect effect relatively small in each case, although greater for mothers than fathers

as one might expect, given the social definition of mothers as child-rearers and "creators" of family environments.

(b) Triple advantage (disadvantage). Figures 6 and 7 provide good support to the remaining aspect of the covariance argument examined in this investigation. In each model, the child's ability exerts a respectable influence upon the opportunities his parents provide for him to interact with people and things in his environment (p_{E_1Q} = .26 or .30 respectively). Note, however, that the major direction of influence is from the environment to the child's ability, and is greater than .4 in each case.

The remaining effects hold few surprises. In Figure 6, father's and mother's ability have roughly equal effects on the child's intellectual abilities, and on the opportunities dimension of the environment. Family size exerts a sizeable negative effect on the opportunities for environmental interaction, as expected. The configuration of effects in Figure 7, where a single parental ability is used, follow the same pattern as in Figure 6.

6. Summary

Models developed to examine the biosocial mechanisms involved in the covariance of heredity and environment provided general support for the existence of a triple advantage (disadvantage). It seems that children of intellectually advantaged parents are themselves advantaged in terms of genetic endowment (although this could not be shown in this investigation), the family environment in which they develop, and in the degree of control they have over this environment.

However, although there appear to be substantial indirect effects of parental abilities on children's abilities via the dimensions of family environment examined here, the existence of opposing effects leads to a relatively minor overall indirect influence. By far the greatest part of the parent-child ability correlation is explained by direct effects unmediated by family environments.

Evidence from the two models allowing for a reciprocal influence between the opportunities dimension of family environments and the child's ability indicates that children can manipulate their own environments (and/or parents) to their own cognitive advantage. As money makes more money, intellect leads to more intellect, or so it seems.

If one can take these data to be a reasonable reflection of what is happening, then it seems that the "middle-class child-rearing model" is only marginally better than the "working-class model" because of the patterns of opposing effects involved. However, some of the effects in question are quite substantial and point to the possibility of producing maximal intellectual development in children by manipulating the environment appropriately. The environment best suited to intellectual development, it seems, is one containing things and people of quality, and in quantity. The often documented importance of appropriate adult models and a wide variety of learning situations is documented again here in the effects of the opportunities dimension of family environments. Cognitive development under these conditions appears to be most enhanced by the relative absence of normative pressure for achievement (the expectations dimension here), and to some extent by the presence of a same-sex adult model, together with the use of physical punishment rather than love-oriented sanctioning techniques.

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Table 1. Correlation Matrix for the Twenty-six Family environment Variables[a]

