COGNITIVE DEVELOPMENT OF ADOPTED AND FOSTERED CHILDREN

APPROVED BY SUPERVISORY COMMITTEE:

COGNITIVE DEVELOPMENT OF ADOPTED AND FOSTERED CHILDREN

by

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DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT AUSTIN

August 1986

ACKNOWLEDGEMENTS

Reflecting on the long course of my education, my strongest impression is of people being patient with me.

More people have helped me than I can thank individually, but my parents and family have done the most and waited the longest for their kindness to bear fruit. In many ways this dissertation is theirs as well as my own.

Many friends have enriched my life and thought while I worked on this project. Naftali Raz, Ron Yeo, Kevin Riley, Michael Bayley and George Daughtrey provided companionship, reflection, argument and common sense. My ongoing dialogue with each of them is the crucible of my ideas.

Several teachers have provided encouragement at difficult times in my education. Douglas Davis was the first to urge me to continue my education in psychology. Mary Ellen Olbrisch supervised me during my first years of graduate school and believed in my ability to do well long before I did. Erin Bigler's enthusiasm has been the inspiration for much productive research. Mike Rossi was tolerant of my slow progress at some cost to his own convenience.

My committee members have been crucial to the completion of this project. Mark Lewis, William Koch and Les Cohen have been generous with their time and knowledge. John Loehlin has taught me a great deal about statistics and measurement, but perhaps even more about the value of unhurried reflection and careful scholarship.

Lee Willerman has been my finest teacher. He conceived this project, then applied his enthusiasm, good humor, diligence and rigor to see it through to completion. To say he taught me everything I know would be faint praise for the depth and breadth of his knowledge.

Finally, I would like to thank my wife, Carol Manning, and her family. Carol has given a great deal of herself in supporting me and my work. I dedicate myself to returning her gift in kind.

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Publication No._____

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The University of Texas at Austin, 1986

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Adopted and fostered children provide an unique opportunity for the study of genetic and environmental influences on cognitive development, but fifty years of adoption studies have not succeeded in resolving the debate between environmentalists and hereditarians. This study attempts to subsume two classic adoption designs that have often led to opposite conclusions. One design compares the mean IQ's of adoptees and a control group of similar but nonadopted children. These studies have usually found an IQ advantage for the adopted children, suggestive of an environmental effect. The second involves regressing IQ's of adoptees on characteristics of their biological parents and adoptive rearing environments. These studies have shown adoptees' IQ's to be more strongly related to their biological than adoptive parents, indicative of a predominant genetic influence.

In the present study, 338 adopted or fostered children were selected from the National Collaborative Perinatal Project, a

large-scale longitudinal study. These children were compared to two groups of matched controls, one matched to characteristics of the biological families of the index cases, and the other matched to characteristics of their adoptive or foster families. All children were administered infant development scales at eight months of age, and intelligence scales at four and seven years.

Structural equation modelling techniques were used to perform simultaneous regressions of cognitive measures on family variables in the three groups, while constraining regression coefficients to be equal across groups. IQ differences predicted by the regressions were then compared to actual differences among the groups.

Adopted children scored significantly higher than controls on most IQ measures. Foster children scored substantially lower than either control group on all tests. Some of the adopted childrens' IQ advantage could be attributed to their adoptive environment, especially for white children. Biological mother's education predicted biological childrens' IQ's for adopted children of both races.

The low IQ's of the foster children appeared largely to be caused by biological deficits predating their fostering, although those raised in poor foster environments showed especially large IQ deficits. Genetic relationships between maternal education and child IQ appeared to have been attenuated by neurological impairment in this group.

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CHAPTER 1: INTRODUCTION

Adoption is among the most radical and permanent changes in environment that children can ever experience, but consensus about the magnitude of its effects on cognitive ability has proven difficult to achieve. Indeed, questions about the development of adopted children have been at the center of the long-standing debate between environmentalists and hereditarians.

The nature-nurture debate is unlikely to be resolved to the satisfaction of strict adherents to either side. Partitioning individual differences in ability into linear components strictly attributable to heredity or environment does violence to the complexity of intellect and its multifarious influences. Recently, both environmentalists and behavior geneticists have issued calls for an end to the long and rancorous debate (Scarr and Weinberg, 1980; Plomin, 1983; McCall, 1981; Wachs, 1983), echoing Anastasi (1958), who recommended emphasizing the question "How?", rather than "How much?" in the study of heredity and environment. The research reported here is an attempt to proceed in that spirit.

Intelligence is at once the best established and most controversial of psychological constructs. Questions about its determination have social as well as scientific implications. One hundred years of research have demonstrated that intelligence is influenced by environments, especially poor ones, and that parental genes have a reliable effect independent of rearing environment. But the relative strengths of the influences have been difficult to determine, and may not be a matter that can be resolved unambiguously.

Adopted children and twins are the most frequent subjects of research for unravelling hereditary and environmental influences. Adoptees differ from ordinary children in that they are genetically unrelated to the parents and siblings whose home they share. Thus, relationships between the intelligence of adopted children and aspects of their family environment provide an index of environmental influence relatively free of hereditary influence. Conversely, uncontaminated measures of genetic influences can be obtained from intellectual similarities between adopted children and their biological parents who do not rear them.

The next chapter describes some of the many conceptual problems clouding the discussion of research in this area. Chapter 3 provides an overview of other research concerning environment and intelligence. Chapter 4 reviews the available adoption studies, and applies a methodological discussion to some continuing controversies. The proposed study is then described. Throughout, the term "intelligence" refers to the underlying trait that IQ tests measure; "IQ" refers to the specific results of those tests. The term "ability" is used to describe the broader context of mental functioning of which intelligence is a part.

CHAPTER 2: WHY ENVIRONMENTAL EFFECTS ARE HARD TO MEASURE

A perusal of the research on hereditary and environmental influences on cognitive ability leaves the impression that genetic components are relatively better understood. Although one may argue about the effect size, studies using a variety of methodologies find substantial relationships between biological parent and child ability. Such is not the case with environmental effects. Many studies report very small correlations between aspects of family environment and childrens' IQ. Other studies, seemingly contradictory, report large gains in ability following environmental intervention. In fact, the only consistent estimates of the magnitude of the environment's role in the development of children's intellect are reached by subtraction. To the extent identical twins' IQ's are not perfectly correlated, the remaining variability is perforce environmental (Willerman, 1979).

One can point to several reasons why environmental effects, even if collectively as powerful as heredity, are harder to specify and measure. A consideration of these will provide a framework for evaluating the results of research to be reviewed below.

Inconstancy of Environment

Environments are changeable and occasionally ephemeral, whereas genotype (if not its effects) remains fixed throughout life. In research on the consequences of adversity in early childhood, the changeability of environment has the salutary effect of offering hope that future environments will be better. In special educational programs for disadvantaged children, it has the unhappy effect of limiting the extent of the environmental improvement, which may dwindle once the program is over. Any assertion of an environmental effect on ability, therefore, must include a consideration of the duration of the environmental change and the durability of its effect.

Correlation of Genes and Environment

Quality of genes and environment typically are correlated, so the variability they share cannot be separated unambiguously. The correlation between aspects of non-adoptive family environment and children's IQ is not interpretable simply as environmental because family environment is also correlated with family genes (Plomin, DeFries and Loehlin, 1977; Wachs and Mariotto, 1978; Scarr and Weinberg, 1978). Many reports making this mistaken interpretation are still published, although statistical techniques for identifying the independent effects of genes and environment are readily available. A simple method is to estimate the partial correlation between family environment and child's ability with parental intelligence held constant. Partial correlation, however, falsely assumes parental intelligence to be measured with perfect reliability (Loehlin, 1985).

Path analysis is a more satisfactory alternative because the effects of unreliable measurement can be controlled. Wachs and Mariotto (1978) suggest several path models for this purpose. Even better is to separate the effects of genes and environment experimentally, by studying adopted children. Plomin, Loehlin and DeFries (1985) show that an independent effect of family environment on IQ can be estimated as the difference between IQ-environment correlations in adoptive and nonadoptive families. They conclude that about half of the relationship naively attributed to family environment in studies of child IQ in nonadoptive families is in fact genetic in origin.

Within Family Variance

Environmental variance in intelligence operates within and between families (Rowe and Plomin, 1981). Within family environment makes children in the family different from each other, while most studies of the environment seek ways in which it makes them similar. Rowe and Plomin (1981) show that the average pair of siblings differ by 13 IQ points, compared to 17 points between the average pair of unrelated people.

McCall (1983) analyzed the IQ scores of single individuals tested several times over a period of years. The average standard deviation within an individual was about 8 IQ points. The pattern of this variation across time is no more similar for siblings or parent-child pairs than it is for unrelated individuals (McCall, 1970). McCall interprets these two findings as evidence for substantial within family environmental variance for IQ.

In general, within family variables are more difficult than between family variables to study because they comprise idiosyncratic differences in life experience which are by their nature hard to systematize. A few, most notably the ordinal position of the child in the family, do lend themselves to systematic research.

Multivariate Nature of the Environment

Intelligence is believed to exist because tests of mental ability are positively correlated with one another, but there is good reason to believe the environment is multivariate (Wachs, 1983). Different aspects of environment may account for small, relatively independent portions of the variance in children's cognitive ability. If this were the case, correlations between IQ and variables measuring specific aspects of the environment would be small, but the cumulative effect of a large number of specific environmental variables could still be substantial. SES and other summary measures of the environment may blunt detailed specification of environmental effects (Wachs, 1983) while paradoxically allowing them to be measured, however grossly, by summing them.

There is a sense in which the difference between our knowledge of genetic and environmental effects is not all that great. Aside from some major genes causing mental retardation, we know as little about the specific genes producing phenotypic IQ as we do about the particulars of environmental transmission. The existence of twins and our knowledge of quantitative genetics, however, allows us to sum whatever is transmitted genetically and arrive at a measurable genetic component. If we lived in a world in which there were occasionally born genetically unrelated "environmental twins" who lived the same lives, moment by moment, we might be able to quantify environmental effects with greater confidence.

Problems with Heritabilities

Heritabilities are the traditional result of nature-nurture analyses. Heritability is the percentage of the total phenotypic variance of a trait that is explained by variation in genotype. Criticizing heritabilities is as traditional as reporting them (Loevinger, 1943; Lewontin, 1974; Layzer, 1974; Feldman and Lewontin, 1975).

A heritability is an effect size. As a proportion of variance explained, it is similar to any other r^2 in that it depends on the variance of the independent variable (genotype), the magnitude of the effect (the amount of genotypic variance transmitted to the phenotype) and the variance of the dependent variable (phenotype). Heritability is not a fixed property of a trait; rather it varies with genotypic and phenotypic variation across populations.

The foregoing account of heritability is uncontroversial. Every discussion of the topic, by friend and foe alike, begins with the caveat that heritabilities are characteristics of populations, not traits. Disagreement results when those reporting heritabilities fail to heed their own warnings and talk of "the heritability of intelligence" (Some examples of this are discussed below), or when critics argue that assumptions required for any heritability estimate are untenable in the analysis of mental measurements.

In any analysis of variance, it is axiomatic that main effects can not be unambiguously interpreted in the presence of significant interactions. This is true for heritability analyses as well. Heritability is a "main effect" of genotype on phenotype; environment is the other main effect in the model. If genotype and environment interact the effects of heredity and environment each depend on the other. That is, a trait might have a high heritability for subjects raised in enriched environments, and a low heritability for subjects raised in poor environments. In this situation, the notion of a single heritability, even within a population, would be meaningless.

Another assumption of most analyses of variance is linearity of effects. Linear effects, by definition, have a constant slope over their entire range. If IQ were linearly related to environment, for example, changes in environment of a given size would produce the same effect on IQ whether the change was between two poor environments or two good ones. If the effect of environment were nonlinear, on the other hand, differences between poor environments might produce large differences in IQ, while numerically equivalent differences between good environments would produce no effect. As with interactions, this situation would result in heritabilites that depended on where and how they were measured, so the notion of a fixed heritability would have no meaning.

Linearity is a common assuption in general applications of analysis of variance, of course, and the presence of interactions is assessed routinely. Interactions may be tested in adoption studies either by using analysis of variance (Plomin, DeFries and Loehlin, 1977), or by adding some assumptions to path analysis to include interactions and non-linearity in the model (Kenney and Judd, 1984). Plomin, DeFries and Loehlin (1977) tested for interactions in two adoption studies, failing to find any. There is ample evidence of gene-environment interaction in animal genetics, however (Erlenmeyer-Kimling, 1972), and research with humans to be reviewed in the next chapter does suggest the existence of gene-environment interaction for intelligence.

Problems of Scale

These statistical problems are compounded because environment is not measured on any meaningful scale. The scale of IQ is also somewhat arbitrary, but is widely accepted and can be applied to the abilities of both parents and children. In the absence of a meaningful scale for environment, it is difficult to know exactly what is meant by asking whether its relationship with ability is linear. Similarly, environment has no specifiable "natural" variation, or even a standard variation like IQ's SD of 15, to use as a reference for correcting correlations with restricted ranges. As a consequence, small environmental effects in a sample of naturally occurring environments may become quite large when an experimental intervention extends environmental variation beyond its "normal" range (Jencks, 1980).

Conclusion

Estimates of heritability and environmental effects are population, situation, and instrument dependent. They are not general properties of the construct of intelligence. This has not prevented a lot of haggling about heritability estimates that vary from study to study and analysis to analysis. The methodolgical confusion inherent in these arguments can be illustrated with reference to two often-observed and apparently contradictory phenomena: (1) IQ's of children raised apart from their biological parents <u>correlate</u> more highly with their biological parents' IQ's than with measurable characteristics of their rearing environment, and (2) the <u>mean</u> of adoptees' IQ's is less similar to that of their biological parents than it is to the IQ's of others reared in their new environment.

Correlations between childrens' IQ's and aspects of their adoptive environment, and mean differences in ability between groups of genotypically similar individuals raised in different environments both estimate the effect of environment on ability. The two methods, however, measure different aspects of the environment's overall effect, and can be expected to vary with both the strength of environmental effects and the mean difference in environment between the biological and adoptive homes. Weak environmental effects might produce large mean differences if the biological and adoptive homes are sufficiently different. Seemingly strong environmental effects are of little importance in the explanation of group differences if there is little variation in environmental quality between groups.

If heritability is incorrectly assumed to be a fixed property of intelligence, explanations must be constructed to explain the wide differences among estimates. These usually involve the notion that environment accounts for group differences in IQ, while genes account for individual differences. Munsinger (1975) writes:

> The conservative empirical conclusion to be drawn from these confusing data is that mainly genetic factors influence the rank orders of children's IQ scores while environmental differences may shift the average group IQ without significantly affecting the individual children's rankings. This empirical conclusion is difficult to understand, because one might reasonably expect that an adopted child placed in a very superior adopting home would gain more in IQ than an adopted child placed in an average or poor environment (p.242).

Scarr and Weinberg (1978), after finding very small correlations between IQ's of adopted children and aspects of their adoptive environment, state:

> Even if differences in several demographic measures of family environments do not contribute much to differences in offspring's IQ scores, however, one must not conclude that the levels of environments in general make no difference for the development of intelligence. Obviously, the average

performance level of the adopted children depends on the average value of their environments.

It is implausible, however, to suggest that the forces shaping the IQ's of groups are different from those shaping individuals; neither environmental nor genetic factors can affect anything but people, one at a time (Werner, Lane and Mohanty, 1981). If environment is correlated with IQ within groups, and the groups differ on the same environmental measures, the environmental differences must translate to predictable group differences in IQ. If they do not, then some other variables must be influencing the analysis. One possible explanation is that non-linearity results in a greater effect for poor environments than for good ones. Another possibility is that there is greater variability for environment between groups than within them.

Genetic "rank orders" cannot be preserved in the presence of substantial environmental effects and environmental variability. The genetic rank order of adopted children appears to be preserved in adoptive homes <u>only</u> because children reared in biological homes are not included in the analysis. If children from both adoptive and biological environments were included in the correlational analysis, the mean difference would necessarily translate to a statistically equivalent correlation.

CHAPTER 3: ENVIRONMENT AND INTELLIGENCE: AN OVERVIEW

The study of adopted children is one of many ways to investigate relationships between environment and ability. This chapter provides an overview of some other methods and summarizes conclusions that bear directly on the present study.

Prematurity and Low Birth weight in Humans

Not all environmental effects are socio-cultural. Some important environmental differences among children are manifest in biological processes such as prematurity and low birthweight. These conditions are particularly important because they allow us to predict low intelligence independently of socio-cultural factors. While adverse birth conditions are more frequent among lower than upper classes (Birch and Gussow, 1970), one can nonetheless obtain a sample of premature, low birth weight children born into upper class homes. In contrast, it is next to impossible to find mothers of low IQ and high SES. Biologically disadvantaged children allow us to study the effect of differing environment on children who are at risk for low IQ; several interesting findings accrue from this possibility.

Evidence suggests that low birthweight accentuates the effect of poor rearing environment on IQ. Drillien (1964) reported that low birth weight infants had significantly lower developmental quotients at four years than normal weight infants, and this effect was especially large in the lowest SES group. The difference in developmental quotient between the high and low birth weight infants for high, middle and low SES groups were 13, 30, and 32 points, respectively. Low SES infants of high birth weight were near normal at four years (95.3) while those with low birthweight were retarded (63.6). Illsley (1966) found a similar pattern. Among children of normal birthweight, there were only small differences in 2 year Cattell IQ among high, medium, and low SES groups, but children exposed to many birth complications showed a substantial SES effect; high SES children were near normal for intelligence, while the low and medium SES children had mean IQ's in the 70's. Werner, Bierman and French (1971) reported a very similar interaction between SES and perinatal complications in their sample of 670 Hawaiian children.

This interaction has also been demonstrated in infants with biological handicaps other than low birthweight. Willerman, Broman and Fiedler (1970) examined the relationship of Bayley Scale scores at 8 months of age to Stanford Binet scores at four years. Among children scoring in the lowest quartile of the Bayley at eight months, low SES children were seven times more likely than high SES children to be moderately retarded at four years. Likewise, Holden and Willerman (1972) showed that neurologically impaired infants were far more likely to be retarded at four years if reared in a low SES family.

A very interesting study of this phenomenon has recently been published by Wilson (1985). Wilson reports on the mental development of pairs of twins, one or both of which have low birthweight. He finds that birthweight is significantly related to measures of infant development, but not to IQ measures at age 6. SES and maternal education are not related to the infant scales, but are related to 6 year IQ. A highly significant interaction was demonstrated between low birthweight on the one hand and maternal IQ and SES on the other. Both low and high SES low birthweight infants showed substantial deficits on infant development scales. By the age of six, high SES children had the same IQ as the full twin sample, but low SES children were a standard deviation below.

These findings suggest that environmental enrichment programs might be particularly successful with low SES children at high biological risk for low intelligence. Two studies have examined this possibility. Williams and Scarr (1971) divided low birthweight, low SES children into three groups: one receiving toys and tutoring on a regular basis, one receiving only toys, and a control with neither. Children divided into those with marked, mild, or no neurological impairment were administered the Preschool Attainment Record before and after the initiation of treatment. Among the neurologically intact, all three groups showed about the same level of improvement. Among the neurologically impaired, however, only the tutored group showed any improvement. The study also observed an interaction between SES and biological impairment; although exact figures are not reported, they state, "The poorest environments were most harmful to the most neurologically vulnerable children."

A similar study was reported by Scarr-Salapatek and Williams (1973), who provided extra stimulation to 15 of 30 low birthweight children in the nursery and with subsequent home visits. Controls were given standard post-natal care in the hospital clinic and at home during the first year. Although the control group had performed slightly better than the experimental group on the Brazleton Infant Development Scale at one week of age, at the end of the first year the experimental group had a mean Cattell score of 95.3, compared to the control group mean of 85.7.

Early Environmental Deprivation in Humans

There is little doubt that environmental deprivation, if sufficiently severe, can produce deficits in intellectual performance. At the most extreme, one can turn to studies of children reared in near total isolation, under conditions that approximate those to which laboratory animals are subjected. Koluchova (1976), for example, reported on a pair of identical twins who

> grew up in almost total isolation, separated from the outside world; they were never allowed out of the house or into the main living rooms in the flat....They lived in a small, unheated closet, and were often locked up for long periods in the cellar. They slept on the floor on a polythene sheet and were cruelly chastised. They used to sit at a small table in an otherwise empty room, with a few building bricks which were their only toys. (p. 47)

The twins, rescued from the family at age seven, displayed extreme fear when confronted by ordinary objects and could hardly walk. They had little spontaneous speech and could not answer questions. Their IQ could not be determined, but Koluchova estimated their functioning to be at about the three year level.

Environmental malleability of behavior is observable not only in the initial destruction of the twins' cognitive performance, but also in their recovery of function once environmental circumstances improved. Within one year of residence in a pre-school, and subsequently in a foster home, the twins' IQ's on the WISC were 80 and 69; three years later, at age 11, their IQ's were 95 and 93; by age 14, both twins' IQ's had levelled off at around 100.

Malnourishment and Cognitive Development

Severely malnourished children show cognitive deficits in all areas (Birch, 1972). The typical study in this area demonstrates cognitive deficits in malnourished children in an impoverished country, relative to better nourished siblings or matched controls (Yaktin and McClaren, 1970, and McClaren, Yaktin, Kanawati, Sabbagh and Kadi, 1973, in Lebanon; Hertzig, Birch, Richardson and Tizard, 1972, and Richardson, Birch and Hertzig, 1973, in Jamaica; Galler, Ramsey, Solimano, Lowell and Mason, 1983, in Barbados).

Several studies suggest that the effects of malnutrition can be modified or reversed by supportive environments. McKay, Sinisterra, McKay, Gomez and Lloreda (1978) reported the results of a carefully designed program for modifying the effects of malnourishment in Columbian children using nutritional supplements, family support, and educational programs. Treated children showed significant gains in cognitive ability relative to randomly assigned untreated controls, and amount of improvement was positively related to amount of time in the program. Follow-up data, however, were not reported.

Winick and his colleagues (Winick, Meyer and Harris, 1975; Lien, Meyer and Winick, 1977) studied Korean children adopted by American families. The children were classified as malnourished, moderately malnourished or well nourished on the basis of height and weight at the time of adoption. At follow-up in the first through eighth grade, the children were above the Korean median for height and weight, and had above average WISC scores for Americans. Degree of malnutrition was moderately related to IQ: the severely malnourished group had an IQ of 102, and the adequately nourished group 112. A group of similar children who were adopted later in life (after two years of age) showed similar results. The severely malnourished group had a mean IQ of 95, and the adequately nourished group 105. Age at adoption had a significant negative effect on IQ.

Children Raised in Institutions

Another type of deprivation results from residence in poor institutions. A large number of studies shows that prolonged exposure to undifferentiated institutional environments can produce severe intellectual deficits, and that sustained removal from the inadequate environment can remediate the deficits to a great extent.

The seminal work in this area is contained in a famous monograph by Bowlby (1951), in which he reviewed research by Spitz (Spitz, 1945; Spitz, 1946) to the effect that disturbances in the mother-child relationship during infancy, for instance those engendered by short-term hospitalization or long-term institutionalization, produce persistent-- indeed permanent-- deficits in the later development of the children.

Bowlby's conclusions and the studies on which he based them have been criticized many times (Clarke and Clarke, 1976; Rutter, 1972; Morgan, 1975). Their thrust is not so much about Bowlby's conclusion of the debilitating effects of severe deprivation, but rather at his assertions about their inevitability and permanence. Two reasons may be cited for the extremity of Bowlby's conclusions. First, Bowlby was a psychoanalyst working from an essentially clinical perspective. A reading of the 1952 monograph makes clear that his primary impression was that a high proportion of disturbed adolescents came from homes with disturbed maternal relationships. From this, he was led to the conclusion that a high proportion of children from poor maternal environments become severely disturbed as adults. Secondly, most of the children in the studies Bowlby reviews lived in poor environments throughout childhood. Their later disturbed behavior, therefore, could as easily have arisen through later as earlier environmental disadvantage (Clarke and Clarke, 1976).

An enormous literature attests to the impermanence of the effects of early deprivation. Much of this research arises from the child welfare literature concerned with showing that adoption and fostering can be successful in rescuing children from poor early environments.

Skeels' (1966) report of an environmental manipulation in an orphanage is the classic study in this area, although its methodological basis is weak and its conclusions hotly disputed. Skeels' study concerns the development of 13 two year olds moved from a sub-standard orphanage to an institution for the mentally retarded in which they were showered with attention and care. They were compared to a "contrast" group of children remaining at the orphanage. At the time of the move from the orphanage, the experimental and contrast groups had mean IQ's of 64.3 and 86.7, respectively. Eighteen months later, at a mean age of 33.4 months, the experimental group's mean IQ had increased to 91.8, while the contrast children's IQ had decreased to 60.5. A follow-up in adulthood found the experimental children to be leading productive lives, while the contrast group remained for the most part institutionalized.

Longstreth (1981) vigorously attacked the methodology and conclusions of Skeels' study. His critique of the contrast group is compelling. The decrease in the contrast group's IQ was known to exist before the study began, and the initial IQ of the group was probably overestimated to a considerable extent. Longstreth's dismissal of the corresponding increase in the IQ of the experimental group hinges on the "meaninglessness" of IQ scores at 16.5 months, the lack of a significant correlation between these scores and those taken later, and the absence of significant correlations between the length of time out of the orphanage and the amount of increase in IQ. The two correlations he refers to are positive, however ($r = .30$ and .36, respectively). A reasonable conclusion, it seems, would be in line with Fleishman and Bartlett (1969), whom Longstreth quotes approvingly: "The simplest explanation is that these children may have had normal intelligence which was temporarily depressed by extreme cultural deprivation."

Many other studies suggest that unstimulating institutions limit children's cognitive development, and that subsequent improvement in environment leads to substantial recovery. Dennis (1976) reported on the development of children raised until the age of six in an extremely poor orphanage in Lebanon. The children were swaddled, with arms and legs bound. The cribs in which they remained until four months were covered with a white sheet that prevented a view of the environment. They had only rare opportunities to interact with adults. Children remaining in the institution until the age of six had a mean IQ of about 50 at that time. Once adopted away from the institution, however, mean IQ increased to 100 within a single year.

Adoption from Poor Family Environment

Perhaps the least debilitating form of early deprivation is that experienced by children with disturbed parents, or, with still less deprivation, parents with low educational levels and socioeconomic status. It is well-known that family socioeconomic status is positively correlated with IQ. This correlation is confounded with genetic factors, as are all correlations between biological families and children's IQ's. We will focus here on studies of children fostered or adopted out of poor homes. These are adoption studies in which the IQ's of biological and adoptive parents were not measured.

One of the earliest of these studies was conducted by Theis (1924). She followed up 910 New York State children fostered or adopted between birth and 10 years. Three hundred of these children were originally from homes characterized as predominantly bad, typified by the existence in one or both parents of inferior mental ability, health, character, or conduct. Despite their disadvantaged early environments, 77% were judged to be functioning normally in young adulthood. Early placement in the foster home was found to be significantly related to good outcome.

Roe and Burks (1945) reported on the development of children adopted from homes of psychotic or alcoholic parents before the age of five. The children, who had been subjected to "unfortunate environmental influences" throughout their earliest years, were compared to adoptees of normal biological parentage. Very few problems were observed in any of the adopted children, and there were no significant differences in adjustment between the children of normal and disturbed parents.

Kadushin (1970) studied 91 adopted children, of whom 52% came from backgrounds described as "culturally deprived." All children had become available for adoption because of evidence of abuse. Nonetheless, the children responded well to their adoptive homes, and the parents were on the average satisfied with the results of the adoption. There was no evidence of permanent disability resulting from early life experience.

Variation in Normal Family Environment

As was discussed in the previous chapter, some investigators have attempted to study the relationship between environment and intelligence by correlating children's IQ with aspects of environment in nonadoptive families. It is not possible to estimate the independent environmental contribution to variance in intelligence without consideration of genetics via parental IQ. Other more limited questions may be answered, such as the age at which correlations between children's IQ and the environment first appear, or the aspects of intelligence that are most sensitive to environmental influence.

A typical study of this type is reported by Moore (1968), a report on the development of 134 Black London schoolchildren administered the Stanford Binet at three, five, and eight years of age. Very small correlations were found between social class and intelligence at three years, increasing to .44 at five years, and leveling out at .39 by eight years. Moore concludes that social class "affects" IQ, although "is correlated with" would reflect more accurately the non-experimental design of the research. Moreover, the mothers' vocabulary scores show the same pattern of relationship to child IQ as social class: .39 at three years, increasing to .62 at five, and decreasing to .49 at age eight. Mothers' vocabulary scores were significantly correlated with the environmental variables as well.

The most sustained research program in this area is that of Caldwell and her colleagues. This work employs the Home Observation for Measurement of the Environment (HOME), which comprises six factor analytically developed subscales that assess "the quality of the stimulation found in the home environment" (Bradley and Caldwell, 1977). Elardo, Bradley and Caldwell (1975) reached the usual conclusion that environmental measures were related to three year IQ but not to infant development scales. Another study (Bradley and Caldwell, 1976) attempted to circumvent the lack of genetic information by showing that the HOME subscales could differentiate children increasing in IQ from infancy to three years from those who lose IQ points. They also attempted to show that the six HOME scales could together account for more variance in IQ than demographic variables such as the parents' occupation and income. Although the

R's they report for the HOME inventory are indeed higher than those for the demographic variables, they do not take into account that there are six HOME scales, and only four demographic variables. The R's they report are not corrected for the number of variables, and given the rather small values on which they base their conclusions (the independent contribution of the six HOME scales was only .209) their results are less than compelling. As always in this type of research, uncontrolled genetic variation is an alternative explanation of the findings.

Longstreth et al. (1981) performed a study similar to those of Caldwell and her colleagues, but included maternal IQ in the analysis. Not surprisingly, they found that both maternal IQ and the HOME scales were correlated with IQ's of children, and with each other. They then performed a series of multiple regressions demonstrating that maternal IQ accounted for more independent variance in children's IQ than the HOME scales. Although Longstreth's et al. analysis relies on unreliable differences among beta weights in regression equations, their conclusion that relations between SES and intelligence have little meaning unless genetic variables are controlled remains accurate.

Recent family studies have used more powerful statistical techniques to achieve some separation of genetic and environmental variables. Mercy and Steelman (1982) solved a path model of IQ development for more than 7,000 American schoolchildren and found that the effects of parent's education on their children's IQ were divided fairly evenly between those operating directly (genetically) and those mediated by environmental variables such as SES. Yeates, MacPhee, Campbell and Ramey (1983) developed a similar path model with the addition of mother's intelligence for children in 122 families tested at 24, 36 and 48 months. Maternal IQ had an independent effect on child IQ at all three ages. Home environment had no independent effect at 24 months, a small effect at 36 months, and a greater effect than maternal IQ at 48 months. Johnson and Nagoshi (1985) used multiple regression to assess the independent effects of parent status and parent ability on child ability in about 1000 families in the Hawaii Family Study of Cognition. Both were found to have significant effects, though the independent effects of parent ability were consistently greater.

Identical Twins Reared Apart

The study of identical twins reared in separate environments is one of the classic methodologies in research on the role of genes and environment in the development of intelligence. Detailed reports of five studies of separated twins have appeared in the literature. One of these, that of Burt, has been discredited and will not be considered.

Newman, Freeman and Holzinger (1937) studied 19 pairs of identical twins separated for most of their childhood. All but one of the pairs had been separated before age 4; the median length of separation was about 25 years, though some pairs had had occasional contact while separated. Five judges rated written accounts of the pairs' development for the between-twin difference in educational, social and physical environments on a scale of one to ten. The difference between their Binet IQ's correlated 0.79 with the rating of education difference, 0.51 with social difference, and 0.30 with health difference. The high correlations between educational differences and IQ differences are difficult to interpret because of uncertainty about the direction of causality. The correlation between differences in social environment and IQ differences is a more appropriate measure of environmental effects. Substantial genetic influence is suggested by the correlation of 0.67 for the IQ's of separated twins.

Shields (1962) administered the non-verbal Dominoes Test and the Mill-Hill vocabulary test to 44 pairs of monozygous twins reared apart and the same number reared together. The combined test scores were as highly correlated for separated twins ($r = .77$) as for those reared together ($r = .76$), suggesting substantial genetic influence. Thirty of the separated pairs were raised by different members of the same family, so there was substantial selective placement. There was only a slight trend for twins raised in more similar environments to be more similar for IQ.

Juel-Nielsen (1965) studied 12 pairs of Danish twins. Nine had been separated during the first year, but others were not separated until age six. The correlation between twins for Wechsler Full Scale IQ was .62, with a 90% confidence interval of .18 - .85.

Lykken (1982) reports preliminary results from a group of 29 separated monozygotic twins. Intraclass correlations for several IQ tests range from .58 to .71.

Conclusion

From the above, we can reach the unsurprising conclusion that children reared in severely deprived, life threatening environments perform more poorly on IQ tests than children reared in normal environments. If the environment provides basic biological support, social and emotional deprivation must be very severe before substantial IQ deficits are observed.

These IQ deficits appear to be largely reversible. When deprived children are removed from an unsupportive environment and placed in a remedial one, their IQ shows rapid increase to near normal levels. The size of the increase appears to be proportional to the degree of the original impairment: severely deprived children show large IQ deficits and dramatic increases when their environment improves; less deprived children show small deficits, and their IQ is difficult to increase with environmental manipulation. This suggests that the relationship of environment to intelligence is not linear: IQ is readily retarded and promoted in the range of extremely poor environments, but relatively unresponsive to environmental change among even minimally supportive environments.

It can also be concluded that environmental effects are easier to observe as differences between children raised in poor environments and adequate ones than in correlations between intelligence and some measure of environmental quality. This is in part because the mean difference approach is more often applied to studies of children in very poor environments, while the correlational approach is often applied to variables like SES that describe environment mostly in the normal range. The correlational approach also leads to smaller environmental effects because the effects it studies are relatively specific. Mean differences in IQ between groups reared in vastly different environments capitalize on the entire range of environmental differences between the groups, while correlations of IQ with the HOME scales, for example, measure only the effects of the individual variables.

CHAPTER 4: ADOPTION STUDIES

Why Do Adoption Studies?

Most children are raised by their biological parents. Their rearing environment is therefore both highly similar to their genetic family background and highly correlated with it. These two kinds of likeness have different implications and do not necessarily go together. Similarity of family background and rearing environment means that children are usually raised in environments not radically different from those into which they were born. Correlation between family background and environment is independent of the mean level of either, and implies that parents with high IQ's tend to provide environments more conducive to the development of IQ in their children.

Similarity and correlation of family background and environment lead to distinct difficulties in the separation of their effects on the IQ's of children. Similarity between children's rearing environment and their family background means that, except for regression effects, the expectation of children's IQ's is the same as their parents. Siblings born and raised in the same family also have the same expectation for IQ. Correlation between family background and rearing environment presents a different problem. It is theoretically possible, even in biologically related families, to regress the IQ's of children on measures of their family background and rearing environment, and thus to obtain estimates of the independent effects of each. But the high correlation between family background and rearing environment in natural familes results in substantial multicollinearity, so estimates of independent effects are unstable.

The use of adoptees helps to separate the effects of family background and rearing environment to the extent that the rearing environment of adoptees is different than what would be expected on the basis of their biological parents, or is uncorrelated with the family background of their biological parents, or both. Most often, children are adopted from relatively poorer homes into middle class homes, providing a mean difference between the biological and adoptive rearing environments. The effects of this difference can then be studied in terms of mean differences in IQ between the adopted children and their parents or unadopted siblings. This mean difference is not a necessary consequence of adoption, however: if the children of a group of biological parents were randomly reassigned to different parents in the same group, rearing environment and family background would be uncorrelated, but there would be no difference in their mean.

Low correlations between family background and rearing environment are not a necessary consequence of adoption either. Although the earliest adoption studies seem to have been founded on the hope that the correlation between background and environment would be zero, it has since become clear that some degree of selective placement is almost inevitable. The difference between adopted and natural children in this regard is therefore one of degree: the correlation between background and environment is lower for adopted children, but it must nonetheless be accounted for statistically. The important consequence of studying adoptees is that regression estimates of the independent effects of family background and rearing environment are more stable when the correlation between them is low.

Munsinger (1975) discusses correlational and mean difference analyses in terms of the different methodological threats to their validity. Correlational analyses are threatened primarily by selective placement, whereas analyses of mean differences are threatened by systematic errors in the measurement of one of the groups. The distinction is not altogether clear: selective placement of genetically superior children in better environments vitiates an analysis of means as much as it does correlations, and systematic mismeasurement of children raised in poorer environments could produce a spurious correlation as easily as a group difference. The essential point is that an analysis of mean differences requires an independent estimate of children's genotype; correlational analyses require partitioning of genetic and environmental correlations. Both would be easy if genes and environment could be separated experimentally.

Freeman, Holzinger and Mitchell

Freeman, Holzinger and Mitchell (1928) and Burks (1928), published as successive reports in the same volume, set the tone for much of the adoption research that followed, in large part by disagreeing about their results. The Freeman et al. study included a diverse multiracial group of children, including 401 adopted children, 36 natural children of adoptive parents, 146 children awaiting placement, and 88 "miscellaneous" children. The children were studied in four groups. The first consisted of 134 children tested before placement and retested by Freeman et al. Of these, 74 had been in a single foster home during the interval between testings. The second group of 185 children consisted of pairs of siblings separated for at least 2 years. Of these, 159 had resided continuously in a single foster home. The third group, which overlapped with the second, included 34 foster children and 36 "own" children from the families into which the foster children were adopted. The final group of 401 adopted children were tested only after adoption.

Only the results from the first group can be interpreted unambiguously. For the 74 children in this group, Freeman et al. found a correlation of .52 between their second IQ score and an index of the environmental quality of their adoptive home. The first IQ score, taken before placement in the adoptive home, correlated .34 with the environmental quality of the adoptive home, demonstrating substantial selective placement. The correlation between the first and second tests was .68.

The children in this group had not been adopted until a mean age of eight years; they were retested after four years in their adoptive homes. Their mean IQ at the first test was 91.2 (13.4), and at the second it was 93.7 (14.0). This increase may be attributable to rearing in the improved environment. Freeman et. al suggest that the difference should be corrected for age, which was negatively correlated with IQ in this standardization of the Stanford-Binet. Doing so increases the differences between the testings to 7.5 IQ points.

The findings for the other groups in the study are difficult to interpret because the substantial selective placement demonstrated in the first group cannot be measured in groups which were not tested before placement. Freeman et al. went to some lengths to argue that selective placement should be less in these groups because there was no IQ test to base it on, but subsequent studies have shown substantial selective placement to be possible for untested children. The findings of these analyses will therefore only be discussed briefly.

For separated siblings sets, the ones placed in the better home had a mean IQ of 95.0, and the sibling in the worse home 85.7. Corrected for age, this difference is reduced to 6 IQ points. Natural children with adopted children in the same family had a mean IQ of 112.4 (13.9); their adopted siblings had a mean IQ of 95.1 (14.8).

The IQ's of both natural and adopted children correlated .47 with the environmental index of their homes and were correlated .34 with each other. The IQ's of the 401 children who were only tested in the adoptive homes correlated .48 with the environmental quality of the home.

Burks; Leahy

Burks (1928) used a different method than Freeman et al. She selected foster children more stringently, especially in limiting them to white children placed during the first year of life. The average age of placement was 3 months. Children and their foster parents from 174 families were tested with the Stanford Binet. These families were compared to a control group of 105 nonadoptive families who were matched to the adoptive families on the basis of age, sex, number of children in the family, type of neighborhood and occupation of the father. Correlations were obtained between child IQ, parent IQ, and various measures of home environment in the adoptive and control families.

The correlations, corrected for attenuation, were consistently higher for the control families (Table 4.1) The highest correlations in the control families were between parent and child IQ, with environment-IQ correlations slightly lower; in the adoptive families the parent-child IQ correlations were smaller than the environment-IQ

Table 4.1

Correlations with Child IQ in Foster and Control Families

	Burks		Leahy	
	Foster r (N)	Control r (N)	Foster r (N)	Control r (N)
Father's MA	.09 (178)	.55 (100)	.19 (178)	.51 (175)
Mother's MA	.23 (204)	.57 (105)	.24 (186)	.51 (191)
Father's Vocab	.14 (181)	.52 (101)	.26 (177)	.47 (168)
Mother's Vocab	.25 (202)	.48 (104)	.24 (185)	.49 (190)
Env. in Home	.24 (206)	.48 (104)	.23 (194)	.53 (194)
Culture in Home	.29 (186)	.49 (101)	.26 (194)	.51 (194)

correlations. Vocabulary scores showed nearly equal correlations in the two groups.

Leahy (1935) was a replication of Burks (1928), collecting 194 adopted children and 194 matched controls with the same selection criteria and testing children and parents with the Stanford Binet. The results were nearly identical (Table 4.1). She also found that a small sample (N = 25) of adopted and own children living together were uncorrelated for IQ or vocabulary.

Five Minor Studies

Several studies published during the late thirties and early forties were narrower in scope and less diligent in methodology. Schott (1937) reported on the IQ's of 74 children tested at a median age of 5.6 years when they were referred for adoptive placement through the courts, and at an average of 4.5 years later when referred for assessment of maladjustment. They were therefore selected for having problems in development. Nonetheless, the median IQ at the second testing increased to 99.3 from an initial median of 93.5, which Schott reports is not statistically significant when tested with the "critical ratio technique." A difference of 5.8 points between two <u>means</u> is significant with an N of 74 if the standard error of the difference is less than 25, which seems highly likely. In any case, 51 of the 74 children showed improvements in IQ, 8 were unchanged, and 15 decreased. The binomial probability of a 51/15 split under a null hypothesis of equal probability of improvement or decrease is less than .001 (z = 4.43).

Snygg (1938) reported biological parent-child correlations for 312 adoptees and their biological mothers. The children were adopted before the age of four into paid foster homes that Snygg describes as "quite homogenous." The biological mother's mean Stanford Binet IQ was 78.3 (10.8) and that of the adopted children was 95.17 (9.5). The correlation between mothers' and childrens' IQ's was only .13. It is difficult to explain why this finding, which no other study has come close to replicating, might have occurred.

Hildreth (1940) reported that the mean IQ of 54 adopted children in a private school was 103.3, while the mean IQ of the general school population was 120.3. This finding was taken as an indication that attending a good school does not increase IQ.

Speer (1940) studied 184 children from extremely deprived circumstances put up for adoption by the court system. He found a strong tendency for higher IQ's in children adopted earlier in life than later. Fifty-nine children retested after placement showed an average increase of 5.1 IQ points.

Layman (1942) tested 105 children before placement and at an unspecified time after placement. The children showed gains of from two to five points between testings, depending on the form of the Stanford Binet used. These differences are not statistically significant.

Skeels and Skodak

In a series of seven papers (Skeels, 1936; Skeels, 1938; Skodak, 1938; Skodak, 1939; Skodak and Skeels, 1945; Skodak and Skeels, 1949; Skodak, 1950), Skodak and Skeels reported on a longitudinal study of 139 children placed for adoption before the age of six months. Subjects were tested with the Kuhlman-Binet or Stanford Binet was administered at a mean age of two years; subsequent testings took place at four, seven, and thirteen years, by which time attrition had reduced the sample to 100.

According to Skodak and Skeels, the biological parents of these children were below average. The mean IQ of 63 tested mothers from the final sample of 100 was 85.7; the average educational level of 92 biological mothers was 9.8 grades, and for 59 fathers it was 10 grades; the average occupational level of 73 of the biological fathers was in the range of slightly skilled laborers. The adoptive parents were not tested for IQ but were substantially better educated than the biological parents.

Two basic and apparently contradictory results were reported. The childrens' mean IQ was 116.8 at two years, then slowly decreased to about 108 by age 13. The correlation between the children's IQ and that of their biological parents increased from .04 at the first testing to 0.31 at the final testing, while correlations of child IQ with adoptive parent education remained near zero throughout. Jensen (1973) showed that the increase in adopted children's IQ (from a theoretical expectation of 93.63) is consistent with a heritability as high as .8 if the environmental level of the adoptive homes was 1.7 SD's above the mean.

Skodak and Skeels' findings produced a wave of enthusiasm for the potency of environment followed by a strong critique concerning grave deficiencies in the study's methodology. McNemar (1940) demonstrated that the intelligence of the biological parents was almost certainly underestimated, in large part due to the incomplete testing of the sample. Munsinger (1975) added the criticism that inadequate controls for attrition were used, which seems to have favored the inclusion of the more intelligent children. One might add that an increase to an IQ of 116 at the age of two with continuing decreases thereafter does not fit any model of environmental action that has been proposed. Skodak's (1950) paper reports a correlation of .64 between the IQ's of 46 pairs of unrelated adopted children raised in the same home, but this analysis is also riddled with methodological flaws, most notably a pair of identical twins among the presumably unrelated adoptees (Loehlin, 1985).

Beckwith; Claeys

These two studies marked the return of the adoption methodology after a hiatus of thirty years. Beckwith (1971) studied 24 children who had been adopted within the first 10 days of life. She obtained a measure of SES for the biological and adoptive mothers and observed the adoptive mothers' interaction with the children at two sessions, about a month and a half apart. The children were administered the Cattell Infant Intelligence Scale and the Gesell Developmental Schedules at each of the sessions. Infants' performance on the tests was related to the biological but not to the adoptive mothers' SES. A few significant relationships were found between adoptive mothers' behavior and infant performance, but considering the large number of correlations computed, the low IQ validity of infant scales, and the questionable direction of effect between infant intelligence and maternal behavior, these relationships are probably uninterpretable.

Claeys (1973) reported on the IQ's of 84 children between age four and eight, of whom 76 were adopted before age one. A measure of SES was available for 26 of the biological fathers and all of the adoptive fathers. Children of the 26 tested biological fathers performed close to Belgian IQ norms for their biological fathers' SES. Correlations between the childrens' IQ and the SES of their adoptive parents were positive but small and mostly nonsignificant.

Munsinger

Munsinger (1975) reported on 21 white and 20 Mexican-American adopted children, and their biological and adoptive parents. An index of midparent SES in the biological parents correlated 0.67 with child IQ in the white sample, and .77 in the Mexican-American sample.

Adoptive parent SES was uncorrelated with child IQ in both samples. Irregularities in the determination of SES indices (Kamin, 1977) make these results impossible to interpret, however. Mean differences could not be computed because parental IQ was not measured.

Fisch et al.

Fisch, Bilek, Deinard and Chang (1976) described the development of 144 adopted children and a sample of matched controls born in a Minneapolis hospital and followed by the National Collaborative Perinatal Project (NCPP). The control group was matched on the basis of gestational age, birth weight, sex, and SES of the mother prior to the birth of the child. The adoptees were divided into 94 children adopted by nonrelatives and 50 remaining with their biological mother but later adopted by stepfathers. The children were tested with a variety of intellectual, developmental, and neurological tests at 8 months, four years, and seven years. Maternal IQ was measured when the child was four.

Adoptive mothers' IQ was uncorrelated with child's IQ at four and seven years. Biological mothers' IQ correlated .35 with child's IQ at four, and .26 at seven. Mean differences between adoptive and control children were only reported for those variables for which significant differences were found. Children adopted by nonrelatives showed no significant increase in IQ over controls, but did do better on an achievement test, and showed somewhat greater physical development for height and weight. They were also less likely to have repeated a grade in school.

Scarr and Weinberg

Scarr and Weinberg conducted two separate adoption studies (Scarr and Weinberg, 1976; Scarr and Weinberg, 1977; Scarr and Weinberg, 1978).

The first study included 176 children adopted into 101 white middle-class homes. Of the 176 children, 130 were socially identified as black, 25 as white, and 21 as Asian or Indian. Most of the socially identified black children (N = 68) had one white and one black biological parent. IQ scores of the adoptive children were above average, in the range of 100 to 110 for different tests. IQ's of the adoptive parents and their natural children were somewhat higher, between 110 and 120. The above average IQ of the adopted children can be interpreted as an environmental effect, but its magnitude is difficult to assess because the IQ's of biological parents were not measured. Children with two black biological parents scored significantly lower (96.8, SD = 12.8) than those with only one black parent 109.0, SD = 12.5). There were additional environmental differences between these groups, however.

Correlations among family members showed two distinct patterns. Midparent IQ correlated 0.49 with IQ of natural children and .26 with adopted children for families with both natural and adopted children. Correlations between siblings, however, were as high for pairs of adopted children (r = .49) as for pairs of related siblings (r = .37). Scarr and Weinberg suggest that this contradiction may occur because siblings share a common rearing environment that is not shared with parents, and because parents may make special efforts in rearing adopted children. As was suggested above, sibling correlations may sum many aspects of the environment shared by siblings, while parent-child correlations only reflect the effects of that part of a child's environment that is influenced by parental IQ.

Scarr and Weinberg's (1978) second study included 104 white adoptive and 120 nonadoptive families. Adoptive children were placed in the families before 12 months. Adopted children were tested at a mean of 18.5 years. Adoptive parent-child IQ correlations were near zero; with natural children the correlation was .40. Notably, the high correlations between unrelated siblings found in the earlier study were completely absent in the older children in the later study. Either the high correlations in the first study were an accident, or the importance of shared rearing environment decreases with age.

Schiff et al.

In two English language reports, Schiff and colleagues (Schiff et al., 1978; Schiff et al., 1982) describe the results of a study of 32 children abandoned at birth by their impoverished, unskilled parents, and later adopted into homes of upper middle class families. These children were compared to 20 biological siblings who remained with the mother. The children were between the ages of 6 and 15 when tested. IQ's of the biological and adoptive parents were not obtained. The mean WISC IQ of the adopted group was 110.6 (11.3) and the mean IQ of the nonadopted group was 94.5 (11.3). Over half of the nonadopted children were in special classes or had repeated a grade; only 13% of the adopted children had done so.

Schiff et al. did not report correlations between adopted children's IQ and the SES of their adoptive homes, though SES data were available and used in the selection of cases for the study. This omission makes it difficult to reject the possibility that selection of adoptees accounted for the results of the study. Schiff et al. discount this possibiltity because the children were adopted before six months of age, but the history of adoption studies shows that selection of this type is impossible to eliminate completely. There also exists a possibility of negative selection for the nonadopted half-sibling controls. Another difficulty with the control group is that it contained 39 children born to only 20 of the 32 biological mothers of the adopted group. Several biological mothers therefore made a disproportionate contribution to the control group. We are left, then, with the usual conclusion that adopted children seem to perform better than nonadopted controls on childhood IQ tests, along with the usual confusion about what the origin of the advantage might be.

Teasdale

Teasdale (1979) describes a very large study of adoptees and their biological and adoptive parents. About 14,000 adoptees were included in the study, although complete data were not available for all of them. Both biological and adoptive parent SES were moderately and about equally correlated with adopted child SES ($r = .184$ and $r = .208$, respectively), suggesting either moderate genetic and cultural transmission of SES, substantial selective placement, or both.

The Texas Adoption Project

This large-scale adoption study (Horn, Loehlin and Willerman, 1979; Horn, Loehlin and Willerman, 1982; Horn, 1983), has examined the development of 300 adoptive families, including 469 adopted and 164 biological children. Revised Beta Examination IQ's had been obtained for 396 of the adopted children's biological mothers during pregnancy. Wechsler IQ's were obtained for adoptive parents and adopted and biological children at the time of the study; Beta IQ's were also obtained for the parents.

IQ correlations between parents and their biological children ranged from .21 to .33. Correlations between parents and adopted children were between .10 and 0.20. The mean IQ of the adoptive and biological mothers were 112.4 and 108.4, respectively. The mean IQ of the adopted children was 111.5, and for the biological children it was 111.7.

The observation that the mean IQ of adoptees in this study is closer to the mean of their adoptive than biological parents, while biological parent-child IQ correlations are higher than adoptive parent-child correlations, led Walker and Emory (1985) to conclude that the results supported an environmental hypothesis as well as a genetic one. In fact, the results are not as discrepant as Walker and Emory or Horn (1985, in a rebuttal) seem to believe. As was discussed above, the mean difference in IQ between adopted children and their biological parents depends not only on the amount of environmental determination of IQ, but also on the amount of difference between the environments in which biological parents and their adopted children were raised. This difference is usually unknown, as it is in this study, because no information is available about the rearing environment of the biological mothers. Using a highly simplified model, however, we can estimate that to produce an IQ difference of about a third of an SD between biological mothers and children with a standardized regression coefficient of .15, the difference between their environments must be about 2 (.3/.15) SD's, not an unreasonable figure.

The Colorado Adoption Project

The most recent adoption study, still in its early stages, is being conducted by Plomin and colleagues (DeFries, Plomin, Vandenberg and Kuse, 1981; Fulker and DeFries, 1983; Plomin and DeFries, 1983). The sample, which is not yet complete, includes over 200 families. So far, IQ data are available for biological and adoptive parents, with developmental quotients for children at one and two years of age. The HOME scale developed by Caldwell and Bradley, discussed in Chapter 3, is being used as a measure of the home environment. Preliminary results show correlations greater than .40 between biological fathers' intelligence and infants' developmental quotients and correlations between .15 and .20 between adoptive parents and infants. Correlations between HOME indices and adopted infants' development are also around .20. Path analyses have shown independent effects for both genes and environment.

Conclusion

The adoption studies reviewed are generally consistent in their findings. The following conclusions seem warranted.

1. IQ's of parents and natural children are positively correlated whether or not the children are reared by their parents. This correlation is generally lower in recent studies (Loehlin, 1980), but has never been much lower than .3, with the exception of Snygg (1938). The magnitude of this correlation, as has been emphasized throughout, may depend on the range of environments in which the

children are raised. In all studies addressing this issue, children were raised in natural or adoptive homes that were relatively homogenous in environmental quality.

2. Correlations between children's IQ and adoptive parents' IQ or other aspects of the adoptive environment are lower, generally around .20. Again, this correlation describes the relationship between environment and IQ in the range of environments generally found in adoptive homes.

3. When children are adopted from very poor environments into middle class homes, IQ's show a reliable increment compared to estimates of what they would have been had the adoption not taken place. Schiff et al. is particularly important in this regard as a replication of Skodak and Skeels' provocative but flawed research. Scarr and Weinberg (1976) provide another, somehat indirect, replication. It is important to emphasize, with Jensen (1973), that a large increase in IQ following a radical environmental change is <u>not</u> evidence for zero heritability. Large environmental effects do not preclude genetic effects any more than demonstrable genetic effects preclude successful environmental manipulation. The relative potency of genes and environment depends on the range of the other in the sample studied.

Why Do Another Adoption Study?

It cannot be said that adoption studies have resolved the issue they set out to analyze, i.e., the relative contributions of nature and nurture to intelligence. In that case, why do another one? Aside from the contention that adopted children are interesting enough to warrant study whenever a good sample is available, several reasons can be cited.

Much of the ambiguity in the results of adoption studies is methodological in nature, and may be clarified by more sophisticated statistical analyses. Structural equation modelling has led to improved understanding of both the results and limitations of adoption studies but has only been applied to the two or three most recently conducted. It has been argued here that some apparently contradictory findings in the literature, most notably that between mean difference and correlational studies, are essentially methodological and in need of resolution.

Many kinds of adopted children have not been extensively studied, especially those adopted into less than ideal environments. Only the Freeman, Holzinger and Mitchell (1928) study has examined nonwhite children adopted into nonwhite homes. No studies have examined children adopted or fostered into homes of relatively poor environmental quality. The present study will address this issue.

The roles of congenital biological impairment and biological environmental disadvantage, while extensively studied independently, have not been considered in the context of adoption effects. In the present study, it will be seen that biological considerations, whether genetic or not, are important in and of themselves, acting as moderators of both genetic and environmental effects.

CHAPTER 5: METHOD

This study uses data collected by The Collaborative Study on Cerebral Palsy, Mental Retardation and Other Neurological and Sensory Disorders of Infancy and Childhood, a.k.a. the National Collaborative Perinatal Project (NCPP), to investigate the relationships among heredity, environment and the development of adopted and nonadopted children. The NCPP studied 53,000 children of 44,000 mothers from the time of the mothers' registration during pregnancy until the children were eight years old. Twelve hospitals from across the U.S. participated in the study. Extensive data are available on perinatal environmental conditions, medical complications during pregnancy, and physical and mental development of the child. Among other data to be discussed below, developmental quotients were obtained in infancy and IQ's at four and seven years.

The NCPP was not intended to produce a representative sample of mothers or their children (Broman, Nichols and Kennedy, 1975). Instead, the intent was to sample as wide a range of pregnancy conditions as possible. Patients were randomly selected within each hospital. The selection ratio in each hospital was based on the total number of patients seen there. Most of the hospitals served primarily poor patients in urban settings, as reflected in the final sample: all subjects were from urban areas, 64% from the northeast. Forty-five percent of the mothers were white, 47% black and 7% Puerto

Rican (Broman, Nichols and Kennedy, 1975). More detailed demographic information about the population will be presented in the next chapter.

The purpose of this study is to assess the effects of adoption on the cognitive functioning of the NCPP children. Two issues discussed in previous chapters motivate our choice of method. First, to assess the relationship between environment and intelligence, there must be some way of identifying environmental variance that is independent of genetic differences among the children. This is accomplished (in the relative absence of selective placement) by the use of adopted children. Second, in order to measure improvements in IQ resulting from adoption into better environments, we need some estimate of what the children's IQ would have been if they had not been adopted.

To meet these methodological requirements, adopted children in the NCPP will be compared to two matched comparison groups composed of intact biological families from the same study. One, matched to characteristics of the adopted children's biological families, will provide an estimate of how the adopted children would have developed had they remained in their original home. The second, matched to characteristics of the adoptive family, will provide an estimate of how the adopted children would have developed if they had shared the genes as well as the environments of the adoptive families. The comparison groups thus provide a partial solution to the problem of estimating how adopted children would have developed without adoption.

In addition, they will serve the more traditional role of "comparison" groups in the studies of Burks (1928) and Leahy (1935). That is, they will model the development of intelligence in natural families in which family background and environment are confounded. By comparing the relationships among family background, environment and IQ in these intact families and in the adoptive ones, improved estimates of independent effects of family background and environment can be obtained even if genes and environment remain to some degree correlated (due to selective placement) in the adoptees.

Selection of Cases

The NCPP database was searched for children listed as having been fostered or adopted by nonrelatives at the time of their seven year psychological exam. This search identified 722 adopted or fostered children, who will be referred to as the **index** group. The following information was obtained for each adopted and fostered child:

1. Institution of birth. The NCPP includes children born in 12 hospitals, which will be listed below.

2. Age of biological mother at registration.

3. Race of child. Children were coded as white, Negro (called black here), Oriental (called Asian here), Puerto Rican, and other.

4. Biological mother's education at registration and adoptive mother's education at the time of the child's 7-year exam.

5. Mother's socioeconomic index (SEI) at registration and at the 7-year exam. The NCPP used an SEI described by Myrianthopoulos and French (1968). The index combines parental education, family income, and parental occupation into a single index.

6. Mother's marital status (MS) at the 7-year exam.

The NCPP database was searched again to identify two matched control groups. The first, referred to as **biological matches**, was matched to characteristics of the index child and his or her biological parents, according to institution (hospital), race, sex, education of mother at time of registration (± 1 year), SEI of mother at time of registration (± 10 points), and age of mother at time of registration (± 2 years).

The second control group, called **adoptive** (connoting adoptive or foster) **matches**, was matched to characteristics of the index child and his or her adoptive parents, according to institution, race, sex, education of mother at time of 7-year exam (± 1 year), SEI at time of

7-year exam, marital status of mother at time of 7-year exam, and age of biological mother at time of registration.

The matching was accomplished by starting with the first non-index case in the sample, and then examining each index case to see if the non-index case matched it. Index cases were removed as they were matched. If a non-index case did not match any of the index cases, it was discarded and the next non-index case was considered. This was continued until all of the non-index cases had been examined. The file of cases was ordered chronologically by mothers' registration within each institution. Each index case finding a match, therefore, was matched to the matching case closest to the beginning of the file of non-index cases. The search resulted in biological matches for 689 of the index cases, and adoptive matches for 635. Biological and adoptive matches were found for 577 index cases.

A limitation of the available data is that time of adoption is known for only a portion of the matched index cases. NCPP records included the total number of changes in environment for each child and the earliest date of the most recent environment. Time of adoption can therefore be computed for children experiencing only one change in environment, i.e., children placed in an adoptive or foster home and remaining there. Of the index cases with a biological match, 426 (61.8%) had only one environmental change. Of the index cases with an adoptive match, 425 (66.9%) had only one change. Of these subjects, 338 found both a biological and an adoptive match. These last children and their corresponding matches will be the focus of the analysis.

Table 5.1 lists data obtained from the NCPP database for each index child and matching child. Cognitive or developmental data are available at eight months, four years and seven years; environmental data are available at birth and seven years. Cognitive data include developmental indices (Bayley Scales, Bender Gestalt) several intellectual measures (Binet, WISC) and achievement measures (grade in school, WRAT). Summary neurological data are available at one year. Behavior profiles are available at eight months, four years and seven years. These comprise clinicians' impressions of the child's behavior, including aggressiveness, restlessness and attentiveness.

Analysis

The analysis involves three groups, one consisting of adopted and fostered children and their families, the other two consisting of children and their biological families. Family environmental data describe the children's families at birth and seven years. Family background of the children is measured by the educational levels of their biological parents. Family background and rearing environment are expected to be correlated in all three groups. This correlation should be smaller for the adopted and fostered children, in whom it arises only because of selective placement. In the natural families, the correlation is expected to be substantial. Differences in family

Table 5.1

Non-matching Variables Obtained for Analysis

<u>Child at Birth</u>

Weight
Gestation

<u>Mother at Registration</u>

Marital Status
Race
Intelligence (SRA)
Father's Education

<u>Child at 8 Months</u>

Bayley Mental and Motor
Infant Behavior Profile
Child Behavior Profile

<u>Mother at 8 Months</u>

Maternal Behavior Profile

<u>Child at One Year</u>

Neurological Examination

<u>Child at Age Four</u>

Fine and Gross Motor Exam
Graham Kendall Block Test
Stanford Binet Intelligence
Behavior Profile

<u>7 Year Environmental</u>

Where Child Lives
# of Rooms in House
# of Persons in House
Mother's Occupation
Father's Occupation
Family Income
Father's Education
Kids<8 in House

<u>7 Year Cognitive</u>

Bender Gestalt
WISC
Audio Visual Exam
Goodenough Test
Grade in School
Grade Repeated?
WRAT
Behavior Profile

<u>8 Years</u>

Speech Hearing Exam
Reading Ability
Observed Aberrations
Type of School
Grade in School
Grade Repeated?
Special School?

background between the index cases and the biological matches have been minimized by matching. Seven year environmental differences between the index cases and the adoptive matches have been similarly controlled.

As has been discussed in previous chapters, two basic questions may be asked about the cognitive development of these children. First, what family background and environmental variables facilitate or retard the development of intellect? Second, to the extent that groups of children differ for variables known to affect IQ, are these differences manifested in IQ differences among the groups? Answers to these two questions must be considered together. If groups of children do not show IQ differences that would be expected on the basis of family differences and demonstrated relationships between the family variables and IQ, then some other differences between the groups also must be influencing IQ. Conversely, if differences in IQ can be demonstrated among groups, yet no family variables for which the groups differ can be shown to covary with IQ, then other differences among the groups must be accounting for the IQ differences.

Simultaneous analysis of between group differences and within group relationships between the dependent variable and other continuously measured variables is known as analysis of covariance (ANCOVA). Essentially, this is the analytic method to be employed here. For several reasons, however, a structural equation model of between and within group differences will be used instead of a traditional analysis of variance format.

One reason for preferring the structural equations approach is that the required statistical assumptions are less stringent and, therefore, more suited to the distinctly nonexperimental data at hand. Although significance tests employed by both methods assume joint multivariate normality, which certainly does not obtain in these data, analysis of variance also assumes homogeneity of variance and covariance among the dependent variable and covariates across groups. There is no reason to expect these variances and covariances to be equal across groups in this study, and in fact differences among them are sometimes an essential feature of the data. For example, we expect the covariance of birth and seven year environments in the matched control groups to be greater than in the index cases. No assumptions of this type are required for a maximum likelihood structural equations approach.

Another reason for not employing the traditional analysis of variance format is that the purpose of this analysis is somewhat different from that of the usual ANCOVA. In most applications of ANCOVA, the intent is analysis of group differences controlling for the effect of the covariates, which are extraneous to the effect of interest. In this study, the relationship between the covariates (family background and rearing environment) and the dependent variable is a primary focus of the study. If no significant group differences are found after the effects of the covariates have been controlled, it will indicate not that adoption and fostering had no effect, but rather that the effect of adoption or fostering was explainable in terms of differences in family variables that were related to cognitive development. The structural equation approach provides more flexibility in the analysis of group differences in terms of (as opposed to controlling for) within group relationships with other variables.

The analytic method to be employed here involves expressing the results of a cognitive measure as a linear combination of family background and environmental variables.

$$IQ = a_1P_1+a_2P_2+...a_nP_n+I+U \qquad (1)$$

In Equation 1, the cognitive variable on the left side of the equation is expressed as a weighted sum of predictor variables (a_iP_i), plus an intercept (I) and error (U). For each cognitive measure, Equation 1 will be estimated within each of the three groups (Index cases and two matched control groups) with the constraint that the unstandardized regression coefficients (a_i) be the same in all groups.

Constraining unstandardized regression coefficients to be equal in adoptive and control groups was first proposed by Wright (1931). In a reanalysis of Burks' data (1928), Wright found that the structural equations describing the control group of natural families were underdetermined. Wright proposed that coefficients determined in the foster families be "borrowed" to help determine the foster family equations:

> In the present case, however, we have another resource. The control group of parents was carefully selected for

> comparability with the foster group. Presumably home environment has closely similar effects in the two cases. We should be able to borrow the environmental coefficient from the foster data. Theoretically, however, it is the concrete partial regression coefficient and not the [standardized] path coefficient that is directly transferable, the latter being affected by the correlation between heredity and environment in the control data.

This design has several consequences. First, it uses the lower correlations among the predictor variables for the index cases as an aid in estimating their independent effects for both the index cases and the groups of natural families in which the predictors are highly correlated. Second, it includes in the regression analysis the full range of environments from both biological and adoptive homes. If adoptees' development is correlated only with the quality of the adoptive environments, information about the effect of their biological environment is omitted. Third, it has the effect of making the intercept terms in the three groups interpretable as the residual group means after the effects of the predictor variables have been accounted for. A test of whether the intercepts are equal across groups, therefore, constitutes a test of the hypothesis that group means for the cognitive variable are explainable in terms of differences in family variables among the groups.

It is important to consider at this point wheher the constraint of equivalent regressions across groups is a reasonable one. One way to do this is to consider in more detail Wright's contention that the unstandardized regression coefficient is the appropriate quantity to hold equal across groups. The assumption of equivalent (unstandardized) regressions means that the a fixed proportion of the variance of each predictor variable will be transmitted to the dependent variable. It does not follow from this that the proportion of variance explained in the dependent variable will be constant, because (1) the variance of the predictors may vary across groups; (2) the covariance among the predictors may vary across groups; and (3) the amount of residual variance in the dependent variable may vary across groups.

The assumption made here, therefore, is not an especially demanding one. Suppose, for example, that each grade of education completed by a mother corresponds to a one point increase in the IQ of her child, across both adoptive and natural families. Within any group, the proportion of variance in childrens' IQ accounted for by mothers' education will depend on the above, which is assumed to be constant, **plus** the variability of mothers' education in each group, the covariance of mothers' education with other variables in each group, and the amount of unpredicted IQ variance within each group, none of which are assumed to be constant. An additional relevant advantage of the structural equation approach is that it provides a simple way of testing the reasonableness of this and other assumptions at each step in the analysis.

The parameters of Equation (1) will be estimated using LISREL (Joreskog and Sorbom, 1984). An example of the LISREL programs that will be used is given in Appendix 1. Equation 1 is estimated simultaneously for the index cases and two matched control groups, with the constraint that the regression coefficients be equal in the three groups. Estimates of the regression coefficients are contained in the Beta matrix, and estimates of the intercepts in the Gamma matrix.

LISREL is usually used to estimate the effects of unmeasured, or latent, variables. No unmeasured variables are included in this analysis. Instead, LISREL is used to perform ordinary regression (albeit with maximum likelihood rather than least squares estimation) with the additional constraint that regression coefficients must be equal across groups. This constraint would be difficult to accomplish using typical multiple regression procedures.

Once Equation 1 has been estimated across groups for a given cognitive variable, each regression coefficient is tested for statistical significance. This is accomplished by a comparison of structural equation models, one of which forces the regression of the target predictor to be zero, while the other allows it to vary. The difference of fit between the two models can be tested as a chi square with one degree of freedom. A significance level of 0.05 will be employed, without any faith in its validity. Violation of normality assumptions and the large number of coefficients to be tested make accurate interpretation of significance levels impossible. In addition, tests are made in groups with different sample sizes, so the statistical power varies across comparisons. The significance tests are used as a rough cutoff, therefore, for distinguishing large effects from small ones. All regression coefficients, regardless of significance, are reported for comparison.

Equality of intercepts across groups is tested using a similar technique. Models forcing the intercepts to be equal are compared to models allowing them to vary, with the difference in fit tested as a chi square with two degrees of freedom (one parameter, rather than three is required for the group intercepts when they are forced to be equal.)

The final result of this analysis is a determination of the family variables showing independent covariance with cognitive measures, and the extent to which differences between adopted and nonadopted children for the same variables can account for differences in their cognitive development.

CHAPTER 6: RESULTS

Description of the Sample

The final sample consisted of 338 adopted or fostered children and their corresponding biological and adoptive matches. Each group was composed of 205 whites (61%), 129 blacks (38%), 3 Puerto Ricans and one child described as "other". The latter four children are pooled with the blacks as "Nonwhites" for subsequent analyses.

At the time of the seven year exam, index children were described as being either "adopted" or "fostered." Although the precise criteria for this distinction are unknown, these two groups of children experienced drastically different consequences of their change in environment and are considered separately in what follows.

Institution and Sex

Table 6.1 breaks down the sample by race, adoption vs. fostering, institution of birth and sex. These variables were precisely matched across groups, so only data for the index cases are presented. White children were more likely to be adopted than fostered, while nonwhite children were more likely to be fostered. Nonwhite adopted children were mostly female. Sex ratios in the other

Table 6.1

Comparison of Adopted and Fostered Children

	White				Nonwhite				NCPP	
	Adopted		Fostered		Adopted		Fostered		White	Nwhite
	N	%	N	%	N	%	N	%	%	%
Institution										
Boston	10	6.8	7	12.3	0	0	0	0	45.1	4.1
Buffalo	0	0	1	1.8	0	0	0	0	9.9	0.3
Charity	0	0	0	0	3	6.4	7	8.1	0.0	8.9
Columbia	0	0	0	0	4	8.5	1	1.2	2.6	5.2
Johns Hopkins	1	0.7	5	8.8	9	19.1	18	20.9	3.3	9.4
Virginia	0	0	6	10.5	10	21.3	23	26.7	3.5	8.1
Minnesota	62	41.9	9	15.8	0	0	0	0	12.5	0.6
NY Medical	0	0	0	0	1	2.1	3	3.5	1.1	14.4
Oregon	36	24.3	13	22.8	4	8.5	9	10.5	9.3	3.2
Pennsylvania	1	0.7	4	7.0	7	14.9	18	20.9	3.7	30.6
Providence	38	25.7	12	21.1	1	2.1	5	5.8	8.8	2.5
Tennessee	0	0	0	0	8	17.0	2	2.3	0.1	12.0
Sex of Child										
Male	76	51.4	31	54.4	17	36.2	45	52.3	51.9	50.0
Female	72	48.6	26	45.6	30	63.8	41	47.7	48.1	50.0
Total	148		57		47		86			

groups did not differ significantly from 50%. Most institutions provided subjects almost exclusively of one race or another.

The adopted and fostered children do not appear to have been randomly sampled from the NCPP population. