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THE RELATIONSHIP BETWEEN FAMILY CONFIGURATION AND COGNITIVE AND LANGUAGE ABILITIES OF PRESCHOOL-AGED CHILDREN

by
Melvin Harold Shelly

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Education and Psychology)
in The University of Michigan
1977

Doctoral Committee:

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High/Scope Educational Research Foundation

DEDICATION

This study is dedicated to Anne Shelly, my wife, without whose love and patience I would never have been able to complete it.

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I would like to gratefully acknowledge the assistance of my five committee members, Drs. Collet, Davidson, Markus, McNeil, and Zajonc. They have given generously of their time and thought throughout the entire project. Particular thanks go to Dr. Judy McNeil, who read successive drafts of this study, from the proposal through the final writing stages. I would also like to thank Dr. LeVerne Collet, my chairman, for his advice regarding organization and presentation.

Staff members of the High/Scope Educational Research Foundation have assisted me in numerous ways since the conception of this idea for the study. Special thanks go to Robert Hanvey, Helen Kiddon, Nancy Naylor, and the data processing staff.

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PREFACE

This study has been an attempt to operationalize certain notions of family influence and to assess their impact on a child's measured intellectual ability. Substantive content aside, this is primarily a methodological study. Common practice suggests that highly technical material, and supporting information, which might otherwise interfere with the flow of a study report, ought to be placed in the appendices rather than in the main text. This practice has been followed in this report.

However, since thorough understanding of this study might depend on a clear understanding of the methodology employed, this researcher urges interested readers to examine the technical material in Appendices D and E. Explanatory power is a key concept in this study. This concept is elaborated in these appendices. These appendices might answer questions that the reader might have regarding explanatory power in the context of this study.

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CHAPTER ONE:

THE RESEARCH PROBLEM

Setting for the Problem

This study examines the impact of an intellectual environment on an individual child's measured intellectual ability. An intellectual environment is a primary group situation in which a child participates as he develops. Each child moves through a number of intellectual environments throughout the period of his intellectual development. The family is the first intellectual environment that the child encounters. Educational programs (schools, classrooms) are additional intellectual environments in which each child typically participates. In this study, the intellectual environment examined was the family. Family intellectual environment is a psychological construct which has been inferred from the family configuration pattern for a target child, as suggested by the Zajonc and Markus (1975) "confluence model." Selected notions concerning the influence of family configuration on intellectual ability, derived from the confluence theory, guided this researcher in casting a multivariate family configuration model for use in a multiple linear regression equation predicting measured intellectual ability. The measured intellectual ability used in this study was a score on a cognitive or language test. The target population for the study was

preschool-aged children participating in compensatory education programs. The degree of influence of the family intellectual environment on a preschool-aged child's measured intellectual ability was assessed by a multiple linear regression analysis of the cognitive-language score regressed on the researcher-contructed, multivariate family configuration model.

Zajonc and Markus (1975) have developed the "confluence model" which attempts to explain family group profile differences in published aggregated intellectual ability data. They suggest a functional relationship between family configuration pattern and family intellectual environment which influences or impacts on the measured intellectual ability of a target child. Family configuration for a target child consists of the child's birth order, number of siblings, number of adults in the home, and the spacing between children in the child's family.

The classroom is a logically parallel intellectual environment to the family. Classroom membership variables also parallel family configuration variables. Stretching ideas from the "confluence model," classroom membership configuration would include: a target child's age relative to the ages of classmates, the number of classmates, numbers of teachers and adult aides, and differences in ages or grades of children in the classroom (particularly under multi-age grouping and cross-age tutoring).

The major task of the researcher in this study was the casting of a multivariate linear equation which adequately mapped five basic notions of family influence derived from the confluence theory: siblings, birth order, adults, spacing, and the "teacher effect." This study is original in that no previous studies using individual level data have attempted to examine the simultaneous influence of these notions, derived from the "confluence model," on the measured intellectual ability of preschool-aged children.

Educational Relevance

The "confluence model" posits a "teacher effect" to explain the observed relative advantage of all children in families of varying sizes who are not last-born or only-children. This notion has a direct parallel to educational programs which include cross-age tutoring. In addition, compensatory elementary education programs for children from this same target population, are typically attempts to modify and improve an intellectual environment (classroom) for these children. It therefore becomes important to know the impact or influence of any intellectual environment (e.g., the family) on a target child's measured intellectual abilities. Estimating and understanding the strength of the influence of family intellectual environment on measured intellectual ability might help researchers in the compensatory education area in two distinct ways. Adequate measurements of the

family's influence would allow them to assess program impact over and above important individual background differences. The procedures used for creating a model of family configuration can be used in parallel fashion as guidelines for creating a model of classroom configuration and assessing its influence on a child's measured intellectual ability.

Focus of this Study

The focus of this study was the family intellectual environment, inferred from the family configuration pattern. Direct implications from this research apply to the family context, and to future research and theorizing about the family. Subjects for this study have been selected from three samples of preschool-aged children entering national evaluations of two Office of Child Development compensatory education programs (n = 556, n = 726, n = 916, respectively). There were certain disadvantages in using extant data out of its original context (e.g., existing design problems including sample selection factors, missing data, and use of subtests from a larger battery). However, the cost of collecting and processing data sets as large as these existing data bases (conservatively estimated at $200,000.00) would have been prohibitive. In this situation, secondary analyses of existing data, containing adequate information on the five chosen notions of family

configuration influence suggested by the theory, provided the most sensible approach to the problem of this study.

Research Question

What is the impact of family configuration pattern on the measured intellectual ability of a preschool-aged child? By operationalizing the notions of family influence suggested by the confluence theory, the research problem became: how much variability in cognitive and language test scores could a multivariate family configuration model explain? This question was answered by assessing the explanatory power of the multivariate family configuration model on its own (percent of variance explained by the family configuration model), and by assessing the explanatory power of the multivariate family configuration model relative to the maximum explanation possible, knowing other important status and demographic characteristics (proportion of maximum explainable variance).

The researcher attempted three tasks in this study: 1) operationalizing notions from the confluence theory into a linear equation; 2) pilot testing the multivariate family configuration model with available information in the exploratory sample; 3) model testing with a replication sample. For the model testing phase, three criteria were defined for evaluating the explanatory power of the multivariate family configuration model:

1) the significance of the R-square value for the multivariate family configuration model obtained in the multiple regression analysis; 2) the comparability of this family configuration R-square value to expectations based on theory and previous research; 3) the size of the R-square value for the multivariate family configuration model relative to the size of the R-square value obtained using all available family configuration, status, and demographic variables as predictors.

Definition of Terms

Certain concepts, repeatedly used in this report, have specific meaning in the context of this study:

Preschool-aged. Target children in this study ranged in age from three years old up to, but not including, six years old.

Children in compensatory education programs. All children whose data were used in this study were from families which met the Head Start eligibility guidelines.

Cognitive and language tests. The original dependent variables for this study were scores on developmentally related subtests selected from the measurement batteries for the evaluations (see Appendix B). Composite scores were created as outlined in Chapter Four.

Model. Zajonc and Markus (1975) chose the term "confluence model" to describe their theory of family configuration and intellectual environment. In this study, the terms confluence model and confluence theory have been

used interchangeably. The multivariate family configuration model specifically refers to this researcher's constructed multiple linear equation model, containing the set of family variables which represent his conceptual framework.

Conceptual pieces. This term refers to five notions of family configuration influence which the researcher selected from the confluence theory as a guide for including predictor variables in his multivariate family configuration model.

Family configuration. Suggested by notions of family influence from the confluence theory, this term stands for the five conceptual pieces in the multivariate model including variables representing the number of siblings, the target child's birth order, the number of adults in the home, spacing between births of children in a family, and the hypothesized "teacher effect."

Map, or mapping. This term, used as a verb, refers to the one-to-one, or, more typically, many-to-one correspondence of family configuration predictor vectors which represent each of the five conceptual pieces in the researcher-constructed, multivariate family configuration model.

Status and demographic variables. These typically included the age of the target child, sex, ethnic background, treatment program assignment, site of project, and mother's education.

Exploratory data-snooping. This term refers to the systematic examination of multivariate relationships among the family configuration variables and the composite dependent variable score in Data Set 1. This procedure was researcher-controlled, based on theoretical considerations. It was used extensively in the model-building phase in examining the adequacy of alternative sets of family configuration vectors in mapping pieces of the conceptual framework.

Explanatory power. This is "explanation" in the logical, not the causal, sense (Kaplan, 1964). Explanatory power is the proportion of variance in the dependent variable accounted for by the set of predictors in the multivariate family configuration model. This is equivalent to the R-square value from the multiple regression analysis for that model.

Maximum explainable variance. This is the R-square value of a multivariate model containing as predictors all available family configuration, status, and demographic variables. It represents a reasonable estimate of the maximum explanation possible with the available information.

Proportion of maximum explainable variance. This is an index of the importance of the family configuration model relative to the best possible explanation. The multivariate family configuration model's R-square value divided by the maximum model's R-square value yields the

proportion of maximum explainable variance attributable to the family configuration model (see Appendix D).

Assumptions and Limitations

The dependent variable scores were assumed to be normally distributed in the target population, justifying the use of parametric statistics. The available data in all three samples were assumed to be accurate, reliable, and sufficiently precise that they reflected the actual values of these variables in the samples. The samples were assumed to be logically (not statistically) representative of the larger target population of pre-school-aged children in compensatory education programs. Selection factors in the existing experimental designs, and the criteria applied for admissability of subject data were not expected to pose any serious threat to the validity of the analytic design.

CHAPTER TWO:

REVIEW OF SELECTED LITERATURE

Purpose and Limitations

This chapter presents a highly selective review of the research literature which might apply to the research problem of this study. Zajonc (1976) has recently assembled a bibliography of over 1000 studies which have some relevance to the "confluence model." The literature on correlates of mental abilities is vast and spans the major research efforts in twentieth century psychology. This researcher surveyed approximately fifty studies and previous reviews whose content applied to the family configuration influence notions. The studies discussed in detail in this chapter were limited to studies which were: 1) relevant to the development of the "confluence model;" 2) focused on preschool intellectual abilities; 3) suggestive of other complex family influence models; and, 4) those with suggestions relating to the teacher effect. The researcher has attempted to discuss these studies with respect to the explanatory power of predictors, or multivariate models.

Correlates of Mental Abilities

It is useful to begin a discussion of the research on intellectual ability with an examination of estimates of the strength of relationships between family, status, and demographic predictors and measured ability. Research in

this area has been extensive. However, much of this research has been bivariate in nature, with grossly defined categorical predictors. The few important multivariate studies have not been based on clearly stated theoretical models. Nevertheless, a summary of typical findings provides an informed base for research expectations and certain directional predictions (see Chapter Four).

The studies, reviews, and collections of papers surveyed in this section included: Bachman, 1972; Broman, Nichols, and Kennedy, 1974; Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, and York, 1966; Deutsch, Katz, and Jensen, 1968; Duncan, Featherman, and Duncan, 1972; Jencks, Smith, Acland, Bane, Cohen, Gintis, Heyns, and Michelson, 1972; Kamin, 1974; Loehlin, Lindzey, and Spuhler, 1975; and, Maccoby and Jacklin, 1974. These studies, using some conventional IQ type test (usually adjusted for age, or by a deviation IQ formula) have presented the following estimates of the strength of bivariate relationships:

1. the number of siblings, negatively correlated with IQ, explained from 5% to 10% of the variance;

2. sex, explained 2% to 10% of the variance;

3. ethnic background explained between 10% and 20% of the variance;

4. socio-economic status, variously defined, explained between 4% and 25% of the variance;

5. age of subject, in spite of age adjustments, explained up to 4% of the variance;

6. parent IQ has been shown to predict from 2% (for adoptive) through 19% of the variance;

7. parent education explained from 5% to 15% of the variance;

8. spacing between births as a single predictor has explained only 1% of the variance;

9. father absence, negatively correlated, explained 2% of the variance;

10. birth order, negatively correlated, explained less than 2% of the variance.

Several of these same studies, using multivariate sets of predictors, have also reported the following:

1. Broman, Nichols, and Kennedy (1974), using a multivariate model created by stepwise regression, including significant prenatal, neonatal, infancy, and childhood variables, and maternal characteristics, explained between 15% and 25% of the variance in four year old's IQ scores for black and white samples.

2. Jencks, et al. (1972), summarizing several comprehensive studies of school age children, attributed 10% to 40% of the variance in school achievement measures to family background.

3. Coleman, et al. (1966), using parent education, smallness of family, intactness of family, and reading materials in the home, accounted for between 10% and 25%

of the variance in the Equality of Educational Opportunity Survey high school test batteries.

4. Thorndike (1973), in a study of reading comprehension in 15 countries, using indices similar to Coleman, accounted for between 14% and 22% of the variance.

5. Bachman (1972), in the Youth in Transition Study, using a combination of socio-economic level, number of siblings, and race by region by school categorization, explained 33% of the variance in Quick Test scores for tenth grade boys.

These variance estimates (10% through 40%) from multivariate analyses can be taken as research-informed limits on the expected maximum explainable variance.

The Birth Order Controversy

Altus (1966) summarized a century of attention to birth order in the study of individual differences. He noted that in numerous studies of gifted, prominent, and educationally advantaged individuals, first borns are over-represented. Although there is some mention of the mediating influence of family size in his review, his stated conclusion was that "ordinal position at birth has been shown to be related to significant social parameters, though the reasons behind the relations are as yet unknown and at best dimly apprehended." Schooler (1972) challenged this position, citing biases in the data examined by Altus. Examining data from the National Occupation Study (n = 3,101 adult males), on birth order and college

attendance, he concluded that "when family size is controlled there are no significant differences among any of the birth ranks, although there is a tendency toward over representation of first borns from small families." He attributes typical birth order differences in educational attainment to social class by birth rate differences. He does suggest that "a more consistent pattern of birth order effects would be discovered if other family structure variables were taken into account," such as family density.

A reply to Schooler by Breland (1973) and a rejoinder by Schooler (1973) continued the debate. Breland's contention, based on his study of 800,000 National Merit Scholarship Qualifying Test subjects (Breland, 1974, discussed below), is that birth order effects are still present, after controlling for family size and other SES indicators. Schooler insisted that Breland's sample is, again, non-representative of the United States population, and that Breland's techniques do not legitimately allow for his conclusions.

Birth Order and Family Size

Belmont and Marolla (1973) presented results of a study of 400,000, nineteen year old men in the Netherlands which investigated the relationships of family size and birth order to scores on the Raven's Progressive Matrices (a test of non-verbal cognitive problem-solving). The population studied represented three broadly defined

occupational levels (non-manual, manual, and farm). The authors stated their assumption that family sizes were fixed at the time of testing. (They probably meant that changes in family size were less likely to occur for these men, and less likely to have any impact on their measured ability.) Belmont and Marolla found that measured intelligence declined with increasing family size, and within family size it declined with increasing birth order. Although they discussed the notion that birth order and family size are not independent, they concluded that birth order and family size have independent relationships to intellectual performance. Their findings within the three occupational status groups were consistent with the total sample findings. No estimates of the strength of these relationships were provided.

Breland (1974) presented results of a study of 800,000 eleventh grade students taking the National Merit Scholarship Qualifying Test administered in 1965. He examined the relationship between birth order and family size to test scores, and additionally, paid attention to the influence of spacing between siblings in two and three child families, and the occurrence of like-sex siblings within a target child's family. His results were highly similar to those of Belmont and Marolla (1973), suggesting that the NMSQT selection score declined with increasing family size, and within family size, declined with increasing birth order. He found no consistent pattern

of differences relating to the number of like-sex siblings in the family. He did find that, in two and three child families, the selection scores declined less as the sibling spacing interval increased (two years or less, versus, three years or more). He noted the anamalous lowered performance of only-children and twins, and suggested a need for a mathematical model of the family configuration influences. He concluded that the observed relationships in his sample are most appropriate for verbal test scores. Again, no estimates of the strength of the observed relationships were provided.

An additional study by Waldrop and Bell (1964) has influenced this researcher's thinking on family size. In a study of preschool dependency behaviors, these researchers created an index of family density by computing a factor score from a principal components analysis of the number of siblings, mean spacing between births forward spacing, and backward spacing. Their procedure was used in this researcher's exploratory data snooping to produce an alternative vector representation of several pieces of the family configuration conceptual framework.

Father Absence

Shinn (1977) at the Institute for Social Research, has recently completed a thorough review of the studies on father absence. She discussed a number of methodological problems which have plagued this research, particularly,

definition of the term issues: reason for absence, duration, child's age at the time of father absence, and availability of father surrogates. Socio-economic status differences further confound the interpretation of results of these studies. Applying criteria developed to avoid these methodological difficulties, Shinn selected 22 acceptable studies. Fourteen of these studies showed detrimental effects of father absence, while the remaining 8 showed non-significant or mixed directional findings. Since the majority of the studies reported effects in terms of test score or grade point average differences, no estimates of the strength of observed negative relationships were provided. Shinn concluded that father absence was associated with lowered cognitive performance. She explained this conclusion by suggesting that father absence represented a loss of supportive interaction for a target child.

Family Configuration

Zajonc and Markus (1975) developed the "confluence model" to explain empirical patterns of relationships observed in the data presented by Belmont and Marolla (1973), Breland (1974), Thorndike (1973), and earlier studies presenting Scottish and French intellectual ability data. This model, outlined in greater detail in Chapter Three, predicts that measured intellectual ability will decline with increasing family size, father absence, and birth order within family size, but longer

spacing between births will moderate the decline for most children in the family. They explain Breland's anamalous findings for only-children, twins, and last borns by suggesting that a positive "teacher effect" accrues to all children having younger siblings, and therefore, being afforded the opportunity to teach. Zajonc and others (Zajonc, 1976; Tavris, 1976) have speculated that traditionally designated status and demographic (sex, ethnic background) differences in intellectual performance may be, in part, a function of different family configuration patterns associated with these status groups.

The current work on the "confluence model" involves a simulation based on a first-order difference equation. Markus and Zajonc (1976) constructed a simulation program which generates scores at any given age up through maturity for children born into families of different size and different mean sibling birth intervals. Using sibling spacing intervals estimated by probability of occurrence from census data, through a Markov chain process (Markus, seminar presentation, 1976) for published Dutch and Scottish data, the simulation program generates (mean) intellectual level scores for children in certain family configuration patterns. Profiles of these family pattern intellectual level scores have been evaluated against published aggregate data with a resulting high degree of similarity (r = .86 for Scottish data, computed by correlating mean values from the simulation with

published mean values).

At this time, no test of the confluence model's ability to explain variance in an intellectual ability scores for individual (as opposed to aggregate) level data has been attempted. Therefore, no current estimate of the theory's explanatory power is available. A recent study by Cicirelli (1976), which purports to test the confluence model makes assumptions about spacing which are not legitimately derived from the theory. Cicirelli "estimated" mean spacing in small families to be two years, and four years in large families. These estimates have no support in the actual theory. Nuttall, Nuttall, Polit, and Hunter (1976) suggested a relationship between their study of academic achievement and the confluence model. However, since they chose a partial correlation approach, no estimate of the explanatory power of their multivariate research model was presented.

Preschool IQ

There is only one comprehensive study of preschool IQ in the current research literature. Broman, Nichols, and Kennedy (1974) published a book length examination of the findings of the Collaborative Perinatal Project. Starting with a sample of 53,000 pregnant women, under medical care at twelve hospitals in different U.S. cities, these researchers followed the development of a sample of black and white, male and female, predominantly urban children using a number of prenatal, neonatal, and early

childhood medical and psychological indicators, with attention to maternal medical and psychological characteristics. At four years of age, all children remaining in the samples (four, sex by race groups, total n = 26,000) were administered the Stanford-Binet. Several findings from this research directly apply to the current study. As discussed previously, the maximum explainable variance reported by these researchers ranged from 15% for black males through 25% for white males. In the analysis of first order relationships with IQ, parity, the number of prior pregnancies greater than or equal to 20 weeks term (roughly equivalent to the number of siblings) was significantly correlated (r = -.11) for whites only. A significantly non-linear relationship was observed for blacks. Gravidity, the number of prior pregnancies, including abortions, plus one (roughly equivalent to the target child's birth order), was significantly correlated (r = -.10) for whites only, again, with a significant non-linear relationship for blacks. Also, for whites only, the interval since last pregnancy (forward spacing) was significantly correlated (r = .06) with IQ. Since these researchers had no commitment to modeling family configuration, and since they used stepwise regression, only one of these family configuration variables appeared in any of their final models. In the four final multiple regression models (one for each sex by race group), a single family configuration variable appeared in only two of the models.

In the full model for white females, the significant partial correlation of gravidity with IQ was -.04. In the full model for black females, the significant partial correlation of parity with IQ was -.04.

In a recent paper, Murray (1977) pooled data from 11 different preschool compensatory education programs (n = 1289). With a pooled sample of all project children tested at age four, the number of siblings explained 3% of the variance in Stanford-Binet IQ scores. Also, for children tested at age four, birth order explained .7% of the variance in Binet IQ's. Multiple regression analyses of IQ at age five on treatment assignment, mother's education, Hollingshead's SES scale, siblings, birth order, birth order squared, and sex, performed separately for five projects, explained between 9% and 26% of the variance. No estimates of separate contributions of the family configuration variables were provided.

Other Complex Models

In a series of analyses using data from a study of eleven year old boys from 185 Canadian families, Marjoribanks and Walberg (1975a; 1975b; Walberg and Marjoribanks, 1976) examined the relationship of their family constellation variables (father's occupation and sibsize or inverse of sibsize) and measures of the family social-psychological environment to measured mental abilities. These researchers have operationalized Henry Murray's (1937) theory of environmental press for the

family social-psychological environment. Parent responses to questionnaires were clustered into scales representing the following dimensions: press for achievement, press for activeness, press for intellectuality, press for independence, press for English usage, and press for a second language. Father occupation and the inverse of sibsize jointly accounted for 44% of press for achievement, 25% of press for activeness, 33% of press for intellectuality, and 13% of press for independence. Ordinal position alone accounted for 16% of press for achievement, 7% of press for activeness, 10% of press for intellectuality, and 1% of press for independence. Regressing the SRA Primary Mental Abilities, Verbal and Number Reasoning scores on all parent-sibling interaction variables (environmental press plus mother and father dominance), explained 50% of the variance. Results of these studies would allow certain meaningful interpretations of family configuration data. The strong relationships of birth order, and sibsize to finer grained environmental measures which significantly predicted intellectual ability suggest that those gross family indicators are holding appropriate places for actual measures of the family intellectual environment.

Teacher Effect

There have been no reported studies which directly tested the "teacher effect" notion as described in the confluence model. However, its educational counterpart,

cross-age tutoring, has been studied with increasing frequency in recent years. Allen, Feldman, and Devin-Sheehan (1976) provided the most complete review to date of studies and methodologies employed in evaluating the effects of cross-age tutoring programs. They found that research in this area prior to 1970 had been largely anecdotal and inconclusive. Their review discussed specific effects and variables affecting the tutoring situation, and they concluded that few generalizations can be made from the recent studies reviewed. Few of these studies employed a control or comparison group. Positive outcomes for tutors and tutees were consequently difficult to understand in the absence of knowledge of other comparable outcomes for non-participating students. While the content and structure of the tutoring programs in most studies was clearly presented, expectations for positive outcomes were not based on explicit theoretical rationales. Allen concluded that researchers addressing cross-age tutoring questions ought to draw on current psychological theory. This conclusion might be seen as a request for a translation of a family-configuration-like theory into the educational setting.

CHAPTER THREE:

CONCEPTUAL FRAMEWORK AND HYPOTHESES

The Confluence Model

The "confluence model" has been developed "to explain empirical patterns of relationship between measures of intellectual ability and such family configuration variables as birth order, family size, and sibling birth intervals" (Markus and Zajonc, 1976). Two major articles (Zajonc and Markus, 1975; Zajonc, 1976) have outlined the development of the model and a number of recent articles have discussed its implications (Zajonc, 1975; Tavris, 1976; Harnischfeger and Wiley, 1976).

The main elements of the model are discussed in Markus and Zajonc (1976). The confluence model assumes that a child's cognitive growth is influenced by family intellectual environment. That intellectual environment is some function of an overall average of the intellectual levels of the family members including the target child's intellectual level. The absolute intellectual level of a family member is similar to the concept of mental age. Attainment of adult absolute intellectual level is cumulative. Family intellectual environment changes over time, and changes most radically at the point of entry of a new family member (e.g., birth, since an infant adds minimal absolute intelligence). Consequently, changes in the intellectual environment are more likely to have greater impact on the measured ability of young children than of

children nearing maturity, since changes in the environment influence the rate of intellectual growth.

The family intellectual environment is a psychological construct inferred from the family configuration pattern for a particular child in a particular family. Trends in published data lend substantive support to certain expectations hypothesized by the theory. Increased family size lowers the intellectual environment of the family and should have a negative relationship to measured intellectual ability of a target child. Relatively short birth intervals should also depress the intellectual environment and have a similarly negative effect on the target child's measured ability. Birth order effects, frequently reported as negative (later borns lower than first borns), may be artifacts of family size and spacing (this could explain equivocal findings in the birth order controversy). Since adults contribute the largest amount of absolute intellectual level to the family intellectual environment, loss of an adult (e.g., father absence) should depress the intellectual environment and also have a negative relationship to the target child's measured ability.

The confluence model assumes an equal amount of adult intellectual ability, fixed at maturity, for all adults in the household. A child at any given age attains some proportion of adult intellectual level based on his age relative to maturity (following growth trends similar to those outlined in Bayley, 1955, and

Bloom, 1962). An oversimplified mathematical illustration can give the reader some flavor of the changes in intellectual environment at the time of successive births. Using an arbitrary value of 19 for adult intellectual level (the figure used in the simulation) and assuming a newborn adds zero to the intellectual environment, the intellectual environment of a family at the time of birth of the first child would be:

(1) $(19 + 19 + 0) / 3 = 12.66$

At the time of birth of the second child and subsequent siblings, each child already in the family receives a value proportional to his achievement of adult intellectual capacity based on his age. If the first born has achieved an intellectual level of 4 by the time of birth of the second child, the reduced intellectual environment of the family would be:

(2) $(19 + 19 + 4 + 0) / 4 = 10.5$

The confluence model predicts that intellectual environment will decline with the entrance of each additional child. If, however, the first born child were to have achieved a higher proportion of adult ability (i.e., if he were older than he was in the previous example) then the intellectual environment will be less depressed:

(3) $(19 + 19 + 8 + 0) / 4 = 11.5$

Within some reasonable limits, extended spacing between children might overcome the negative effects of family size (Zajonc, 1976). The simplified mathematics

presented here are illustrative only of changes in intellectual environment at a point of entry (birth). The current confluence model makes a sophisticated attempt to explain the dynamic process of the changing intellectual environment. The intellectual environment has impact on each child in the family, but each child's growth process also has impact on intellectual environment and therefore has influence on the measured intellectual ability of every child in the family including the target child himself at any given time point.

Birth order provides one distinct piece of information for the model, i.e., whether or not a child is the "last born" at a given time point. This distinction has been labeled a "teacher effect," since a mid-aged child who is not last born (some age from preschool through early adolescence) should have an hypothesized opportunity to teach a younger sibling and therefore accrue the benefits of learning-through-teaching (Zajonc and Markus, 1975). These researchers' examination of data on last-borns and only-children seems to conceptually validate this notion.

Based on the current confluence theory, Markus and Zajonc (1976) have constructed a simulation program using a first order difference equation. This simulation models the family intellectual environment, the impact of the child on the family, and the dynamic growth process for a target child. It allows for the influence of the

teacher effect, and adjusts for other cumulative trend influences (unspecified status and demographic factors). Profiles generated by this simulation parallel profiles in aggregated published data.

The Research Model Differentiated from the Confluence Model

The researcher makes a clear distinction between the confluence model or theory, and the multivariate family configuration model used in this study. The confluence theory is a sophisticated explanation of the influence of family intellectual environment on the dynamic process of a child's intellectual development. It has attempted to explain this influence relative to findings in published aggregated data, for children tested at several different ages. In this study, this researcher attempted to construct a multivariate model of family configuration variables for use with data from individual target children. These children were all approximately the same age at testing (preschool). Only one child from a given family was included in the samples. These children occupied different ordinal positions in families of varying sizes.

This researcher has selected certain notions of family influence on intellectual ability from the confluence theory as a guide in constructing a multivariate family configuration model. These notions or conceptual pieces of the confluence theory include the hypothesized

influence of: the number of siblings, the number of adults, the target child's birth order, spacing between births of children in the family, and the hypothesized teacher effect. From the theory, the influences of the number of siblings and birth order were expected to be negative. The influences of the number of adults and increased spacing were expected to be positive. The teacher effect has had no prior empirical test, but, it was hypothesized to have an overall positive influence on measured intellectual ability. Each of these conceptual pieces was mapped by a family variable vector or set of vectors in the multivariate family configuration model.

This researcher did not attempt to map the dynamic process of intellectual development (change and growth terms) nor the mutual influence (child's impact on the family intellectual environment), suggested by the confluence theory, in his multivariate family configuration model. This was a single time point study, not a longitudinal examination of intellectual development. Therefore, while this study might contribute to the knowledge base of the confluence theory, it should not be considered a test of the confluence model.

The teacher effect. The notion of a "teacher effect" is the most educationally relevant of the notions derived from the confluence model. This piece of the theory was invented to explain the observed "bumps" in profiles of published data with respect to last born children. In the

simulation model, a child receives a teacher effect if he is not last born during the previous time interval (year). This effect also cumulates each time the simulation is advanced one year (or time interval). Consequently, the multivariate research model constructed in this study needed at least two terms to map that notion (last-born versus not-last-born, and, time as last born, or not-last-born). Since the teacher effect had not been empirically tested in the family context, the nature of its functional relationship to measured ability could only be hypothesized. The ability to accrue a positive teacher effect might depend on other factors. One likely factor is the opportunity to have been a student -- to have learned some skills -- prior to having the opportunity to be a teacher. For this reason, the researcher used the time-as-last-born as the first variable in combination with the last-born, not-last-born grouping. Since the effect of this variable as suggested by this discussion is complex, and might depend on competing influences, it was hypothesized that a second order or interaction term would be needed to adequately map the teacher effect. Age proximity of older siblings with regard to other inputs (schooling), and the peer reference group of older siblings could also have influence on this piece of the model.

Research Hypotheses

The following hypotheses were developed for use in the pilot-testing and model-testing phases:

Hypothesis 1. The multivariate family configuration model will significantly predict variance in the composite dependent variable at the .05 significance level.

Hypothesis 2. The multivariate family configuration model will account for at least 10 percent of the variance in the composite score.

Hypothesis 3. The multivariate family configuration model will account for at least 30 percent of the maximum explainable variance.

CHAPTER FOUR:

RESEARCH DESIGN AND METHODOLOGY

The Data

Data for this study were drawn from three existing data sets. Data Set 1 data (Home Start Study) were collected in Fall 1973. Data Set 2 and 3 data (Project Developmental Continuity) were collected in Fall 1975, and Fall 1976. All three data sets were created for use in national evaluations of two Office of Child Development compensatory education programs. The evaluation contractor for both projects was the High/Scope Educational Research Foundation. Appendix A contains supporting information on these compensatory education projects and characteristics of the samples. Data Sets 1 and 2 were used for model building. Data Set 3 was used exclusively for model testing and replication.

Criteria for admissability of subject data. The analytic samples included data from subjects who met the following criteria: English as the dominant language; no evidence of an interfering handicap; preschool-age. Since multiple regression procedures require non-missing data on all variables in a particular analytic run, the number of subjects for any analysis was restricted by the availability of data on all predictors and dependent variables in that analysis. Since the study depends on age and position relations of the target child to siblings,

children with no siblings were excluded from analyses.

Types of variables and coding rules. Descriptions of dependent measures appear in Appendix B. Concerning sources, the researcher makes a distinction between "available" and "derived" variables. "Available" variables are data which were collected by High/Scope through testing of children and interviewing of parents. "Available" variables included raw test scores on dependent measures, and such family, status, and demographic variables as: the target child's sex, age, ethnic background, number of siblings, ages of siblings, and previous preschool experience, mother's education, and father absence. "Derived" variables were constructed by the researcher from available, non-missing data. "Derived" variables included: spacing of births, birth order of the target child, the teacher effect, and composite dependent variable scores.

Since the majority of the parents interviewed reported all ages of target children and siblings in years, all ages and age-related variables were coded in years. Birth order was determined by examining the ages of all siblings. It is the number of older siblings plus one.

Dependent variables. Composite scores (some combination of all cognitive and language test scores) were used as dependent variables in both the model building and model testing processes. It was more economical to run exploratory analyses with a single dependent variable

than with three separate variables. This procedure also reduced the "conceptual error rate for the experiment" (Kirk, 1973). That is, it guarded against the likelihood that spurious significant differences might have occurred as a probabilistic error from increasing the number of non-independent statistical tests.

If a composite score is reliable, and sufficiently representative of the separate dependent variable score distributions, any test of explanatory power (in model-building and replication model-testing) should have broader generalizability. Random errors particular to a single measure of the construct are assumed to be counter-balanced in a composite score created from several measures of the same construct. Therefore, the composite is more likely to be a valid measure of the desired construct than a single measure would be (Cronbach, Gleser, Nanda, and Rajarantnam, 1972). The criteria used for evaluating the adequacy of a composite score in each of the three data sets were: the composite makes conceptual sense; the composite is highly reliable (i.e., it has a large common factor loading -- Cronbach, 1951); the composite has substantial positive correlations with each dependent variable. In this study, large common factor loading was defined as a Cronbach's alpha value for the composite of at least .70. Table 4.1 lists all major variables for this study, classified by type, location, and source.

Table 4.1

List of Variables

variable	independent status	independent family	dependent	Data Set 1	Data Set 2	Data Set 3
sex	x			x	x	x
age	x			x	x	x
ethnic	x			x	x	x
mother's education	x			x	x	x
site	x			x	x	x
program	x			x	x	x
previous preschool	x				x	x
number of siblings		x		x	x	x
birth order		x		D		D
father absence		x		x	x	
birth intervals		x		D		D
number of adults		x				x
mean spacing		x		D		D
teacher effect		x		x		x
Preschool Inventory			x	x		
Denver - Language			x	x		
8-Block Total			x	x		
Bilingual Syntax			x		x	x
WPPSI-Block			x		x	x
McCarthy Verbal Fluency			x		x	x
McCarthy Verbal Memory			x		x	x
McCarthy Draw-A-Child			x		x	x
Cognitive - Language composites			x	D	D	D

x = available

D = derived

Design Issues

The original research designs for these evaluation studies were quasi-experimental since each project was an intervention program. Data from these three time points (Fall 1973, 1975, 1976) were collected as baseline information for subsequent longitudinal evaluation. The actual research design employed in this study was the analytic sample survey (Campbell and Stanley, 1966; Tuckman, 1972). This design implies simultaneous collection of a number of observations or pieces of information on a particular subject at a single point in time. This design was appropriate for exploration and examination of multivariate functional relationships in individual and group data. It was not appropriate for temporal or causal prediction. Due to selection and assignment problems in the original experimental designs, use of the analytic sample survey allows only tentative generalization from samples to the larger population of preschool-aged children in compensatory education programs (i.e., no estimate of sampling error rate was possible).

Analytic Techniques

Multiple linear regression was the analytic technique of choice for most of the analyses. Regression was used for descriptive purposes (strength of relationship) in the model building process, and for hypothesis testing (explanatory power) in the model testing process. Use of

multiple linear regression for hypothesis testing required the researcher to cast a multivariate model in the form of a functional linear equation. A linear equation model is far more flexible than the term "linear" implies. Its essential assumption is that all terms in the equation have an additive influence on the criterion variable. Using a flexible set of data analysis programs, with readily available capability for data transformation, such as the Michigan Interactive Data Analysis System (MIDAS) Regression and Transformation routines, a researcher might successfully cast a linear equation, including interaction and higher order terms, which attains a high degree of functional fit to the data and minimizes error variance in the criterion.

Model building. Procedures followed in this process were comparable to Sondquist's (1970) "inductive exploratory technique" and McNeil, Kelly, and McNeil's (1975) discussion of "data-snooping." In either approach, the process involves sub-sample analyses based on theoretically sensible expectations in an effort to derive a functional multivariate model and generate hypotheses. This process has similarities to the use of stepwise regression procedures (Draper and Smith, 1966; Kerlinger and Pedhazur, 1973). However, in stepwise regression, a researcher has minimal control over the order of entry of variables into the equation. The procedure that this researcher chose for this study is closely tied to his

conceptual framework. Since the model building process involved replacement of sets of predictors in order to map a conceptual piece of the confluence theory, the procedure employed was more similar to "set-wise" regression (McNeil, Kelly, McNeil, 1975; Williams and Lindem, 1971) than to traditional stepwise regression. And since, in all cases, the variables included as predictors for any run were selected by this researcher, and not by a computer algorithm, the resulting multivariate model was somewhat less likely to be overfitted, and consequently, was more likely to be replicable.

Preference for R-square. The square of the multiple correlation is the conventional figure used in reporting regression results. This researcher wished to present bivariate relationships of family variables with composite scores in a parallel fashion. Therefore R-square, rather than r (the product moment correlation) has been presented for all results of regression and correlational analyses of family and composite variables.

Analysis - Phase I: Model Building

The model building phase involved three logical steps: examination of simple relationships; specification of vector contents; and, "best" model choice with pilot-testing.

Simple relationships. Using the MIDAS Regression program, the researcher computed and examined the strength of bivariate and simple joint (two predictor) relationships

of family configuration predictors to composite scores in Data Sets 1 and 2.[1] For Data Set 1 (most complete family variables), the researcher cast an initial multivariate model of family configuration predictors. Predictors chosen for this initial equation were the best initial representatives of each of the five conceptual pieces, with respect to definition and significant prediction. This initial model served as the starting point for set-wise replacement of vectors in the data-snooping procedure. It contained a variable or set of variables representing each piece of the conceptual framework, derived from notions of influence in the confluence theory, which the researcher desired to map in his model.

Specification of vector contents. Through systematic replacement of the vectors mapping the five conceptual pieces in the initial multivariate model, the researcher assessed the adequacy of alternative sets of predictor vectors in mapping these family configuration conceptual pieces using Data Set 1 data. Considerations guiding this exploratory data-snooping were:

1. desire for maximum R-square value, keeping in mind economy (degrees of freedom) and parsimony (minimum neces-

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[1]Based on a review of the literature, the researcher predicted a negative directional effect for number of siblings and birth order. The effect of father absence was predicted to be positive (since a higher value indicated father presence).

sary terms);

2. desire to adequately map the conceptual package of family configuration variables suggested by the confluence theory: number of siblings, number of adults, birth order, spacing, and teacher effect;

3. desire to attain/maintain statistical significance for each vector in the model;

4. desire to attain/maintain expected direction of effect (sign) for each conceptual piece, based on theory and exploratory analyses.

Analytic strategy. Data Set 1 was the most complete of the two data sets chosen for the model building process, with respect to available family configuration variables (i.e., more variables and less missing data). Data Set 1 contained the target child's age, number of siblings, ages of each sibling, and a potential indicator of father absence. Data Set 2 lacked information on siblings other than the number of siblings for a target child. Consequently, most of the model building process has dealt with Data Set 1 (Home Start Study). The Data Set 2 sample was drawn from the same population (Project Developmental Continuity) as Data Set 3 (the replication data set), and included the same dependent measures as Data Set 3 included. Data Set 2 was used to compare relationships between composite scores and available family, status, and demographic predictors common to Data Sets 1 and 2, which also appeared in Data Set 3. The first analyses presented

in Chapter Five (Model Building) and Chapter Six (Model Testing) are comparisons of these relationships, with reference to sample similarity and similarity of the constructs represented by the composite scores.

Model choice and pilot test. Based on examination of the results of exploratory data-snooping, the researcher chose the "best model" of family configuration variables. Choice of this model was influenced by availability of those same family predictors in Data Set 3 (the replication data set). This best multivariate family configuration model was pilot tested with the available, family configuration variables in Data Set 1, using procedures described in the following section on model testing.

Analysis - Phase II: Model Testing (Replication)

The model testing or replication phase had two steps: test of explanatory power of the best model; test of explanatory power of the best model relative to the maximum explainable variance.

Explanatory power. The composite score in Data Set 3 was regressed on all predictors in the best multivariate family configuration model. This evaluated Hypotheses 1 and 2 (significance of the regression analysis results and comparability of the R-square value to expectations).

Relative explanatory power. The maximum explainable variance was computed by regressing the composite score in Data Set 3 on all available family configuration,

status, and demographic variables. The proportion of maximum explainable variance attributable to the multivariate family configuration model was computed by this formula:

$$\text{Proportion of } R^2_{max} = \frac{R^2_{family}}{R^2_{max}}$$

and compared to expectations (Hypothesis 3). Appendix D explains this concept in greater detail.

Supporting Information

Subsequent to the pilot testing of the best model in Data Set 1, two additional analyses were performed, assessing the adequacy of the selected vectors in mapping the five pieces of the conceptual framework. The contribution to the total variance explained by the best multivariate family configuration model attributable to each conceptual piece was computed for the set of vectors mapping each piece in the presence of the other four conceptual pieces. A principal components factor analysis of the predictors included in the best model was also performed as a check on the construct validity of the multivariate family configuration model.

In Data Set 3, after model testing, these same analyses were performed. In addition, Chapter Six presents a comparison of methods for verifying the Data Set 1 R-square value of the multivariate family configuration model. These methods included: replication (model-testing

on a new sample), shrinkage formula application, and cross-validation (applying regression weights from the Data Set 1 analysis to the Data Set 3 predictors). Technical consideration for all of these supporting information analyses are discussed in Appendix E.

CHAPTER FIVE:

RESULTS - MODEL BUILDING

The results of the model building process presented in this chapter parallel the analytic design procedures discussed in Chapter Four. These findings are presented in a sequence which follows the order in which the analyses were performed. The analyses and results fall into four categories: preliminaries, results of the model building process, model choice and pilot testing, and findings from additional supporting analyses. The preliminaries include a discussion of the definition of family configuration variables, the properties of composite scores, and the comparability of Data Sets 1 and 2. A number of findings are presented concerning the model- building process, including: the results of simple family configuration to composite relationships; the formulation of an initial multivariate model; the specification of predictor vector contents; the choice of the best multivariate model among alternatives; and the results of pilot-testing the best multivariate family configuration model using the research hypotheses. Results of additional supporting analyses include: estimates of the unique variance accounted for by each of the five conceptual pieces within the multivariate family configuration model; and, findings supporting the construct validity of the best multivariate family configuration model.

Preliminaries

Definition of Family Variables

Table 5.1 presents definitions of available and derived predictors in Data Set 1, including those developed in the data-snooping phase. Available family predictors in Data Set 2 were defined in the same manner, with the exception of father absence. In Data Set 1, father absence or presence was inferred from a parent interview question asking, "Does anyone else in your family earn an income that is used to support the family?" With a response of "no" coded as "1", and "yes" as "2," this index might be an overestimate of father absence. In Data Set 2, father absence was determined from Head Start records, answering the question "Does the father live at home?" with "no" coded as "1" and "yes" coded as "2." Although the Data Set 2 index was more likely to be accurate, the incidence of missing data is substantially higher on this variable in Data Set 2 than in Data Set 1.

Composite Scores

Tables 5.2 and 5.3 present the properties of the composite scores in Data Sets 1 and 2. In both data sets, the composite has been computed as the mean of the standardized dependent variables. Reliability estimates are high (alpha = .80 for Data Set 1, and .71 for Data Set 2) and the correlations of the separate dependent variables with the composites are adequate. Evaluated by criteria

Table 5.1

Definitions of Family Variables

in Data Set 1

Label	Description
sibs1	number of siblings
sibs2	number of siblings, if the target child has any siblings
totkids	number of siblings plus one
fathabs	1 = no one else financially supports 2 = someone else financially supports
birthord(1)	birth order, where only child receives a value of 1
birthord (2)	birth order for children who have siblings
famsize	total kids plus adults (from father absence)
notfixed	0 = no new siblings at a later time 1 = new siblings at later time (from 1975 data)
meanspac	average of birth intervals
xspace&1	integer value of mean birth interval
teachefk	1 = last born 2 = not last born
forward	birth interval to next older
backward	birth interval to next younger
varspace	variance of birth intervals around mean
sd.space	standard deviation of birth intervals

Table 5.1

(continued)

Label	Description
agerange	age of oldest child in family minus age of youngest
timelast	if last born, age in years; if not last born, backward spacing
sibsquar	square of numbers of siblings, if the target child has siblings
boinvers	reciprocal of birth order, if the child has siblings
oldpre#	number of older, preschool-aged siblings, if the child has siblings
oldsch#	number of older, school-aged siblings (greater than six years old), if the child has any siblings
timelsq	the square of the time spent as last born (timelast)

Table 5.2

Properties of the Composite Score

in Data Set 1

Description: Computed by taking the mean of three standardized dependent variables: Preschool Inventory, Denver Developmental Screening Test-Language, 8-Block Total Child Score.

Reliability: For n = 501, Cronbach's alpha = .80.

Relationships: Product moment correlations.

Composite	n	r
with Preschool Inventory	501	.88
with Denver Language	501	.88
with 8-Block Total	501	.78

Table 5.3

Properties of the Composite Score

in Data Set 2

Description: Computed by taking the mean of six standardized dependent variables: Bilingual Syntax Measure-English, WPPSI-Block Design, MSCA Verbal Fluency, MSCA Verbal Memory I, MSCA Verbal Memory III, MSCA Draw-A-Child.

Reliability: For n = 670, Cronbach's alpha = .71.

Relationships: Product moment correlations.

Composite	n	r
with Bilingual Syntax	670	.69
with WPPSI-Block Design	670	.62
with Verbal Fluency	670	.70
with Verbal Memory I	670	.56
with Verbal Memory III	670	.65
with Draw-A-Child	670	.62

from Chapter Four (conceptual sensibility, reliability, strength of relationships), both composites were judged appropriate for use in data-snooping analyses.

Comparability of Data Sets

Table 5.4 details a comparison of the first-order correlation of composite scores with the family, status, and demographic predictors common to Data Sets 1 and 2. It appears that the family size (siblings), ethnic background, and perhaps, sex variables, show the same degree of relatedness to composite scores in both data sets. However, there are differences between the data sets in the strengths of these common variables to composite score relationships. The composite in Data Set 1 is much more age-related than is the composite in Data Set 2. Mother's education shows a strong relationship to the composite score in Data Set 2 only. The difference in the father absence to composite relationship probably reflects the difference in definition.

The observed differences in the strength of these relationships within these two data sets have implications for the replication model-testing phase using Data Set 3. Since Data Set 2 is assumed to be similar to Data Set 3 (drawn from the same project), these results suggest either differences in target populations between Data Set 1 (Home Start Study) and Data Sets 2 and 3 (Project Developmental Continuity), or differences in the constructs represented by the composites, or both possibilities.

Table 5.4

Comparison of Relationships Between Composite Scores and Family, Status, and Demographic Predictors in Data Sets 1 and 2

	Product moment correlations with composite scores			
	Data Set 1		Data Set 2	
Predictor	n	r	n	r
number of siblings	497	-.11	661	-.16
sex	501	-.02	668	.07
age in months	501	.50	662	.32
mother's education	368	.08	387	.22
mother's age	454	.04	-	-
father absence[b]	500	.18	456	.03
ethnic background[a]	390	.30	664	.27

[a]From regression analysis using dummy coded variables.

[b]Defined differently in each data set. In Data Set 1, 1 = no one else financially supports, 2 = someone else financially supports. In Data Set 2, 1 = father reported absent, 2 = father reported present.

In any case, the observed differences set up a lowered expectation for replicating the size of the R-square value produced by a multivariate family configuration model in the model building phase.

Model Building

Simple Family to Composite Relationships

Table 5.5 summarizes analyses of bivariate and simple joint (two predictor) family and composite variable relationships in Data Set 1, with family variables defined in several ways. Directional predictions for number of siblings, birth order, and father absence have been confirmed. Based on examination of these results, the researcher has selected one vector, or set of vectors, for each conceptual piece of the family configuration model (siblings, birth order, adults, spacing, teacher effect) for inclusion in an initial multivariate model.

Initial Model

Table 5.6 contains the MIDAS Regression output for the initial multivariate family configuration model. This model included at least one vector for each conceptual piece of family configuration. The initial model included as predictors: the number of siblings, birth order, father absence, the teacher effect (last-born versus not-last-born), time-as-last-born, mean spacing, and the age range of all children in the family. This initial equation formed the basis for exploratory data-snooping in Data Set 1.

Table 5.5

Results of Analysis of Simple Relationships, Composite Score with Family Predictors in Data Set 1

Predictor	n	R^2-value	Direction of effect	Directional significance	Non-directional significance
sibs1	497	.0104	negative	.0116	
sibs2	428	.0119	negative	.0120	
totkids	499	.0093	negative	.0155	
fathabs	500	.0316	positive	.0000	
birthord(1)	497	.0069	negative	.0320	
birthord(2)	428	.0072	negative	.0401	
famsize	498	.0022	negative		.2956
notfixed	501	.0038	negative		.1699
meanspac	428	.0083	positive		.0598
xspace&1	428	.0081	positive		.0624
teachefk	497	.0000	?		.9201
forward	318	.0000	?		.9338

Table 5.5

(continued)

Predictor	n	R^2-value	Direction of effect	Directional significance	Non-directional significance
backward	249	.0457	positive		.0007
forward & backward	139	.0295	negative & positive		.1306
teachefk & timelast	428	.0815	positive & positive		.0000
meanspac & agerange	428	.0239	positive & negative		.0059
meanspac & varspace	428	.0123	positive & negative		.0714
meanspac & sd.space	428	.0115	positive & negative		.0857

Table 5.6

Analysis of Composite Regressed on

Initial Multivariate Family Model

in Data Set 1

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF COMPOSITE SCORE N= 427

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	7	35.201	5.0287	7.8926	.0000
ERROR	419	266.96	.63714		
TOTAL	426	302.16			

MULT R= .34132 R-SQR= .11650 SE= .79821

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-1.7087	.35966	-4.7509	.0000
SIBS	.00698	.14982 -1	.10485	.14289	.8864
BIRTHORD	.00806	.16536 -1	.10025	.16495	.8691
FATHRABS	.16703	.27326	.78801 -1	3.4677	.0006
MEANSPAC	.05461	.58490 -1	.52243 -1	1.1196	.2635
AGERANGE	-.05776	-.29037 -1	.24520 -1	-1.1842	.2370
TEACHEFK	.10989	.34627	.15301	2.2631	.0241
TIMELAST	.24588	.24646	.47466 -1	5.1923	.0000

Full Model Equation:

$$\text{Composite} = a_0 \text{ Unit Vector} + a_1 \text{ siblings} + a_2 \text{ birth order} + a_3 \text{ father absence} + a_4 \text{ teacher effect} + a_5 \text{ time-as-last-born} + a_6 \text{ mean spacing} + a_7 \text{ age range} + \text{error}$$

Specification of Vector Contents

In an effort to develop the best multivariate family configuration model, the researcher explored logical alternative ways for specifying the number and contents of vectors necessary to adequately map family configuration. Guided by considerations outlined in Chapter Four (maximum R-square value, economy, parsimony, theory, and statistical significance), the researcher systematically replaced conceptual pieces of the initial model with alternative vectors in a set-wise manner. Table 5.7 summarizes these alternatives and designates the set of vectors which most adequately mapped each of the five conceptual pieces of family configuration. The influence of siblings was best mapped by the number of siblings squared, the number of older preschool-aged siblings, and the number of older school-aged siblings. Birth order was best mapped by the inverse (reciprocal) of birth order. Number of adults was mapped by father absence. The influence of spacing was most adequately mapped by mean spacing and the age range of all children in the family. The teacher effect was mapped by three vectors: last-born versus not-last-born, time-spent-as-last-born, and time-spent-as-last-born squared.

Model Choice and Pilot Test

Best Model

After examining the results of exploratory data-snooping, the researcher chose a set of 10 vectors for

Table 5.7

Summary of Exploratory Data-Snooping

in Data Set 1

Conceptual Piece	Alternative Vectors Examined
siblings	number of siblings
	separate sibling dummy vectors
	inverse (reciprocal) of number of siblings
	number of siblings squared[a]
	siblings plus siblings squared
	sibling breakdown (younger, older preschool, older school)[a]
	siblings X birth order
Birth Order	birth order
	separate birth order dummy vectors
	birth order squared
	inverse (reciprocal) of birth order[a]
Adults	father absence[a]

[a]Indicates "best" vector mapping of conceptual piece in presence of other family configuration conceptual pieces.

Table 5.7

(continued)

Conceptual Piece	Alternative Vectors Examined
Spacing	mean spacing
	mean spacing squared
	log of mean spacing
	mean of logs of separate birth intervals
	mean spacing plus agerange[a]
	mean spacing X siblings
	separate sibling birth intervals (interactions of sibling number times birth interval)
Density (from Waldrop and Bell)	factor scores of siblings, forward, backward, and mean spacing
Teacher Effect	teacher effect
	teacher effect plus timelast
	teacher effect plus timelast squared
	teacher effect X timelast interaction
	teacher effect plus timelast plus timelast squared[a]

inclusion in the best multivariate family configuration model for Data Set 1. This multivariate family configuration model was selected from three alternative models as the best representative of the researcher's conceptual framework.

The researcher cast two other alternative multivariate models, the first including the 10 best predictors plus the designation "fixed versus not fixed family size" and the second including only 9 predictors, with father absence removed. In the first of these alternative models, the "not fixed" variable contributed .7% to the overall variance explained by the model (significant at the .05 level). However, since this determination of fixed family size was based on information from a later time point in the Home Start longitudinal evaluation, which could not be obtained in parallel fashion for Data Set 3, inclusion of this term in the best model was not appropriate.

The second of these alternative models was created to handle the problem of definition of father absence. Loss of the father absence term from the best model resulted in a significant decrease in the proportion of the total variance explained by the multivariate family configuration model from 18% down to 16%. The influence of the number of adults has been predicted by the confluence theory, and is an important piece of the researcher's conceptual

framework. A more accurate measure of the number of adults is available in Data Set 3. In spite of the possible confusion on the definition of father absence in Data Set 1, the researcher decided to include this term in the best multivariate family configuration model.

Pilot Test

These hypotheses were developed for use in both the pilot-testing and model-testing phases of the study:

Hypothesis 1. The multivariate family configuration model will significantly predict variance in the composite dependent variable at the .05 significance level.

Hypothesis 2. The multivariate family configuration model will account for at least 10 percent of the variance in the composite score.

Hypothesis 3. The multivariate family configuration model will account for at least 30 percent of the maximum explainable variance.

Table 5.8 presents the regression output of a pilot test of the best model and that model's equation. The multivariate family configuration model accounted for 18% of the variance in the composite score ($p = .0000$). This best multivariate family configuration model meets the criteria for expected R-square value and significance outlined in Hypotheses 1 and 2.

Maximum Explanation

The Data Set 1 composite was regressed on all avail-

Table 5.8

Analysis of Composite Score Regressed on "Best" Family Configuration Model in Data Set 1

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF COMPOSITE SCORE N= 427

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	10	54.563	5.4563	9.1674	.0000
ERROR	416	247.60	.59519		
TOTAL	426	302.16			

MULT R= .42494 R-SQR= .18058 SE= .77148

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-.93685	.36282	-2.5821	.0102
SIBSQUAR	-.07506	-.94277 -2	.61407 -2	-1.5353	.1255
OLDPRE#	-.07487	-.17755	.11594	-1.5314	.1264
OLDSCH#	.09024	.13226	.71561 -1	1.8482	.0653
BOINVERS	-.08247	-.39512	.23409	-1.6879	.0922
FATHRABS	.15713	.24775	.76344 -1	3.2452	.0013
MEANSPAC	.09313	.85164 -1	.44638 -1	1.9079	.0571
AGERANGE	-.12025	-.56325 -1	.22798 -1	-2.4706	.0139
TEACHEFK	.20299	.54611	.12916	4.2282	.0000
TIMELAST	-.12862	-.39992	.15118	-2.6454	.0085
TIMELSQ	.20625	.11668	.27141 -1	4.2992	.0000

Full Model Equation:

$$\text{Composite} = a_0 \text{ Unit Vector} + a_1 \text{ siblings squared} + a_2 \text{ older preschool sibs} + a_3 \text{ older school age sibs} + a_4 \text{ birth order inverse} + a_5 \text{ father absence} + a_6 \text{ mean spacing} + a_7 \text{ age range} + a_8 \text{ teacher effect} + a_9 \text{ time-as-last-born} + a_{10} \text{ time-as-last-born squared} + \text{error}$$

family configuration, status (sex, age, ethnic background, treatment group assignment), and demographic (site, rural-urban, mother's age and education) variables for all cases with non-missing data (*n* = 304). The resulting R-square value was .33516, as shown in Table 5.9. The computation of the proportion of maximum explainable variance attributable to the set of 10 vectors in the multivariate family configuration model is presented in Table 5.10. For the restricted sample with non-missing data (*n* = 304), the multivariate family configuration model's R-square value (.19274) accounts for 57.5% of the maximum explainable variance (.33516). Table 5.10 also includes regression output, regressing a maximum composite (a score computed by applying regression weights from the maximum explainable variance model to all respective predictors) on the multivariate family configuration model. This analysis yields results identical to the proportion formula and provides an *F*-test of the significance of the proportion formula. (See Appendix D for a discussion of the regression procedure.)

A proportion of maximum explainable variance of 57.5% attributable to the family set of configuration predictors exceeded the expected value of 30% outlined above in Hypothesis 3. The significance of the *F*-statistic computed by the regression program suggests that this proportion is a statistically reliable piece of information, demonstrating the relative importance of the multivariate

Table 5.9

Analysis of Composite Score Regressed on Maximum Explainable Variance Model in Data Set 1

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF COMPOSITE SCORE N= 304

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	24	73.537	3.0640	5.8604	.0000
ERROR	279	145.87	.52284		
TOTAL	303	219.41			

MULT R= .57893 R-SQR= .33516 SE= .72308

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-2.4681	.76829	-3.2125	.0015
SIBSQUAR	-.10047	-.12087 -1	.71658 -2	-1.6867	.0928
OLDPRE#	-.01807	-.42920 -1	.14217	-.30189	.7630
OLDSCH#	.08493	.11657	.81880 -1	1.4237	.1556
BOINVERS	-.06707	-.30477	.27145	-1.1227	.2625
FATHRABS	-.03329	-.55133 -1	.99086 -1	-.55642	.5784
MEANSPAC	.07220	.59395 -1	.49122 -1	1.2091	.2276
AGERANGE	-.09485	-.42970 -1	.27001 -1	-1.5915	.1126
TEACHEFK	.10487	.29210	.16583	1.7615	.0793
TIMELAST	.01941	.61068 -1	.18836	.32422	.7460
TIMELSQ	.01099	.66496 -2	.36214 -1	.18362	.8544
SD1	.02105	.34621 -1	.98437 -1	.35171	.7253
SD2	.15412	.29360	11269	2.6055	.0097
SD3	-.08719	-.17640	.12066	-1.4620	.1449
SD4	-.05182	-.13066	.15076	-.86666	.3869
SD5	-.03684	-.75316 -1	.12232	-.61572	.5386
ED1	-.02168	-.73535 -1	.20304	-.36217	.7175
ED2	.01204	.49481 -1	.24594	.20119	.8407
ED3	.04562	.16343	.21427	.76272	.4463
GROUP	.00455	.45364 -2	.59706 -1	.75979 -1	.9395
SEX	.02663	.38537 -1	.86613 -1	.44493	.6567
KID.AGE	.23581	.41859	.10328	4.0531	.0001
RUR.URB	-.04745	-.83053 -1	.10467	-.79347	.4282
MOM.ED	.11167	.92917 -1	.49502 -1	1.8770	.0616
MOM.AGE	.00473	.91172 -3	.11534 -1	.79045 -1	.9371

site dummy variables = SD1 - SD5

ethnic dummy variables = ED1 - ED3

Table 5.10

Regression Results Computing Proportion

of Maximum Explainable Variance

in Data Set 1

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF MAXIMUM COMPOSITE N= 304

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	10	42.289	4.2289	39.654	.0000
ERROR	293	31.247	.10665		
TOTAL	303	73.537			

MULT R= .75834 R-SQR= .57508 SE= .32657

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-.79215	.19160	-4.1345	.0000
SIBSQUAR	-.18927	-.10275 -1	.31143 -2	-3.2994	.0011
OLDPRE#	-.15344	-.16654	.62655 -1	-2.6580	.0083
OLDSCH#	.15767	.98554 -1	.36060 -1	2.7330	.0067
BOINVERS	-.28824	-.61092	.11857	-5.1526	.0000
PATHRABS	.29582	.20427	.38535 -1	5.3009	.0000
MEANSPAC	.20296	.76272 -1	.21497 -1	3.5480	.0005
AGERANGE	-.29125	-.58101 -1	.11149 -1	-5.2113	.0000
TEACHEFK	.43096	.53795	.65805 -1	8.1749	.0000
TIMELAST	-.22737	-.31333	.78398 -1	-3.9966	.0001
TIMELSQ	.39966	.10418	.13959 -1	7.4631	.0000

For n = 304

R^2_{family} = .19274

R^2_{max} = .33516

oroportion of R^2_{max} = 57.5%

family configuration model's explanatory power.

Additional Supporting Information Analyses

As outlined in Chapter Four, several after-the-fact analyses were performed to assess the adequacy of the mapping of predictor vectors to the five pieces of the researcher's conceptual framework.

Conceptual Pieces

Estimates of the unique contribution of the five conceptual pieces to the overall explanatory power of the multivariate family configuration model were computed using procedures described in Appendix E. Table 5.11 summarizes these estimates, and is presented as an additional source of information of the importance of the separate conceptual pieces of family configuration in the best multivariate family configuration model in Data Set 1. Results presented in this table suggest that each conceptual piece of the model is both necessary and important. The teacher effect, the most educationally relevant piece of the conceptual framework, contributes most to the explanatory power of the multivariate family configuration model (at least half of the total variance explained by the set of 10 family configuration predictors in the best model).

Construct Validity

Subsequent to the model building process, a principal components factor analysis of the 10 family configuration predictors was performed. This analysis provided a check

Table 5.11

Estimates of Contribution to "Variance Accounted For" by Comceptual Pieces of Family Configuration Model in Data Set 1

(n = 427, total R^2 = .18058)

Conceptual Piece	Predictor Vectors	Variance Contribution[a]	Significance
siblings	sibsquar	.0173	.0339
	oldpre#		
	oldsch#		
Birth Order	boinvers	.0056	.0922
Adults	fathabs	.0210	.0013
Spacing	meanspac	.0121	.0479
	agerange		
Teacher Effect	teachefk	.0970	.0000
	timelast		
	timelsq		

[a]Defined either as unique contributions of set of predictors to total R-square in the presence of the other predictors, or, incremental R-square when this set of vectors is entered last into the equation.

on the construct validity of the best multivariate model in mapping conceptual pieces. Table 5.12 summarizes the results. There appears to be a high degree of match of factors and a priori definition of conceptual pieces. Factor 1 represents siblings and birth order, including the number of siblings squared, the number of older school-aged siblings, the reciprocal of birth order, and the full age range from the youngest to the oldest child in the family. This loading of both siblings and birth order on the first factor confirms the confluence model's theoretical expectations of the confounded nature of family size and birth order. Factor 2 maps the notion of teacher effect. Factor 3 mapping spacing, included the mean of the birth intervals, and the number of older preschool-aged siblings (holding a place for an estimate of forward spacing). Factor 4 includes only father absence, mapping the conceptual piece for number of adults. These four factors account for most of the variability (82.7%) in all 10 predictors included in the best multivariate family configuration model.

Summary of Important Findings

A multivariate family configuration model was developed, mapping five pieces of the conceptual framework which correspond to the notions of family configuration influence suggested by the confluence theory. This multivariate family configuration model has explained 18% of

Table 5.12

Contruct Validity Check - Results of Factor Analysis of Family Predictors[a] in Data Set 1

(n = 469, Kaiser's statistic = .99243)

Predictor	Factor Loadings[b] 1	2	3	4
sibsquar	.87	-	-	-
oldpre#	-	-	-.65	-
oldsch#	.94	-	-	-
boinvers	-.80	-	-	-
fathabs	-	-	-	.99
meanspac	-	-	.82	-
agerange	.90	-	-	-
teachefk	-	-.82	-	-
timelast	-	.94	-	-
timelsq	-	.94	-	-
% variance	32.1%	27%	13.5%	10.1%

[a]Principal components solution, varimax rotation, accounting for 82.7% of the variance.

[b]Only highest loading presented.

the total variance in a composite cognitive-language score ($\underline{p}$ = .0000). In addition, this model explained 57.5% of the maximum explainable variance. Supporting analyses indicated the adequacy of the mapping of predictor vectors to conceptual framework pieces, and suggested that the multivariate family configuration model has construct validity with reference to the conceptual framework and the confluence theory.

CHAPTER SIX:

RESULTS - MODEL TESTING

The presentation of results in this chapter is similar to the order of presentation in Chapter Five, and parallels the analytic plan for model-testing discussed Chapter Four. Again, these findings are presented in a sequence which follows the order performed. The analyses and results fall into three categories: preliminaries, model testing, and findings from additional supporting analyses. The preliminaries include a discussion of the definition of family variables, the properties of the composite score in Data Set 3, and the comparability of Data Set 1 and 3. The results of the replication model-testing of the explanatory power of the multivariate family configuration model are evaluated using the research hypotheses. Results of additional supporting information analyses include: estimates of the unique variance accounted for by each of the five conceptual pieces within the multivariate family configuration model; findings replicating the construct validity of the best multivariate family configuration model; and, a comparison of procedures used to verify the estimate of explanatory power of the pilot-testing of that model in Data Set 1.

The reader should remember that Data Sets 1 and 2 were used for the model-building process. Data Set 3

was reserved exclusively for replication model-testing.

Preliminaries

Definition of Family Variables

The family configuration variables in Data Set 3 were defined in precisely the same manner as they were defined in Data Set 1 (see Table 5.1) with one exception. The number-of-adults variable in Data Set 3 was collected from the target child's mother on the parent permission form. The question asked for the "number of adults in the home (include yourself, adult relatives, etc)." Responses to this question ranged in value from 1 through 8 (mean = 1.64). Since it was likely that some mothers included adult siblings in this figure, the "adults" variable used in regression analyses for Data Set 3 was recoded "1" for one adult, and "2" for two or more. The definition of this variable has been presented here in contrast to the definition of father absence in Data Set 1, which was inferred from a question on sources of financial support within the family.

Model Testing

Composite Score

Table 6.1 presents the properties of the composite score used in Data Set 3 analyses. This composite was constructed in the same manner as were the composites in Data Sets 1 and 2 (the mean of the standardized dependent variables). Evaluated by the criteria outlined in

Table 6.1

Properties of the Composite Score

in Data Set 3

Description: Computed by taking the mean of six standardized dependent variables: Bilingual Syntax Measure-English, WPPSI-Block Design, MSCA Verbal Fluency, MSCA Verbal Memory I, MSCA Verbal Memory III, MSCA Draw-A-Child.

Reliability: For $n = 882$, Cronbach's alpha = .72.

Relationships: Product moment correlations.

Composite	n	r
with Bilingual Syntax	882	.63
with WPPSI-Block Design	882	.63
with Verbal Fluency	882	.68
with Verbal Memory I	882	.61
with Verbal Memory III	882	.69
with Draw-A-Child	882	.66

Chapter Four, this composite was judged appropriate for use in model testing replication analyses.

Comparability of Data Sets 1 and 3

Table 6.2 details a comparison of relationships between the composite and family, status, and demographic variables common to Data Sets 1 and 3 (parallel to Table 5.4). The family size (siblings) to composite relationship is similar in both data sets. Observed differences for the other variable pairs suggest two possibilities. The Home Start and Project Developmental Continuity samples may represent two somewhat different populations within the larger population of preschool-aged children in compensatory education programs. The composite used in Data Set 1 is more closely related to age (a developmental age indicator) than is the composite in Data Set 3. Although both composites can be considered cognitive-language variables, subject to family influence, suggested differences in populations and in the nature of the construct that each composite represents, again, set up lowered expectations for replicating the size of the pilot-test R-square value.

Model Testing

Restatement of Research Hypotheses

Hypothesis 1. The multivariate family configuration model will significantly predict variance in the composite dependent variable at the .05 significance level.

Table 6.2

Comparison of Relationships Between Composite Scores and Family, Status, and Demographic Predictors in Data Sets 1 and 3

	Product moment correlations with composite scores			
	Data Set 1		Data Set 3	
Predictor	n	r	n	r
number of siblings	497	-.11	813	-.09
sex	501	-.02	882	.10
age in months	501	.50	869	.37
mother's education	368	.08	795	.12
mother's age	454	.04	239	-.09
father absence[b]	500	.18	818	.12
ethnic background[a]	390	.30	692	.20

[a]From regression analysis using dummy coded variables.

[b]Defined differently in each data set. In Data Set 1, 1 = no one else financially supports, 2 = someone else financially supports. In Data Set 3, 1 = one adult in the home, 2 = two or more adults in the home.

Hypothesis 2. The multivariate family configuration model will account for at least 10 percent of the variance in the composite score.

Hypothesis 3. The multivariate family configuration model will account for at least 30 percent of the maximum explainable variance.

Model Testing - Replication

Table 6.3 is the MIDAS Regression output for the test of explanatory power. The Data Set 3 composite has been regressed on the best multivariate family configuration model (developed in the model building phase). This model includes: the number of siblings squared, the number of older preschool-aged siblings, and the number of older school-aged siblings, mapping sibling influence; the inverse of birth order, mapping birth order influence; the number of adults in the family mapping adult influence; the mean spacing between births, and the age range of all children in the family, mapping spacing influence; the last-born versus not-last-born classification, time-spent-as-last-born, and time-spent-as-last-born squared, mapping the teacher effect.

Hypothesis 1. The multivariate family configuration model was expected to predict a significant proportion of the variance in the composite cognitive-and-language score. With an $F_{(10,693)} = 6.0812$, and an associated $p = .0000$, the results of this regression analysis confirm

Table 6.3

Analysis of Composite Score Regressed
on Multivariate Family Configuration Model
in Data Set 3

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF COMPOSITE SCORE N= 694

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	10	23.556	2.3556	6.0812	.0000
ERROR	683	264.57	.38736		
TOTAL	693	288.12			

MULT R= .28593 R-SQR= .08176 SE= .62238

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-.49626	.25420	-1.9523	.0513
SIBSQUAR	.03091	.46195 -2	.57161 -2	.80816	.4193
OLDPRE#	-.08647	-.22604	.99656 -1	-2.2682	.0236
OLDSCH#	-.01097	-.20173 -1	.70377 -1	-.28664	.7745
BOINVERS	-.04892	-.23390	.18272	-1.2801	.2009
ADULTS	.12924	.16940	.49734 -1	3.4061	.0007
MEANSPAC	.05747	.53126 -1	.35314 -1	1.5044	.1329
AGERANGE	-.05724	-.28475 -1	.19006 -1	-1.4983	.1345
TEACHEFK	.05406	.13605	.96157 -1	1.4149	.1576
TIMELAST	-.03058	-.78154 -1	.97740 -1	-.79961	.4242
TIMELSQ	.08143	.36038 -1	.16878 -1	2.1352	.0331

Full Model Equation:

Composite = a_0 Unit Vector + a_1 siblings squared + a_2 older preschool siblings + a_3 older school age sibs + a_4 birth order inverse + a_5 adults + a_6 mean spacing + a_7 age range + a_8 teacher effect + a_9 time-as-last-born + a_{10} time-as-last-born squared + error

this hypothesis.

Hypothesis 2. The multivariate family configuration model was expected to account for 10% of the variance in the composite score. The observed R-square value of .08176 falls short of this expectation.

Maximum Explanation

Table 6.4 is the regression output assessing maximum explainable variance. Regressing the Data Set 3 composite on all available family configuration, status (sex, age, ethnic background, and treatment group assignment), and demographic (site, mother's education, and previous preschool experience) variables for all cases with non-missing data (n = 671), produced an R-square value of .24293. Table 6.5 shows the computation of the proportion of maximum explainable variance. From the proportion formula and by the maximum composite regression method (see Chapter Five and Appendix D).

Hypothesis 3. The multivariate family configuration model was expected to account for 30% of the maximum explainable variance. For the 671 children with non-missing data on all maximum model predictors, the family configuration R-square value of .08389 divided by the maximum R-square value of .24293 yields a proportion of maximum explainable variance attributable to the multivariate family configuration model of 34.5%. This proportion exceeded the expected value and confirms Hypothesis 3.

Table 6.4

Analysis of Composite Score Regressed on Maximum Explainable Variance Model in Data Set 3

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF COMPOSITE SCORE N= 671

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	29	67.494	2.3274	7.0925	.0000
ERROR	641	210.34	.32815		
TOTAL	670	277.84			

MULT R= .49288 R-SQR= .24293 SE= .57284

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-2.3893	.44901	-5.3213	.0000
SIBSQUAR	.00278	.38446 -3	.54525 -2	.70510 -1	.9438
OLDPRE#	-.02613	-.64905 -1	.98091 -1	-.66168	.5084
OLDSCH#	.02981	.51339 -1	.67990 -1	.75510	.4505
BOINVERS	-.03873	-.17092	.17416	-.98142	.3268
ADULTS	.08681	.10983	.49786 -1	2.2061	.0277
MEANSPAC	.08528	.74438 -1	.34352 -1	2.1670	.0306
AGERANGE	-.08655	-.40260 -1	.18305 -1	-2.1994	.0282
TEACHEFK	.01891	.45200 -1	.94378 -1	.47892	.6322
TIMELAST	.01692	.40279 -1	.94021 -1	.42840	.6685
TIMELSQ	.00023	.99238 -4	.16968 -1	.58485 -2	.9953
SD1	-.04148	-.11825	.11250	-1.0511	.2936
SD2	.04502	.10707	.93840 -1	1.1410	.2543
SD3	-.00292	-.60183 -2	.81372 -1	-.73960 -1	.9411
SD4	-.10020	-.25063	.98302 -1	-2.5496	.0110
SD5	-.01684	-.29919 -1	.70150 -1	-.42649	.6699
SD6	-.02785	-.56335 -1	.79860 -1	-.70541	.4808
SD7	-.14750	-.24096	.63819 -1	-3.7757	.0002
SD8	.22327	.56629	.97648 -1	5.7992	.0000
SD9	.06316	.98247 -1	.61321 -1	1.6022	.1096
SD10	.00673	.11364 -1	.66668 -1	.17046	.8647
ED1	-.03677	-.58457 -1	.62755 -1	-.93151	.3519
ED2	.00532	.10879 -1	.80800 -1	.13464	.8929
ED3	-.04416	-.13999	.12509	-1.1191	.2635
ED4	.07296	.10865	.58664 -1	1.8522	.0645
GROUP	.05775	.69839 -1	.47689 -1	1.4645	.1436
SEX	.12681	.14607	.45127 -1	3.2368	.0013
KID.AGE	.15138	.28571	.73687 -1	3.8773	.0001
MOM.ED	.13870	.48233 -1	.13603 -1	3.5458	.0004
PRESCHL	-.00090	-.18705 -2	.82043 -1	-.22798 -1	.9818

ethnic dummy variables = ED1 - ED4

site dummy variables = SD1 - SD10

Table 6.5

Regression Results Computing Proportion

on Maximum Explainable Variance

in Data Set 3

LEAST SQUARES REGRESSION

ANALYSIS OF VARIANCE OF MAXIMUM COMPOSITE N= 671

SOURCE	DF	SUM SQRS	MEAN SQR	F-STAT	SIGNIF
REGRESSION	10	23.307	2.3307	34.812	.0000
ERROR	660	44.187	.66950 -1		
TOTAL	670	67.494			

MULT R= .58763 R-SQR= .34531 SE= .25875

VARIABLE	PARTIAL	COEFF	STD ERROR	T-STAT	SIGNIF
CONSTANT		-.47405	.10677	-4.4399	.0000
SIBSQUAR	.07175	.44474 -2	.24067 -2	1.8479	.0651
OLDPRE#	-.20228	-.22469	.42345 -1	-5.3062	.0000
OLDSCH#	-.02238	-.17237 -1	.29978 -1	-.57497	.5655
BOINVERS	-.12891	-.25797	.77247 -1	-3.3395	.0009
ADULTS	.29756	.16864	.21061 -1	8.0070	.0000
MEANSPAC	.13797	.53576 -1	.14970 -1	3.5788	.0004
AGERANGE	-.13965	-.29481 -1	.81367 -2	-3.6233	.0003
TEACHEFK	.13618	.14369	.40686 -1	3.5315	.0004
TIMELAST	-.09214	-.97507 -1	.41017 -1	-2.3772	.0177
TIMELSQ	.21269	.39643 -1	.70891 -2	5.5921	.0000

For $\underline{n}$ = 671

R^2_{family} = .08389

R^2_{max} = .24293

proportion of R^2_{max} = 34.5%

Analysis of variance of regression of the maximum composite, with an $F_{(10,660)} = 34.812$, and a $p = .0000$, suggests that the multivariate family configuration model accounts for a significant amount of explainable variation.

Additional Supporting Analyses

Conceptual Pieces

Table 6.6 parallels Table 5.11 in presenting estimates of the importance of conceptual pieces within the context of the multivariate family configuration model. Three conceptual pieces contribute significantly to the overall explanatory power of the family configuration model (siblings, adults, and teacher effect). As in Data Set 1, the teacher effect predictor set contributes most to the explanatory power of the multivariate model. Although the variance contribution of the spacing variables to the family model's explanatory power is not significantly large in the context of the other family predictors, Table 6.4 indicates that mean spacing and age range are each significant predictors in the presence of all available family status, and demographic predictors.

Construct Validity - Replication

Subsequent to the model testing phase, a principal components factor analysis of the 10 family configuration predictors was performed. This analysis again provided a check on the construct validity of the multivariate model in mapping conceptual pieces. The results of this analysis

Table 6.6

Estimates of Contributions to "Variance Accounted For" by Conceptual Pieces of the Family Configuration Model in Data Set 3

($\underline{n}$ = 694, total $\underline{R}^2$ = .08176)

Conceptual Piece	Predictor Vectors	Variance Contribution[a]	Significance
siblings	sibsquar oldpre# oldsch#	.0116	.0359
Birth Order	boinvers	.0022	.2009
Adults	adults	.0156	.0007
Spacing	meanspac agerange	.0034	.2866
Teacher Effect	teachefk timelast timelsq	.0270	.0002

[a]Defined either as unique contribution of set of predictors to total R-square in the presence of the other predictors, or, incremental R-square when this set of vectors is entered last into the equation.

for Data Set 3 (Table 6.7) are virtually identical to the factor analysis results for Data Set 1 (Table 5.12). The sizes of loadings of family variables on the four factors, the signs on the loadings, the proportion of variance accounted for by each factor and by all four factors, are all remarkably similar in both data sets. All Discussion pertaining to the factor analysis in Data Set 1 applies here also. Family size and birth order are confounded, and teacher effect, spacing, and number of adults are each represented by distinct factors. Replication of the factor structure confirms the mapping of predictor vectors to conceptual framework pieces and notions from the confluence theory.

Additional Verification of Explanatory Power

Table 6.8 compares procedures for verifying the R-square value of the family configuration model obtained in Data Set 1. Even the most conservative chrinkage procedure (Lord's formula, given in Klein and Newman, 1974) does not "shrink" the R-square value enough to match the obtained R-square value in Data Set 3. After examining the replication and cross-validation R-square values, this researcher estimates the explanatory power of the multivariate family configuration model to be between 7% and 8% for the larger target population of preschool-aged children served by Project Developmental Continuity. (For a discussion of these procedures, see

Table 6.7

Construct Validity Check - Results of Factor Analysis of Family Predictors[a] in Data Set 3

(n = 711, Kaiser's statistic = .99411)

	Factor Loadings[b]			
Predictor	1	2	3	4
sibsquar	.91	-	-	-
oldpre#	-	-	-.80	-
oldsch#	.96	-	-	-
boinvers	-.72	-	-	-
adults[c]	-	-	-	.96
meanspac	-	-	.82	-
agerange	.88	-	-	-
teachefk	-	-.86	-	-
timelast	-	.95	-	-
timelsq	-	.95	-	-
% variance	30.5%	29.6%	15.1%	10.3%

[a]Principal components solution, varimax rotation, accounting for 85.5% of the variance.

[b]Only highest loading presented.

[c]Full range of reported values, 1 through 8.

Table 6.8

Cross-Validation and Shrinkage Analysis

in Data Set 3

Analysis	n	R-square	Significance
1. Data Set 1 Composite regressed on best family configuration model	427	.18058	.0000
2. Data Set 3 Composite regressed on best family configuration model	694	.08176	.0000
3. Predicted R-square value from Lord's shrinkage formula[a]	(large)	.1372	(0.00)
4. Cross-validation[b] R-square, based on squared correlation of "predicted" composite in Data Set 3 with observed composite in Data Set 3	694	.07127	.0000

Table 6.8

(continued)

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[a]Lord's formula, suggested by Klein and Newman (1974) as the most conservative (shrinks most) of the shrinkage formulas, predicts the R-square value for an infinitely large population similar to the sample population, by

$$\underline{\hat{R}}^2 = 1 - (1 - \underline{R}^2)\left[\frac{N + K + 1}{N - K - 1}\right]$$

where:

$\underline{\hat{R}}^2$ = predicted $\underline{R}^2$ for a large population

$\underline{R}^2$ = sample $\underline{R}^2$ value

N = total sample subjects

K = number of predictor vectors

[b]The "predicted" composite for Data Set 3 is computed as the linear combination of the regression weights from Data Set 1 applied to the respective predictors in Data Set 3. In this case,

$$\hat{Y} = -.93685 - .0094277\ \text{sibsquar} - .17755\ \text{oldpre\#} + .13226\ \text{oldsch\#} - .39512\ \text{boinvers} + .24775\ \text{adults} + .085164\ \text{meanspac} - .056325\ \text{agerange} + .54611\ \text{teachefk} - .39992\ \text{timelast} + .11668\ \text{timelsq}$$

Appendix E.)

Summary of Important Findings

The multivariate family configuration model explained 8% of the variance in the Data Set 3 composite cognitive-language score (p = .0000). This R-square value fell short of the expected R-square value (.10) predicted by Hypothesis 2. Differences between Data Sets 1 and 3 with regard to actual target populations, and constructs represented by the composites are likely explanations for the failure to replicate the R-square value obtained in the pilot-testing, and the failure to confirm the hypothesized expectation. However, the proportion of maximum explainable variance (34%) attributable to the multivariate family configuration model, and the significance of the F-statistic produced by the maximum regression procedure (p = .0000), suggest the statistical reliability of this proportion. This is evidence for the importance of the family configuration influence in the Data Set 3 target population. Additional analyses[2] added support for the adequacy of the predictor vector to conceptual piece mapping, and the construct validity of the multivariate family configuration model. Alternative procedures for verifying the pilot-test estimate of explanatory power provided additional estimates of the family configuration pattern influence in the target population served by Project Developmental Continuity.

[2]Tables 6.6 and 6.7.

CHAPTER SEVEN:

DISCUSSION AND INTERPRETATION

The important findings of this study have been summarized and discussed in Chapters Five and Six. This chapter presents a discussion of specific issues relating to: conceptual framework mapping; limitations inherent in the data; replication of the pilot-test findings; the complexity of the teacher effect; generalizability of the findings; and the possible meaning of family configuration. The discussion of conceptual mapping and limitations of the data refer back to the researcher's conceptual framework (Chapter Three) and certain research design issues (Chapter Four). The discussion of replication is supported by discussions in Appendix E. Interpretation of the teacher effect parallels the suggestions presented in the conceptual framework. Generalizability is discussed relative to the problems of using existing data sets, mentioned in Chapter One. In "The Meaning of the Data," this researcher has attempted to place this study in the context of past and future research. All of these discussions relate to the four goals of educational research using multiple linear regression: Prediction, Parsimony, Verification, and Validity Generalization, suggested by McNeil, Kelly, and McNeil (1975).

Conceptual Mapping

In this study, the researcher has attempted to operationalize notions from the Zajonc and Markus "confluence model" into a multivariate linear equation model for use in a multiple regression analysis with data on individual children. The conceptual pieces of the confluence theory included in the multivariate equation were: number of siblings, birth order, number of adults, spacing between births, and the "teacher effect." By examination of simple relationships, and a systematic data-snooping procedure in Data Set 1, the researcher has constructed a multivariate family configuration model which has produced an acceptable degree of functional fit to the data. Each of the five notions of family configuration influence, derived from the confluence theory, which became the five pieces of the researcher's conceptual framework, was mapped by a predictor vector or sets of predictor vectors in the multivariate family configuration model. The obtained R-square values for the multivariate family configuration model and estimates of variance contributions for each set of vectors in that model suggest that the equation adequately maps the five conceptual pieces. Factor analysis of predictors in Data Set 1, and replication of that same factor structure in Data Set 3, provided a positive check on the construct validity of this conceptual mapping. Further, the confounding of family size and birth order, illustrated

by the common loading of predictors mapping these conceptual pieces on the first factor in each of these analyses, suggested that the multivariate family configuration model was closely related to the original confluence theory. The observed significance of the partial correlations of both vectors mapping the spacing notion in the maximum explainable variance model in Data Set 3 also corresponds to expectations described by the confluence model.

Limitations Inherent in the Data

Despite limitations in the accuracy of the available data, differences in the definitions of variables (e.g., father absence), and the constraint of the coding rules for ages of siblings and intervals between births (in years), the model has performed well in pilot testing and model testing. The following discussion specifically addresses the problems the researcher encountered and his attempts to resolve them in these areas: the definition of the number of adults; the occurrence of zero-value birth intervals; and, the possible confounding of age influence in the timelast variable.

Number of adults. Although the researcher suggested that the father absence variable in Data Set 1, based on sources of financial support, overestimated actual father absence, its usefulness should not be entirely discounted. On the Home Start Parent Interview, responses to subse-

quent questions about the job status of "anyone else" who earned income, suggest that a "no one else" response on the financial support question may indeed closely approximate father absence: 83 % of the "anyone else" persons were reported to be working full time, with additional figures reported for regular and occasional part-time employment. In addition, in the replication regression analysis, the size of the partial correlation and its significance for the number-of-adults variable as defined in Data Set 3, closely matches the pilot test partial correlation and significance for the father absence variable as defined in Data Set 1. Whether or not the Data Set 1 father absence variable underestimated father presence, it has apparently held the appropriate place for number of adults in the multivariate family configuration model.

Zero-value birth intervals. Since 90% of the sibling age data was originally reported in years, rather than months, birth intervals could only be computed in years. Consequently, a birth interval of zero, logically reserved for twin births, could occur. Also, a value of zero was more likely to occur as the immediate forward or backward spacing around the target child. In all but a few instances of duplicate ages reported for siblings, or sibling and target child, no designation of twin status was provided. After examining the matrices of birth intervals for both Data Sets 1 and 3, the researcher

calculated the occurrence of a zero-value birth interval as a proportion of total occurrences of all birth intervals, approximately 2% in both data sets. This figure could be considered as an index of the possible inappropriateness of the coding rules which might have invalidated the spacing variables used in the multivariate family configuration model. The 2% figure is probably less than the occurrence of twins in samples of families as large as 500 and 900. Also, it is possible that some families included in the samples actually contained two same-aged children from initially separate families, put together through remarriage or adoption.

In Data Set 1, prior to data-snooping, the researcher regressed the composite score on the initial multivariate model with all children included (n = 427) and with a restricted sample including only children with no occurrence of a zero-value birth interval (n = 407). Dropping those children from the sample resulted in a minimal decrease (.09%) in the observed R-square value. (No estimate of the significance of this decline in R-square value can be made, since one model is not a restriction of the other -- different samples of children.) Consequently, considering the degrees of freedom needed for data-snooping, the researcher decided to continue to include all children with non-missing family and composite

score data in the model building analyses. The same decision has been followed in the model testing phase.

Age confounding. The timelast variable has been defined as backward spacing for not-last-borns, and age in years for last-borns. Since this variable was an important predictor vector in the "teacher effect" conceptual piece, it became necessary to know whether or not its influence was an artifact of including age for all last born children (40% of the samples). In a series of analyses performed in Data Set 1, the researcher observed the following: 1) the R-square value of the composite regressed on timelast was .05213; 2) the R-square value of the composite regressed on age in years was .2165; 3) regressing the composite on both timelast and age for the not-last-born sample, age predicts 19% of the variance over and above the significant prediction (3% unique variance) attributable to timelast; 4) regressing the composite for the full sample on two separate interaction vectors, timelast times last-born, and timelast times not-last-born, the partial correlations of each interaction term with the composite are identical (.24), indicating the same effect in both groups. The researcher concluded that timelast was not an artifact of age, and that the definition of this variable was appropriate.

Pilot Testing and Replication

The pilot test of the best multivariate family configuration model in Data Set 1 was highly successful. It confirmed all three research hypotheses (significance and size of the R-square value, and size of the proportion of maximum explainable variance). The results of the actual model testing in Data Set 3 were somewhat less successful. Hypothesis 2, comparing an expected estimate of explanatory power (based on theory and previous research) to the obtained replication estimate, was not confirmed. There are four plausible reasons for the lack of confirmation of this hypothesis, each of which may have had some influence on the outcome of the model testing process:

1. Attenuation. "Attentuation is the reduction in predictability due to the unreliability of the criterion." (McNeil, Kelly, and McNeil, 1975). The composite score used in Data Set 1 was not perfectly reliable (Cronbach's alpha = .80). The composite score used in Data Set 3 was somewhat less reliable than the Data Set 1 composite (alpha = .72). Shrinkage formulas can be used for adjusting the original R-square value downward. However, even after applying Lord's conservative shrinkage formula (reducing obtained explanatory power from 18% to 13%), one has only adjusted for unreliability in the first criterion (Data Set 1 composite). The lack of perfect reliability in the second criterion (Data Set 3 composite)

suggests that more "shrinkage" is necessary.

2. Overfitting. In the absence of previous parallel multivariate research, data-snooping is a legitimate procedure for model building and hypothesis generating, especially when guided by theory, and conducted in a systematic, researcher-controlled fashion. Even under such conditions, choice of predictors that "work," considering theory and statistical significance, capitalizes on serendipity. Overfitting is an unfortunate consequence of attempting to maximize explained variance with data containing idiosyncracies particular to that sample. The best model with the best set of vectors is likely to be overfitted to the original data. Replication or cross-validation is required to verify the estimate of the model's explanatory power.

3. Different populations. Replication or cross-validation is most likely to be successful when a new sample (preferably larger) from the same population can be obtained. Although both the Home Start and Project Developmental Continuity samples were assumed to be drawn from the larger population of preschool-aged children in compensatory education programs, there are several family, status, and demographic differences which suggest that the samples might represent two sub-populations. Appendix A provides descriptive information on the characteristics of the Home Start and Project Developmental Continuity samples used in the analyses in this study.

Data Set 3 children, on the average, came from smaller families, were somewhat older, with mothers who had completed more years of school than their counterparts in Data Set 1. The observed differences between the first order correlations of status and demographic variables with composite scores within samples also suggest population differences.

4. Different constructs. In both data sets, the composite score is assumed to represent a cognitive-language performance construct. The three dependent variables in Data Set 1 are highly age-related measures of school readiness. The composite score is also highly representative of the separate scores (r values in the .70 - .90 range). Previous factor analysis results have shown that all three tests load on a common factor. In Data Set 3, the composite is not as strongly age related. The six dependent measures tap two somewhat distinct dimensions: language fluency, and cognitive problem solving (from results of factor analyses performed by this researcher in the Project Developmental Continuity evaluation). Although the composite is interpretable and reliable, and adequately represents the separate tests, the product-moment correlations of test to composite in Data Set 3 are lower than in Data Set 1 (r ranges in .60's).

All of these reasons contributed to a lowered expectation for replicating the R-square value from the pilot-

test in the model-testing phase. Considering these difficulties, it is encouraging to obtain cross-validation and replication estimates of explanatory power for the multivariate family configuration model as large as 7% to 8%. In addition, the model-testing phase confirmation of expectations regarding the proportion of maximum explainable variance supports the the validity of the model for somewhat different populations and/or somewhat different measured constructs.

Complexity of the "Teacher Effect"

As discussed in Chapter Three, the "teacher effect" is the most complex notion in the theory. The researcher speculated that, beyond the advantage one obtains from being not-last-born, factors of time, age proximity and peer reference group of older siblings, and other educational inputs may contribute to the influence of this conceptual piece to the mode's explanatory power. Age proximity of older siblings, their peer reference group, and other potential educational inputs they have received have been handled in the multivariate family configuration model by including two terms: the number of older preschool-aged siblings, and the number of older school-aged siblings. The teacher effect was originally hypothesized to include a last-born status designation, and as estimate of the time spent as last born. Two vectors mapped the teacher effect notion in the initial multivariate model: teachefk (last-born, not-last-born), and

timelast. Addition of a second order term for timelast significantly improved the ability of this conceptual piece to account for variance in the presence of the other four conceptual pieces in the full multivariate family configuration model. With an observed negative sign on the timelast coefficient, and a positive sign on the timelast-squared coefficient, the time-spent-as-last-born appeared to have a curvilinear (partial "U" shaped) relationship to the composite, in the presence of the other predictors. This may be interpretated in the following manner: If a target child is not last born, his ability to accrue a positive teacher effect declines somewhat and then increases as a function of the time he has spent as last-born. This suggests that the teacher effect may depend on a prior student effect. The child may need time to learn from older siblings, particularly school-aged siblings, before he can successfully teach and obtain the benefits of the teaching experience. That is, he may need to spend some reasonable amount of time as a last-born child, learning from more knowledgeable siblings, in order to gain the skills which might be refined by teaching.

Generalizability

Since the original experimental designs for the evaluation studies did not include systematic sampling procedures, no estimate of statistical representativeness of the findings of this study could be computed. However,

the researcher can evaluate the logical representativeness of the samples relative to the target population of preschool-aged children in compensatory education programs.

All children in Data Sets 1, 2, and 3 came from families which met the Head Start eligibility guidelines (an income by family size ratio). Head Start-type programs were created to serve preschool-aged children most likely in need of compensatory education and their low socio-economic status families. The suggestion that the Home Start and Project Developmental Continuity samples are drawn from two distinct sub-populations is useful here. If true, it indicates that the family configuration influence is important in several segments of the larger target population. The children in the samples come from at least five different ethnic backgounds (Black, Hispanic, Anglo, Native American, and Oriental), and were participating in compensatory preschool education programs at 17 different, rural and urban sites, throughout the United States. Since the original evaluations were conducted in different years, replication of findings suggests some independence of the effect of family influence from fluctuations in social, political, and economic conditions.

Therefore, the researcher believes that the results of this study can be logically generalized from the samples to the larger population of preschool-aged children in

compensatory education programs. He estimates that the multivariate family configuration model would explain between 8% and 12% of the variability in a measure of preschool cognitive and language ability in the target population. He further suggests that the explanatory power of this model would account for at least a third of the maximum variation that could be explained by conventional designations of demographic and status classification.

Meaning of the Data

Since the multivariate family configuration model has demonstrated significant explanatory power, the next logical question is: What does a family configuration pattern represent? The confluence model suggests that the family intellectual environment is functionally related to the family configuration pattern. The family configuration variables used in this study can be considered gross indicators of certain limiting factors which constrain the amount and quality of intellectual interaction in the family setting. Family size and membership (additional adults, extended family members) set limits on the availability of time and space within the home that a target child can use alone or in interaction with others. The developmental ages of all children in the family may limit the quality of their input into the intellectual pool of the family environment. Closeness of sibling spacing may reduce the likelihood that a target

child's intellectual needs might be met by adults, or by older, more knowledgeable siblings. In this light, family configuration variables may be seen as place holders for finer grained measurements of the amount of intellectual resources, in whatever fashion these resources are delivered, available to a target child of a given age in a particular family. These grossly defined limits of the intellectual environment have a significantly measured impact on a preschool-aged child's measured intellectual ability. This suggests that more precise measures of the intellectual resources of the individual family members, and their availability to a target child through interaction with other family members, should demonstrate at least as strong an influence as is accounted for by the multivariate family configuration model (see Marjoribanks and Walberg, 1974b).

CHAPTER EIGHT:
CONCLUSIONS, IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

Summary of Results and Conclusions

A multivariate family configuration model has been developed to operationalize notions of family configuration influence derived from the "confluence model." The multivariate model is believed to adequately map five notions of influence or pieces of the conceptual framework: number of siblings, birth order, number of adults, spacing between births, and the "teacher effect." A pilot test of this model in the data-snooping data set demonstrated that the multivariate model explained 18% of the variance ($\underline{p} = .0000$) in a cognitive-language composite score. In the same data set, the multivariate family configuration model accounted for 57.5% of the maximum variance explained by all available family, status, and demographic predictors, suggesting strong relative importance of the family configuration influence.

In a replication data set, the multivariate family configuration model explained 8% of the variance ($\underline{p} = .0000$) in a cognitive-language composite score. Although this estimate of the model's explanatory power was lower than original expectation, the model's ability to account for 34% of the maximum explainable variance attests to its relative importance in the target population. The researcher concluded that the family configur-

ation pattern of a target child's family has a significant, measurable influence on his/her measured cognitive and language ability. Results of supporting information analyses, using both Data Sets 1 and 3, suggest the adequacy of the mapping of the 10 family configuration predictor vectors to the five pieces of the conceptual framework, and the construct validity of the multivariate family configuration model relative to the notions of family influence derived from the confluence theory.

Research Implications

The findings of this study suggest a refocusing of effort for future research on measured intellectual ability. This researcher proposes that future researchers shift their attention away from emphasis on fixed, unchangeable, or non-manipulable status characteristics of children (sex, ethnic background) toward focus on modifiable, amenable to choice, or potentially manipulable characteristics. At this point in time, family size and spacing of children can be chosen through use of available family planning methods.

The multivariate family configuration model's explanatory power may represent a legitimate constraint on the region of expected effect sizes in family interaction research. That is, instead of attempting to explain overall variability in their chosen criterion, researchers in the family area might have greater success in explaining effects of family interaction

within the variance explained by the multivariate family configuration model. Since family configuration, as currently defined in this study, is a gross indicator of family intellectual environment, finer grained measures of the family configuration and intellectual environment should account for at least as much variance as the current model predicts. If family configuration, or the family intellectual environment construct which is inferred from family pattern, were to be completely measured, it should define the parameters of family influence on measured intellectual ability. The proper domain of research relating family interaction (mother-child, etc.) to ability or achievement would then fall within those limits (the variance explained by the family intellectual environment).

Educational Implications

The "teacher effect" is important. This notion is the most educationally relevant idea from the confluence model. In both the pilot testing and replication model testing analyses, the vectors mapping this conceptual piece accounted for the largest unique proportion of the multivariate family configuration model's explanatory power. This demonstrates the importance of the teacher effect in the family context.

The primacy of the teacher effect suggests that a translation of the family configuration model into a model of classroom membership configuration seems logical and

potentially productive. Classroom membership variables could parallel family configuration variables: siblings become children in the classroom; adults in the family correspond to teachers and adult aides; spacing suggests examination of age differences in multi-age classrooms; birth order translates to age or grade ordinal position within a classroom group; and the teacher effect has direct parallels to the provision for cross-age tutoring. In addition, the family configuration model in this study has been tested using preschool-aged children in compensatory education programs. This is the same target population for most compensatory or innovative elementary education programs, whose purpose is to improve the quality of the (classroom) intellectual environment.

Relevance to Theory

The findings of this study have limited relevance to the complete confluence model. The multivariate family configuration model mapped only selected notions of the theory, not including change terms, dynamic growth processes, or the influence of the target child on the family intellectual environment. It can add to the knowledge base of family influence on measured ability at a single age. The "confluence model" researchers might derive some heuristic value from an examination of the procedures used by this researcher in the model-building process. The systematic data-snooping strategies which

this researcher employed, particularly with reference to the selection of necessary predictor vectors and the specification of vector contents, might be particularly helpful. The findings relating to the complexity of the "teacher effect" may be of importance to the refinement of the theory with regard to this notion of influence. It is clear that a valid test of the confluence model would require a longitudinal study with finer grained measurements of family configuration and intellectual environment than those which were available in this study.

Suggestions for Future Research

The multivariate family configuration model developed in this study could be used as a set of covariates in intervention research to determine program effectiveness over and above family influence. The set of 10 family configuration predictors would allow greater control over possible background differences which complicate quasi-experimental designs. Necessary additional information would include number of siblings, ages of siblings, and number of adults in the home.

The researcher has suggested that a translation of the family configuration model into a classroom membership model could be useful. It might provide the sophisticated theoretical base which Allen, et al. (1976) observed was lacking in studies of cross-age tutoring. Translation of

the theory into an educational environment would require the following:

1. a large sample of classrooms with occurring variations in classroom membership and organization;

2. collection of data on the number of adults in the classroom, the ages of each child in the classroom, the years of schooling of each child in the classroom, and the availability of older children in the classroom for cross-age tutoring. (In addition, for target children -- students or tutors -- it would be useful to have family configuration data also.) It would be currently feasible to conduct such research in a large city or county school system. Much of the necessary information could be obtained directly from school records.

APPENDIX A:
SUPPORTING INFORMATION FOR
DATA SETS 1, 2, AND 3

The information presented in this appendix has been selected and paraphrased from a number of reports to the Office of Child Development concerning the evaluations of the National Home Start Demonstration Project (prepared by the High/Scope Educational Research Foundation and Abt Associates) and Project Developmental Continuity (prepared by High/Scope). Complete citations for these reports appear in the References. Program information on Home Start has been abstracted from the final project report. Specific information on entry samples comes from Home Start Evaluation Study Interim Report IV. Program descriptions and specific information on Project Developmental Continuity has been selected from A Process Evaluation of Project Developmental Continuity, Interim Reports, III, and IV.

Data Set 1.

Home Start. The National Home Start Demonstration Program was established by the Office of Child Development in 1971 to demonstrate "alternative ways of providing Head Start-type comprehensive services for young children in their home" (Final Report, 1976, p. 1). The program started in March 1972 and concluded in June 1975. Home Start served low income preschool children and their families in sixteen sites throughout the nation, with each

local project receiving approximately $100,000 per year to service 80 families. The program focused primarily on parents as educators, and retained a total family rather than single child focus in service delivery. Home visitors (trained paraprofessionals) spent time bi-monthly with a parent and child separately and in interaction, providing education, health, nutrition, and social/psychological services.

The evaluation effort ran concurrently with the duration of the Home Start program. Six sites were selected as summative evaluation sites, and recruited an additional 80 families (with target children of the same age) to serve as a delayed-entry control group. Families were randomly assigned to Home Start or Control in these sites. In four of these sites, a Head Start comparison group from the same region was also observed for the evaluation period. Entry data for the first full year of the evaluation (Fall 1973) for all three groups has been included in Data Set 1. Although these children were assessed in a number of cognitive, social, and nutritional areas, only cognitive and language tests (essentially school readiness measures) appeared as dependent variables in Data Set 1.

Characteristics of the Data Set 1 Sample. A total of 556 target children were tested in the Fall of 1973, ranging in age from 28 months, to 70 months (mean = 47.2 months, 50% between 3½ and 4 years of age). Sex distri-

bution was evenly balanced. 60% of the families lived in urban settings (small town or city), with a majority of the parents representing low economic status (Duncan index) and less than a high school education (reflecting selection guidelines). The ethnic background of the families served was approximately 60% white, 5% Chicano, 35% Black. The number of siblings for a target child ranged from 0 through 12 (mean = 2.34, S.D. = 1.98).

Analytic samples. Table A.1 provides descriptive information on the 427 children who were included in most analytic samples using Data Set 1. The sample was restricted to children with siblings with non-missing data on the basic family variables and dependent measure scores. Appendix B describes the tests used as dependent measures.

Data Sets 2 and 3

Project Developmental Continuity. Project Developmental Continuity was instituted by the Office of Child Development in 1974 to provide greater continuity of education and child development services for children in transition from preschool (Head Start) to elementary school. Like Home Start, its target population was young children from low income families. Its focus was the social competence of these children, an increased everyday effectiveness in dealing with all aspects of their environment. The project also aimed at institutional change, linking Head Start center services to elementary

Table A.1

Descriptive Information on the

Analytic Sample in

Data Set 1

(children with siblings)

variable	n	mean	standard deviation
sex	427	1.4988	.50059
age in months	427	47.932	7.1037
number of siblings	427	2.6979	1.8360
father absence	427	1.5597	.4970
birth order	427	2.9415	1.9023
mean spacing	427	2.5700	1.5529
mother's education[a]	427	4.99	.96817
Preschool Inventory	427	9.5252	4.6680
Denver-Language	427	26.182	4.1079
8-Block Total	427	3.3060	1.4871

[a]Adjusted scale created by Abt Associates. Actual mean equals eighth grade.

school services, either in self-contained early childhood schools, or with organizational relationships established between centers and schools. School organizations in fifteen locations throughout the nation received Office of Child Development funding to plan and implement these continuity linkages in curriculum, parent participation, social and health services, training, administrative coordination, and special service programs (handicapped, bilingual). The evaluation effort began during the planning year (1974-1975). The High/Scope Educational Research Foundation collected pilot year data (1975-1976) and baseline longitudinal study data (Fall 1976) on Head Start children on a variety of cognitive, social-emotional, psychomotor, and nutritional measures (see Appendix B). In each of the program sites (with one exception) a comparison Head Start group of children was also tested. The data which appeared in Data Set 2 were selected from the Fall 1975 data collection. Data Set 3 was created from Fall 1976 data.

Characteristics of Data Set 2 Sample. Data were collected on a total of 1179 PDC and comparison children in the Fall of 1975, of which 726 met the criteria of English-Language dominant, non-handicapped. The children ranged in age from 44 through 75 months (mean = 52.78; approximately two-thirds falling in the 4 through 4½ years age range). Sex distribution was evenly balanced. Limited

indicators of socio-economic status (with considerable missing data) suggested low SES, with moderately high mother's education (high school) and sizeable father absence (40% - 50%). Number of siblings ranged from 0 through 12 (mean - 2.08, S.D. = 1.71). The sample children in Data Set 2 were predominantly Black (proportions are approximately 50% Black, 38% Anglo, 12% Spanish surnamed).

Characteristics of the Data Set 3 Sample. Data were collected on 1207 Head Start children in the Fall of 1976, of which 916 met the English-dominant, non-handicapped criteria. The children ranged in age from 45 through 65 months. Sex distribution was evenly balanced. Again, although the Head Start eligibility criteria and substantial father absence would suggest low SES, the mean years of education completed by the mother was higher than would have been expected for this population (mean = 11.2 years). The number of siblings ranged from 0 through 11. The sample children in Data Set 3 were approximately 42% white, 34% Black, and 20% Spanish surnamed.

Analytic samples. Tables A.2 and A.3 provide descriptive information for the subjects who appear most frequently in analytic runs using Data Sets 2 and 3. In Data Set 3, children without siblings were usually excluded from analyses. Again, the dependent measures are described in Appendix B.

Table A.2

Descriptive Information on the

Analytic Sample in

Data Set 2

variable	n	mean	standard deviation
sex	724	1.4862	.50015
age in months	718	52.815	4.0534
number of siblings	700	2.0700	1.7430
father absence	499	1.5551	.49745
mother's education	423	13.154	1.8260
Bilingual Syntax	691	9.2634	4.0174
WPPSI-Block Design	724	5.7293	3.5134
Verbal Fluency	726	5.8292	4.4045
Verbal Memory I	708	9.8008	3.6055
Verbal Memory III	725	2.1848	2.7735
Draw-A-Child	725	4.0634	2.7469

Table A.3

Descriptive Information on the

Analytic Sample in

Data Set 3

(children with siblings)

variable	n	mean	standard deviation
sex	694	1.5187	.50001
age in months	684	53.756	3.8611
number of siblings	694	2.0937	1.4912
number of adults	694	1.6354	.48165
birth order	694	2.4467	1.5697
mean spacing	694	2.5662	1.3206
mother's education	673	11.141	1.7267
Bilingual Syntax	694	9.9063	4.0756
WPPSI-Block Design	694	5.2161	3.6577
Verbal Fluency	694	6.0418	4.9225
Verbal Memory I	694	12.421	6.0859
Verbal Memory III	694	2.6844	2.5255
Draw-A-Child	694	4.2752	2.7467

APPENDIX B:

DESCRIPTIONS OF THE DEPENDENT MEASURES

Instruments used in Data Set 1

Preschool Inventory (PSI). The PSI is a general measure of children's achievement in areas often regarded as necessary for success in school: general knowledge (e.g., "What does a dentist do?") and basic concepts (e.g., "Put the blue car under the green box."). Originally developed by Bettye Caldwell for Educational Testing Service (ETS) in 1968, the version used in the Home Start evaluation was a 32-item adaptation designed by the Stanford Research Institute. The test included a number of manipulable child materials (plastic cars, tape, checkers, crayons). This test had been previously used in the national, Head Start Planned Variation evaluation.

Denver Developmental Screening Test, Language Scale (DDST-LAN). The DDST was developed by Frankenburg, Dodds, and Fandal (1970), primarily for use in diagnosis of other than normal functioning. The High/Scope staff selected the 32 most age-appropriate items, and created four scale scores, including the 6-item language scale. The Language scale included items which called for comprehension of certain concepts (e.g., hungry), prepositions (e.g., behind), and analogous relationships (e.g., mother-father). This test also included manipulable materials

(wool, raisins, bottle, bell).

8 - Block Sort Task - Child Total Score. This instrument is a widely used procedure for assessing mother-child interaction in a teaching context. Developed by Hess and Shipman (1968), it has been used in the Head Start Planned Variation evaluation and the ETS Longitudinal Study. The task involves sorting eight blocks into four groups defined by two criteria out of four attributes. In this procedure, the tester trains the mother to sort the blocks correctly and explains reasons for the grouping. The mother subsequently trains the child in whatever manner she wishes. The child is then asked to place two additional blocks in the proper place and explain his/her reasons for this grouping. A number of maternal-teaching style dimensions were coded and evaluated from a tape-recording of the session, but were not used as data in this study. The child received two scores, one for placement and one for explanation, summed to a total score (0 - 8) which was used as a dependent measure score for this study.

Instruments Used in Data Sets 2 and 3

Bilingual Syntax Measure - English (BSM-E). This recently developed test by Burt, Dulay, and Hernandez (1975) has not been previously used in any large scale evaluations. It was, however, the only available instrument which met the needs of bilingual evaluation for Project Developmental Continuity, and the criteria

suggested by Dr. Luis Loasa, High/Scope bilingual evaluation consultant. The BSM was designed to measure children's oral proficiency in English and/or Spanish by using samples of natural speech for making judgments on the child's grammatical structures. Simple questions have been used with cartoon-type colored pictures to elicit conversational speech. The child's utterances were scored for structural language proficiency in Standard English or Spanish. This measure has also been used as a measure of language dominance in the bilingual demonstration sites. Only the English version, with only English-dominant children, appeared as a dependent measure in Data Sets 2 and 3.

Wechsler Preschool and Primary Scales of Intelligence - Block Design (WPPSI - Block). This familiar subtest from the WPPSI (1967), based on the original Koh's block designs of the 1930's, was selected for use in the evaluation battery as a maturational covariate. It is a measure of speed, facility, and flexibility of problem-solving style, and visual-motor organization. The task requires reproduction (construction) of designs with colored blocks either from an examiner's model or from a picture on a card. This task has an extensive history of clinical and educational usage.

McCarthy Scales of Children's Abilities (MSCA): Verbal Fluency, Verbal Memory, Draw-A-Child. The McCarthy Scales (1972) were developed to tap a number of dimensions

of children's problem solving, psychomotor, and conceptual abilities, similar in intent to the Weschsler Scales, but with stronger emphasis on age-related maturational indicators. These subtests were chosen for the Project Developmental Continuity Evaluation because of their expected sensitivity to program (educational) influences. In the Verbal Fluency task, the child is asked to name as many numbers of a specific category (e.g., animals) as he/she can. Verbal Memory involves repeating sequences of words, and retelling as much as possible of a one paragraph story. Draw-A-Child is a simple drawing (representation) task which has been scored for completeness of body parts on a rough, nine-point scale. All of these subtests were reported in raw score form, since certain modifications in the administration direction precluded the use of McCarthy scale scores.

The researcher wishes to again acknowledge that most of the material contained in this appendix has been selected and paraphrased from the published reports of the Home Start and Project Developmental Continuity evaluations.

APPENDIX C:
PSYCHOMETRIC CHARACTERISTICS OF THE DEPENDENT MEASURES

Reliability

Extensive psychometric analyses have been performed on these measures and these samples as part of High/Scope's evaluation effort. Floor and ceiling effects, single item characteristics, and the overall factor structure of the measures have been examined and documented (Home Start Study: Interim Report IV; Project Developmental Continuity Interim Reports III, IV, and V). The discussion of reliability here will focus on Cronbach's coefficient alpha. Alpha is an internal consistency reliability estimate, or an index of common factor loading across items in a test. The definition formula for alpha is: (from Cronbach, 1951)

$$r_{alpha} = \frac{n_i}{n_i - 1} \left[1 - \frac{\sum s^2_i}{s^2_s} \right]$$

where:

n_i = number of items in the scale

$\sum s^2_i$ = sum of the item variances

s^2_s = variance of the scale

and

$\frac{n_i}{n_i - 1}$ = a correction factor, with increasing weight for few item scales

Tables C.1, C.2, and C.3 present reliability estimates for the single dependent variables in Data Sets 1, 2, and 3. These figures have been obtained from High/Scope's reports to the Office of Child Development, and apply to the aggregate samples of English-dominant, non-handicapped children included in these evaluations in Fall 1973, Fall 1975, and Fall 1976. In each case, the researcher has selected from among the available dependent measures, only those cognitive and language tests which met High/Scope's reliability criteria.

Issues of Validity

In designing strategies for data analysis of the Home Start data, High/Scope researchers grappled with the issue of "valid score" on the dependent measures that this researcher has subsequently chosen for use in this study. Test author instructions on several instruments dictated a minimum number of completed responses prior to test termination before a child's score could be considered a valid measure of his competence on those tasks (e.g., on the Preschool Inventory, a child must have had responses recorded for at least 28 out of 32 items in order to be included in the baseline analytic sample). This procedure, unfortunately restricted the sample size for any given measure, and severely reduced the analytic sample for any multivariate analyses. The Home Start Project involved longitudinal data collection. Since a majority

Table C.1

Internal Consistency Estimates for Data Set 1

	Fall 1973	
measure	n	alpha
Preschool Inventory	425	.77
Denver Language	516	.84
8-Block Total Child Task	455	.84[a]

[a]Estimate, based on a later time point.

Table C.2

Reliability Estimates for Data Set 2

(English-Dominant Sample Only)

measure	Fall 1975		Spring 1976		Test-Retest	
	n	alpha	n	alpha	n	r
Bilingual Syntax Measure-English	691	.82	430	.88	331	.68
Draw-A-Child	737	.82	456	.74	361	.51
Verbal Fluency	726	.75	458	.74	362	.45
Verbal Memory I	724	.64	435	.73	328	.38
Verbal Memory III	725	.85	434	.83	342	.43
WPPSI-Block Design	724	.75	80	.78	-	-

Table C.3

Reliability Estimates for Data Set 3

	Fall 1976	
measure	n	alpha
Bilingual Syntax Measure	913	.83
Draw-A-Child	896	.83
Verbal Fluency	895	.76
Verbal Memory I	913	.82
Verbal Memory III	905	.82
WPPSI-Block Design	915	.76

of the non-valid scores at entry could be considered to have occurred because of maturity problems, it seemed logically plausible to examine the valid scores of these children when they were older, and estimate their earlier missing scores using a regression procedure. Based on an examination of time point one (Fall 1973) interrelationships and factor analyses, and time point four (Spring 1975) interrelationships of scores, Robert Hanvey and Terry Bond of the High/Scope Research Department constructed a regression procedure for computing predicted scores for those subjects missing one out of three of the original dependent variable scores at time point one. The following example is the equation for estimating missing scores on the Preschool Inventory, based on a series of three regression equations including Preschool Inventory, Denver Developmental Screening Test Language Scale, and the 8-Block Child Task Total Score:

Predicted PSI = -11.198 x Unit vector + .073131 x DDST-LAN + 0.48459 x 8-Block Total

In the Home Start Final Report, variables containing these predicted scores were used as the pre-test covariates for analyses of treatment group effects. In this study, the three dependent variables in Data Set 1 contained such scores.

Since the Project Developmental Continuity evaluation was conceived as an evaluation of the impacts of the

program on the broad area of child "social competence," research staff involved in instrument selection performed a thorough review of all previously used instruments in this area. Based on this review, and conceptual expectations, those researchers designed an hypothesized matrix of intercorrelations of child test measures. Following a comparison procedure developed by Dr. Arthur Granville (discussed in Project Developmental Continuity, Interim Report III, Part A), the concurrent and construct validity of the PDC child test battery was evaluated within site and within aggregate language samples. Again, the researcher has selected only those measures which were considered reliable and valid, according to the High/Scope criteria, for both Fall, 1975 and Fall, 1976 samples in the Project Developmental Continuity evaluation. For further information, the reader is referred to the previously cited reports.

APPENDIX D:

PROPORTION OF MAXIMUM EXPLAINABLE VARIANCE

This researcher has invented an index or statistic for use in this study that does not appear in the literature on research techniques. The <u>proportion of maximum explainable variance</u> attributed to the family configuration model, computed by the formula:

$$\text{proportion of } R^2_{max} = \frac{R^2_{family}}{R^2_{max}}$$

is offered as an indicator of the relative importance of the family model. While perfect predictability (R-square value of 1.00) is always desired, in most cases, educational and psychological research fails to meet this goal. Alternatively, estimates of strength of relationship can be examined from a different perspective. Instead of asking, "How much (in absolute terms) variation does a theoretical model explain?" this procedure says "knowing everything we can know at this time which accounts for any systematic variability, how much of what we know can be explained using only the theoretically relevant pieces of information?"

The most general regression analysis question is typically stated as -- "Does the full model significantly predict variance over and above the restricted model?" -- or, in covariance form -- "Does predictor (or predictor

set) X_2 predict variance in dependent variable Y, over and above the variance already accounted for by predictor (or predictor set) X_1?" The research question addressed by the proportion method is "How much of the variance that has been predicted by all available information can be accounted for using only the theoretically relevant predictors?"

The proportion procedure involves a comparison of a restricted model's explanatory power to a full model's explanatory power for the same set of subjects. In this study, the restricted model is the original model of interest, the multivariate family configuration model. In that model, all variance not attributable to the set of 10 family configuration predictors has been treated as error. In the full model, which in this case, is the maximum explainable variance model, the restricted model's error term has been partitioned into variance attributable to other available status and demographic predictors, and remaining error variance. The amount of the restricted model's explained variance is then compared to the amount of the full model's explained variance, and reported as a simple proportion.

Examining the theoretically relevant proportion of total explained variation is parallel to evaluating the importance of one's research study (strength and significance of relationships) in the context of previous research

(typical findings, or findings under maximal conditions). Suggestions for such a systematic literature review are presented in McNeil, Kelly, and McNeil (1975). A discussion of one form of relative importance (proportional-reduction-in-errors-of-prediction) is given by Costner (1965).

Although this researcher presents a formula, the MIDAS Regression programs can be used to calculate this index directly, and will compute an F-statistic evaluating the significance of the proportion of maximum explainable variance. After regressing the composite score on all available family, demographic, and status predictors, the PREDICTED score is saved for each complete case. This means that the regression weights have been applied to respective predictors and a linear predicted composite has been created. Subsequently, the PREDICTED composite, which is the maximum explainable variance, is regressed on only those predictors which map the family configuration conceptual framework. The resulting R-square value is the proportion of maximum explainable variance attributable to the family configuration model. The researcher contends that the F-statistic produced with this regression analysis is appropriate for evaluating the significance of the family configuration's explanatory power relative to maximum explanatory power. In this case, the significance of the

F-test is a measure of the statistical reliability (the probability of non-chance occurrence of a proportion value of that magnitude in the population) of the proportion of maximum explainable variance.

This index, the *proportion of maximum explainable variance*, could prove useful to other researchers in several ways. It helps place the findings in context. If it were not practically possible to explain more than 15% of the variance in a dependent measure, explaining 10% with a few, theoretically chosen predictors would be important. This may have implications for the costs of securing information, considering importance (explanatory power relative to best explanations).

APPENDIX E:
TECHNICAL CONSIDERATIONS FOR THE SUPPORTING INFORMATION ANALYSES

Variance Contributions

This researcher agrees with Darlington (1968) that "independent contribution to variance has no meaning when predictor variables are intercorrelated." The figures offered in tables 5.10 and 6.6 are estimates of the unique or incremental contribution of a conceptual piece to the explained variance, which can be defined in three equivalent ways:

1. increase in the total R-square value attributable to the addition of a set of predictors to the predictors already included in the model;
2. decrease in the total R-square observed when the set of predictors mapping a conceptual piece is dropped from the equation;
3. partitioning the sum of squares attributable to the family model into a sum of squares for one conceptual piece and a sum of squares for other conceptual pieces, then dividing the first sum of squares by the total sum of squares.

"Unique" contributions to variance have been criticized in the research literature, particularly with reference to the Coleman Report (Cain and Watts, 1971). In this study, variance contribution estimates are useful for assessing the relative importance of conceptual pieces

to the explanatory power of the full family configuration model. In contrast to Coleman, this is not an attempt to suggest social policy implications for experimental manipulation of resource allocation. The partitioning of variance here is based on theory. Multicollinearity is not only acknowledged, but is accepted as a necessary feature of the complex interrelationships of family variables.

Methods for Verifying Explanatory Power

Replication, repeating the experimental design and analysis with a new sample, is one means of verifying the estimate of explanatory power (obtained R-square value) of a multivariate model. Where a second sample cannot be obtained, a number of authors present "shrinkage" formulas to adjust the obtained R-square value downward so as to more closely approximate a population value (Klein and Newman, 1974). In a study such as this one, there are two reasons to expect shrinkage: 1) the original, zero-order relationships among predictors and dependent measures are conventionally assumed to be error free, when in actuality, this is not the case (Kerlinger and Pedhazur, 1973); 2) when a set of predictors is pre-selected on the basis of theory and/or statistical significance, and refined through a data-snooping procedure, the resulting model takes advantage of serendepity, biasing the multiple correlation upward (Nunnally, 1967). Where a second sample can be obtained, an additional verifica-

tion of the estimate of explanatory power can be attempted by cross-validation. Cross-validation is the application of regression weights for predictors obtained in the first sample to the respective predictors in the second sample. The observed dependent (actual) variable in the second sample is regressed on the "predicted" dependent variable, and the obtained R-square value is the cross-validated estimate of explanatory power.

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