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Mean	St. Dev.
1	.12	.34	.37	-.10	-.01	-.14	.23	.34	.47	.20	-.07	-.04	.11	.38	.08	-.07	-.10	.04	.32	.28	.22	.27	-.07	.31	-.18	6.98	2.63
2		.10	.29	-.13	-.02	.12	.16	.24	.23	.07	.02	-.02	-.01	.21	-.10	-.20	.13	-.08	.14	.33	.07	.13	-.02	-.03	.34	59.84	15.83
3			.32	.05	-.23	-.14	.17	.09	.28	.34	.04	-.08	.02	.22	.14	.03	-.24	-.10	.33	.28	.15	.29	-.04	.24	-.00	62.65	28.42
4				-.13	-.02	-.13	.40	.14	.41	.16	-.15	-.17	-.04	.26	.01	-.09	-.15	-.21	.27	.38	.25	.19	-.09	.20	.02	43.19	12.59
5					.28	.06	-.35	-.12	-.09	.08	.38	.36	.36	-.16	.15	-.08	.01	.01	.02	-.11	-.02	-.10	.21	.02	-.08	8.48	3.69
6						-.03	-.12	.04	-.05	-.06	.14	.29	.34	-.01	.03	-.11	-.04	-.00	-.09	-.17	.05	-.06	-.02	.11	-.08	17.05	3.79
7							-.22	-.07	-.16	.08	.05	.08	-.04	-.17	.13	.33	.35	.22	-.08	-.04	-.03	-.23	.49	-.13	.22	41.53	20.17
8								.26	.32	.07	-.29	-.44	-.20	.35	-.05	.03	-.13	-.07	.08	.29	.14	.14	-.09	.06	.01	3.91	1.47
9									.23	.03	-.37	-.24	-.04	.23	-.03	-.12	-.05	.04	-.01	.22	.05	.07	-.15	.05	.21	5.15	.91
10										.19	-.16	-.26	.10	.33	.18	-.05	-.05	.05	.31	.38	.37	.22	-.14	.34	.13	3.34	1.13
11											.05	.02	.21	.12	.26	.04	-.16	-.13	.06	.21	.08	.09	-.00	.18	.12	4.22	1.32
12												.50	.24	-.12	.03	.03	.09	.01	.08	.01	-.06	.00	.06	-.08	-.21	2.40	1.42
13													.38	-.31	.02	-.10	-.09	.04	-.08	-.26	-.03	-.15	.11	.09	-.11	3.79	1.23
14														-.12	.20	-.08	.05	.03	.05	-.10	.14	.09	-.08	.31	-.19	4.82	1.06
15															.02	.06	-.02	-.06	.19	.31	.29	.15	-.03	.18	.06	3.55	1.55
16																.20	-.08	-.11	-.05	-.03	.14	.05	.14	.14	.11	3.79	1.02
17																	.24	.17	-.02	-.14	-.10	-.14	.45	-.08	.11	4.57	1.05
18																		.28	-.01	-.05	-.20	-.21	.21	-.15	.01	4.23	.79
19																			-.06	-.15	.06	-.19	.30	.01	.06	3.75	1.23
20																				.07	.27	.21	.01	.16	-.08	4.99	1.16
21																					.18	.26	-.13	.18	.07	3.98	1.08
22																						.25	-.01	.37	-.03	4.22	1.28
23																							-.10	.25	-.14	4.12	1.10
24																								-.17	.03	3.47	2.00
25																									-.03	40.64	13.10
26																										4.62	1.17

a. See Table 2 for a description of each variable.

Table 2. Family Environment: Pattern Matrix from Oblique Rotation[a] of Principal Factor Solution

Items: item makeup shown in parentheses and keyed to Appendix A in Williams (1973)	Rotated Factor Loadings				h^2
	I	II	III	IV	
1. Concrete evidence that parents are concerned with the child's education (3 + 4)	.62	.05	.05	.02	.41
2. Parental encouragement for the child to engage in school-related activities (12c + 12d + 13 + 14c + 51a + 55d + 56D + 56e + 58(axb) + 59b)	.14	-.18	.06	.94	.87
3. Availability of school-related learning materials in the home (12a + 15a + 15b + 51((d + e) x c))	.54	.04	-.00	-.03	.30
4. Degree of child's exposure to learning material outside school (14a + 14b + 15f + 15g + 16 + 17 + 55a + 55b + 56a)	.48	.14	.13	.18	.36
5. Female dominance in child-rearing: I (26(a + b))	.06	-.57	-.09	-.04	.35
6. Female dominance in child-rearing: II (29(a + c + d))	-.01	-.38	.11	.02	.14
7. Use of physical punishment: I (46((a + b) x c))	-.07	-.11	-.66	.25	.53
8. Father's interest in child's school activities (8)	.28	.51	.10	.04	.40
9. Family interaction: I (19)	.17	.23	.10	.23	.19
10. Family interaction: II (20)	.64	.14	.01	.13	.49
11. Child's interaction with non-parent adults (23)	.40	-.11	-.10	.04	.16
12. Degree of father/child contact: I (24)[b]	.00	-.56	-.04	.03	.31
13. Degree of father/child contact: II (25)[b]	-.08	-.76	.03	.04	.58
14. Female dominance in child-rearing: III (28)	.28	-.59	.05	-.04	.41
15. Family interaction: III (31)	.43	.27	-.01	.09	.30
16. Parental concern over nature of child's interaction with environment (42)	.30	-.11	-.24	-.12	.15

Table 2 - continued

Items: item makeup shown in parentheses and keyed to Appendix A in Williams (1973)	Rotated Factor Loadings I	II	III	IV	h^2
17. Use of physical punishment: II (44)	.07	.23	-.66	-.20	.47
18. Rigidity of rules for behavior: I (45)	-.17	-.02	-.37	.19	.22
19. Rigidity of rules for behavior: II (48)	-.04	.01	-.35	-.01	.12
20. Child's hobby activities (49)	.41	-.02	-.01	.02	.17
21. Parent/child interaction in hobby activities (50)	.39	.14	.10	.29	.33
22. Child's interaction with environment through outdoor activities (52)	.49	-.03	.01	-.03	.24
23. Provisions for exploration/independence at early age (53)	.38	.03	.21	-.03	.22
24. Child's fear of physical punishment (47b)	.04	-.04	-.69	-.01	.48
25. Rating of mother's language quality	.52	-.14	.10	-.11	.31
26. Variety in methods of encouragement to complete tasks (59c)	.03	.11	-.19	.35	.19

a. direct oblimin with delta = 0 (Harman, 1967:334).

b. reversed scoring: high contact scored as 1, low contact scored as 7.

Factor Correlations

	II	III	IV
I	.08	.17	.06
II		.09	.26
III			.02

Table 3. WISC and WAIS Sub-test Correlations: children [a] and parents [b]

Wechsler Scale Sub-tests	Information	Comprehension	Arithmetic	Similarities	Digit Span	Vocabulary	Coding	Picture Completion	Block Design	Picture Arrangement	Object Assembly	Mazes [c]	Mean	St. Dev.
Information		.55	.52	.56	.39	.52	.22	.39	.35	.16	.30	.16	11.30	2.66
Comprehension	.74		.31	.44	.25	.63	.28	.40	.36	.17	.16	.15	12.22	3.14
Arithmetic	.49	.39		.41	.23	.27	.08	.22	.28	.08	.14	.05	11.54	2.22
Similarities	.66	.64	.45		.17	.66	.23	.32	.36	.23	.41	.00	12.86	3.31
Digit Span	.41	.33	.36	.45		.25	.11	.24	.26	.11	.10	.03	9.96	2.32
Vocabulary	.82	.79	.45	.75	.47		.28	.42	.38	.23	.29	.03	12.58	3.22
Digit Symbol	.34	.39	.23	.42	.34	.40		.30	.26	.21	.34	.28	11.55	2.54
Picture Completion	.64	.60	.39	.54	.25	.60	.21		.38	.16	.21	.11	11.90	2.96
Block Design	.49	.46	.41	.42	.43	.51	.29	.48		.18	.44	.21	11.80	2.83
Picture Arrangement	.48	.43	.27	.43	.22	.50	.28	.58	.45		.20	.01	11.20	2.67
Object Assembly	.40	.42	.22	.37	.11	.32	.13	.41	.34	.42		.22	11.81	3.16
Mean	11.50	13.07	12.06	11.94	10.05	11.62	9.46	10.19	11.12	9.56	10.40	11.56		
St. Dev.	2.72	3.29	2.99	3.01	2.89	3.10	2.46	2.56	2.45	2.41	2.76	2.71		

a. children above the diagonal; b. parents below the diagonal; c. "mazes" sub-test omitted from analysis.

Table 4. Intellectual Abilities: Pattern Matrices from Oblique Rotations of Parent and Child Principal Factor Solutions

Wechsler Scale Sub-tests	I		II		h^2	
	Parents	Child	Parents	Child	Parents	Child
Information	-.64	-.84	-.33	-.03	.76	.68
Comprehension	-.56	-.64	-.34	.10	.67	.48
Arithmetic	-.46	-.60	-.13	-.11	.30	.30
Similarities	-.67	-.53	-.20	.28	.64	.52
Digit Span	-.64	-.42	.17	-.02	.31	.16
Vocabulary	-.74	-.58	-.22	.26	.78	.57
Digit Symbol	-.48	.01	.02	.53	.22	.27
Picture Completion	-.16	-.35	-.70	.27	.65	.30
Block Design	-.34	-.23	-.35	.46	.38	.38
Picture Arrangement	-.05	-.04	-.67	.32	.49	.12
Object Assembly	.04	.08	-.60	.70	.34	.43

Factor Correlations

		Parents	
		I	II
Child	I		.59
	II	-.55	

Table 5. Correlation Matrix[a]: Parental Status Attainments, Family Size, Parent and Child Abilities, and Family Environment Indicators

	S_1	S_2	S_3	S_4	N	F_1	F_2	M_1	M_2	Q_1	Q_2	E_1	E_2	E_3	E_5	E_7	E_{10}	E_{13}	E_{14}	E_{17}	E_{21}	E_{24}	E_{26}
S_1		.82	.68	.61	-.30	.57	.39	.59	.46	.40	.42	.57	.09	.26	-.22	-.24	.41	-.12	.15	-.26	.27	-.35	-.05
S_2	100		.71	.55	-.22	.68	.34	.53	.50	.39	.41	.52	.16	.20	-.21	-.26	.36	-.11	.09	-.23	.29	-.27	-.11
S_3	100	100		.58	-.28	.70	.40	.52	.29	.34	.29	.52	.20	.30	-.18	-.24	.40	-.08	.11	-.23	.30	-.37	.05
S_4	58	58	58		-.22	.45	.39	.36	.34	.25	.34	.25	.27	.09	-.03	-.29	.28	-.05	.23	-.38	.31	-.27	-.00
N	100	100	100	58		.03	-.07	-.15	-.05	-.19	-.24	-.42	-.11	-.40	.08	.20	-.27	-.09	-.12	.20	-.24	.28	.13
F_1	57	57	57	55	57		.63	.49	.43	.32	.26	.21	.22	-.04	-.11	-.00	.31	-.01	.07	-.14	.19	-.21	.22
F_2	57	57	57	55	57	57		.41	.39	.25	.31	.15	.37	.23	-.18	-.14	.31	-.06	-.12	-.19	.29	-.35	.20
M_1	67	67	67	55	67	57	57		.72	.33	.36	.33	.05	.12	-.12	-.09	.30	.37	.31	-.24	.16	-.15	.14
M_2	67	67	67	55	67	57	57	67		.07	.20	.08	.03	-.08	-.08	-.13	.04	.30	.13	-.39	.18	-.20	.01
Q_1	100	100	100	58	100	57	57	67	67		.66	.38	.07	.18	-.16	.11	.44	-.17	.15	-.03	.19	-.10	-.01
Q_2	100	100	100	58	100	57	57	67	67	100		.42	.08	.18	-.14	-.06	.42	-.17	-.08	-.09	.16	-.12	.06
E_1	91	91	91	53	91	52	52	61	61	91	91		.12	.34	-.10	-.14	.47	-.04	.11	-.07	.28	-.07	-.18
E_2	91	91	91	53	91	52	52	61	61	91	91	91		.10	-.13	.12	.23	-.02	-.01	-.20	.33	-.02	.34
E_3	91	91	91	53	91	52	52	61	61	91	91	91	91		.05	-.14	.28	-.08	.02	.03	.28	-.04	-.00
E_5	91	91	91	53	91	52	52	61	61	91	91	91	91	91		.06	-.09	.36	.36	-.08	-.11	.21	-.08
E_7	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91		-.16	.08	-.04	.33	-.04	.49	.22
E_{10}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91		-.26	.10	-.05	.38	-.14	.13
E_{13}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91	91		.38	-.10	-.26	.11	-.11
E_{14}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91	91	91		-.08	-.10	-.08	-.19
E_{17}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91	91	91	91		-.14	.45	.11
E_{21}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91	91	91	91	91		-.13	.07
E_{24}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91	91	91	91	91	91		.03
E_{26}	91	91	91	53	91	52	52	61	61	91	91	91	91	91	91	91	91	91	91	91	91	91	

Table 5 --continued

Notes:

(a) correlation coefficients appear above the diagonal;

(b) figures appearing below the diagonal indicate the case base for each correlation coefficient;

(c) correlation coefficients underlined are not significantly different from zero at the .05 level of confidence (two-tail test).

Key to the symbols used:

S_1.....father's occupational prestige

S_2.....father's education

S_3.....mother's education

S_4.....family income

N.....family size

F_1, M_1, Q_1.....verbal factor in fathers, mothers and children respectively

F_2, M_2, Q_2.....non-verbal factor in fathers, mothers and children respectively

E_1 to E_{26}.....indicators of family environment dimensions shown in Table 2

Table 6. Hypothesized Oblique Factor Model: Father, Mother, and Child Abilities, Family Environment Dimensions, Parental Status Attainments

Indicators	Factors										
	F	M	Q	E_1	E_2	E_3	E_4	S_1	S_2	S_3	S_4
F_1	f_1	0	0	0	0	0	0	0	0	0	0
F_2	f_2	0	0	0	0	0	0	0	0	0	0
M_1	0	m_1	0	0	0	0	0	0	0	0	0
M_2	0	m_2	0	0	0	0	0	0	0	0	0
Q_1	0	0	q_1	0	0	0	0	0	0	0	0
Q_2	0	0	q_2	0	0	0	0	0	0	0	0
E_1	0	0	0	e_1	0	0	0	0	0	0	0
E_2	0	0	0	0	0	0	e_2	0	0	0	0
E_3	0	0	0	e_3	0	0	0	0	0	0	0
E_5	0	0	0	0	e_5	0	0	0	0	0	0
E_7	0	0	0	0	0	e_7	0	0	0	0	0
E_{10}	0	0	0	e_{10}	0	0	0	0	0	0	0
E_{13}	0	0	0	0	e_{13}	0	0	0	0	0	0
E_{14}	0	0	0	0	e_{14}	0	0	0	0	0	0
E_{17}	0	0	0	0	0	e_{17}	0	0	0	0	0
E_{21}	0	0	0	0	0	0	e_{21}	0	0	0	0
E_{24}	0	0	0	0	0	e_{24}	0	0	0	0	0
E_{26}	0	0	0	0	0	0	e_{26}	0	0	0	0
S_1	0	0	0	0	0	0	0	.93	0	0	0
S_2	0	0	0	0	0	0	0	0	.97	0	0
S_3	0	0	0	0	0	0	0	0	0	.97	0
S_4	0	0	0	0	0	0	0	0	0	0	.94

Note: The f_i, m_i, q_i and e_i represent factor loadings to be estimated, while the zeros indicate hypothesized zero loadings. S_i loadings constrained to validity coefficients shown.

Table 7. Maximum-likelihood Estimates of Factor Loadings and Factor Correlations for Ability-Environment-Ability Model: Separate Parental Abilities

Indicators	Factors							
	F	M	Q	E_1	E_2	E_3	E_4	Residual
F_1	.75	0	0	0	0	0	0	.66
F_2	.84	0	0	0	0	0	0	.54
M_1	0	1.00	0	0	0	0	0	.00
M_2	0	.72	0	0	0	0	0	.70
Q_1	0	0	.80	0	0	0	0	.60
Q_2	0	0	.83	0	0	0	0	.56
E_1	0	0	0	.63	0	0	0	.78
E_2	0	0	0	0	0	0	.59	.81
E_3	0	0	0	.38	0	0	0	.92
E_5	0	0	0	0	.37	0	0	.93
E_7	0	0	0	0	0	.57	0	.83
E_{10}	0	0	0	.78	0	0	0	.63
E_{13}	0	0	0	0	.99	0	0	.12
E_{14}	0	0	0	0	.39	0	0	.92
E_{17}	0	0	0	0	0	.52	0	.85
E_{21}	0	0	0	0	0	0	.58	.82
E_{24}	0	0	0	0	0	.88	0	.48
E_{26}	0	0	0	0	0	0	.34	.94

Factor Correlations						
F	.54	.43	.44	-.05	-.40	.62
M		.42	.42	.38	-.20	.20
Q			.70	-.21	-.14	.24
E_1				-.25	-.20	.59
E_2					.10	-.25
E_3						-.11

Table 8. Maximum-likelihood Estimates of Factor Loadings and Factor Correlations for Ability-Environment-Ability Model: Single Parental Ability

Indicators	Factors						
	P	Q	E_1	E_2	E_3	E_4	Residual
F_1	.56	0	0	0	0	0	.83
F_2	.51	0	0	0	0	0	.86
M_1	.92	0	0	0	0	0	.39
M_2	.76	0	0	0	0	0	.65
Q_1	0	.79	0	0	0	0	.61
Q_2	0	.84	0	0	0	0	.55
E_1	0	0	.64	0	0	0	.77
E_2	0	0	0	0	0	.42	.91
E_3	0	0	.40	0	0	0	.92
E_5	0	0	0	.36	0	0	.93
E_7	0	0	0	0	.60	0	.80
E_{10}	0	0	.76	0	0	0	.65
E_{13}	0	0	0	1.0	0	0	.00
E_{14}	0	0	0	.38	0	0	.92
E_{17}	0	0	0	0	.57	0	.82
E_{21}	0	0	0	0	0	.77	.64
E_{24}	0	0	0	0	.81	0	.59
E_{26}	0	0	0	0	0	.20	.98
	Factor Correlations						
P		.44	.41	.36	-.30	.28	
Q			.70	-.21	-.13	.27	
E_1				-.25	-.22	.63	
E_2					.09	-.30	
E_3						-.17	

Table 9. Maximum-likelihood Estimates of Factor Loadings and Factor Correlations for "Reciprocal Effects" Model: Separate Parental Abilities

Indicators	Factors					Residual
	F	M	Q	E_1	N	
F_1	.87	0	0	0	0	.50
F_2	.73	0	0	0	0	.68
M_1	0	1.00	0	0	0	.00
M_2	0	.72	0	0	0	.70
Q_1	0	0	.80	0	0	.60
Q_2	0	0	.83	0	0	.56
E_1	0	0	0	.73	0	.69
E_3	0	0	0	.45	0	.89
E_{10}	0	0	0	.65	0	.76
N	0	0	0	0	1.00*	.00
	Factor Correlations					
F		.56	.42	.38	-.00	
M			.42	.44	-.15	
Q				.70	-.26	
E_1					-.56	

*constrained to this value

Table 10. Maximum-likelihood Estimates of Factor Loadings and Factor Correlations for "Reciprocal Effects" Model: Single "Parental" Ability.

Indicators	Factors				
	P	Q	E_1	N	Residual
F_1	.62	0	0	0	.79
F_2	.55	0	0	0	.83
M_1	.88	0	0	0	.48
M_2	.77	0	0	0	.64
Q_1	0	.78	0	0	.62
Q_2	0	.84	0	0	.54
E_1	0	0	.74	0	.68
E_3	0	0	.46	0	.89
E_{10}	0	0	.64	0	.77
N	0	0	0	1.00*	.00

Factor Correlations			
P	.44	.40	-.12
Q		.70	-.26
E_1			-.56

*constrained to this value

Figure 4. Causal Model Linking Parent and Child Abilities Across Generations Directly, and Indirectly via Family Environments: Separate Parental Abilities

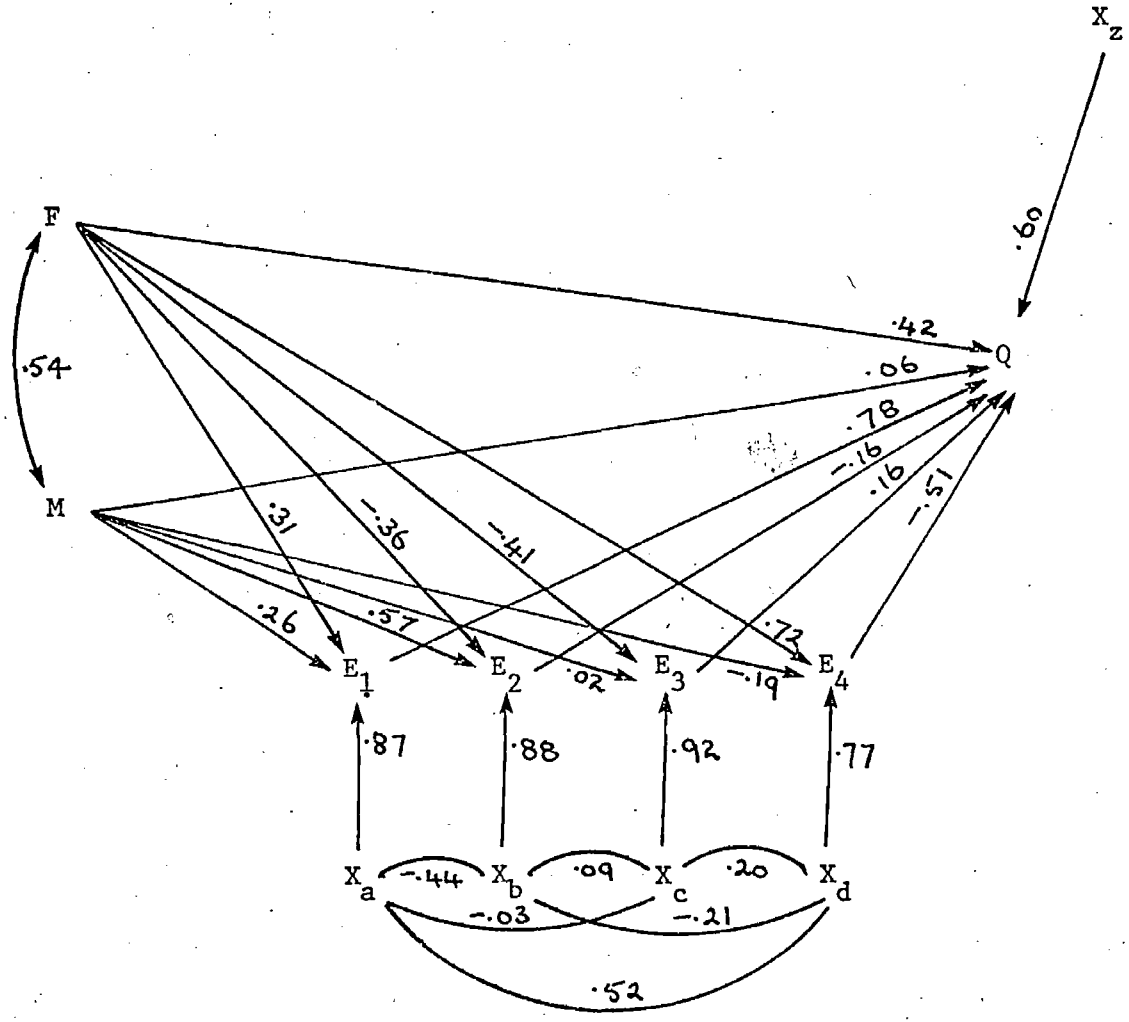

Figure 5. Causal Model Linking Parent and Child Abilities Across Generations Directly, and Indirectly via Family Environments: Single "Parental" Ability

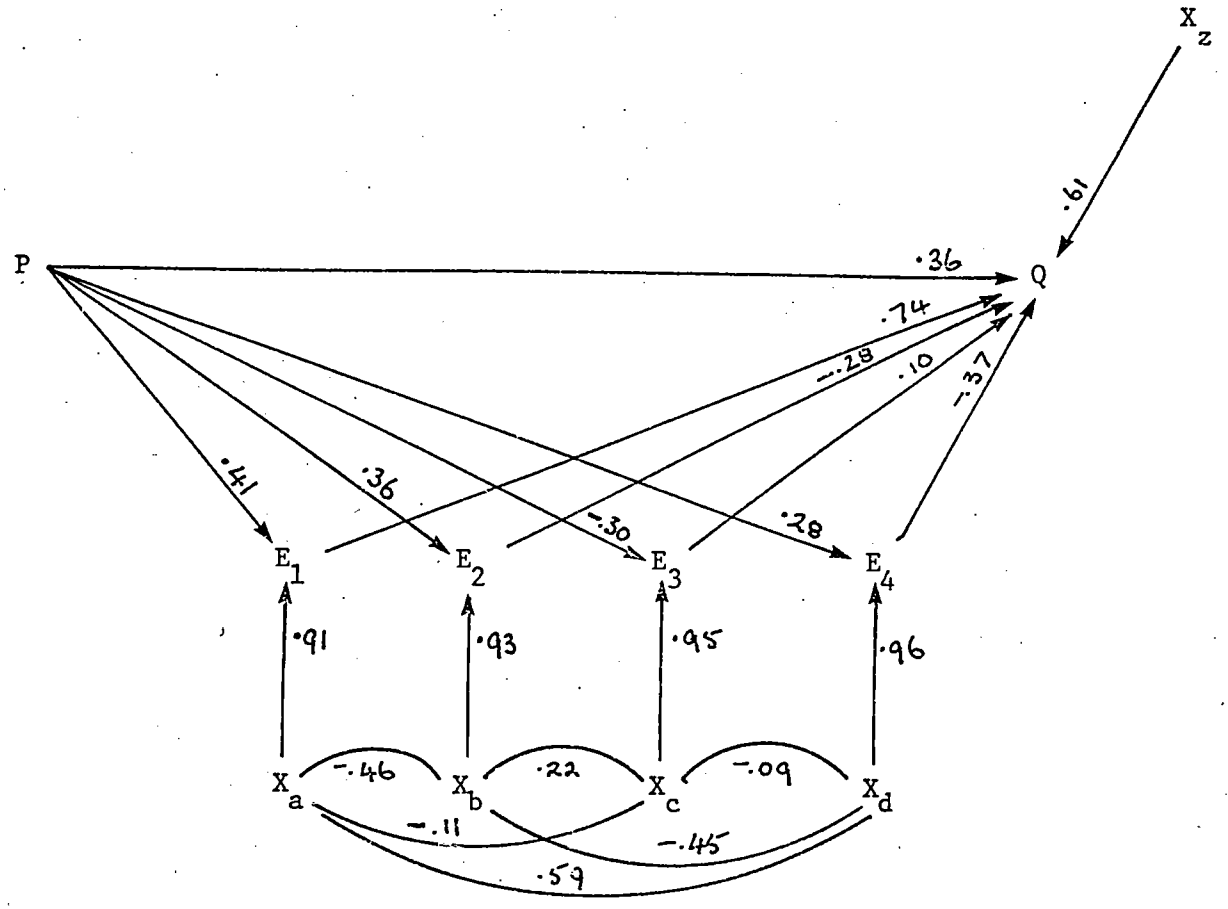

Figure 6. Causal Model Allowing for Reciprocal Influence Between Child's Ability and One Dimension of Family Environment: Separate Parental Abilities

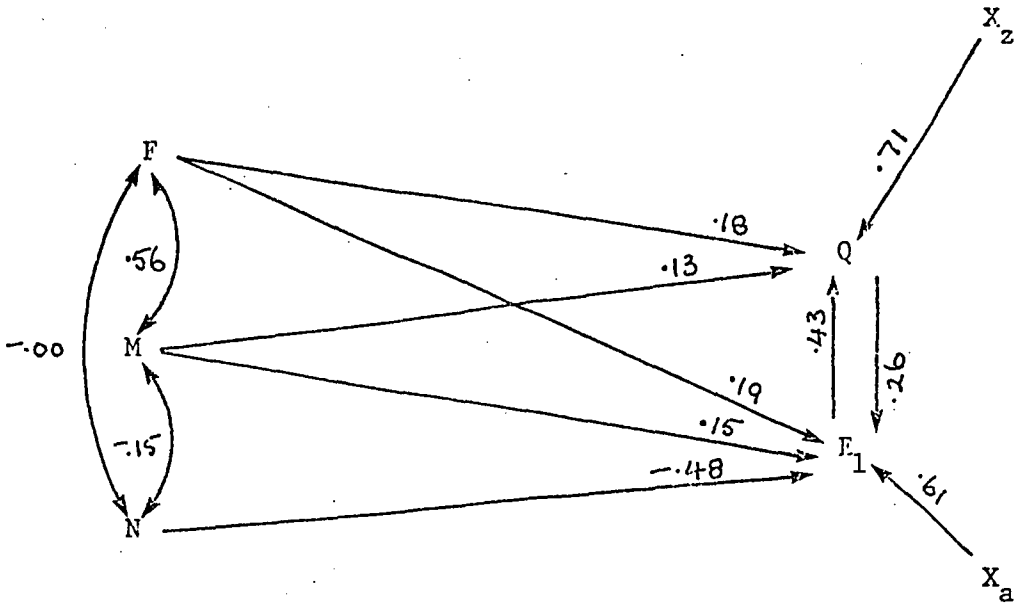

Figure 7. Causal Model Allowing for Reciprocal Influence Between Child's Ability and One Dimension of Family Environment: Single "Parental" Ability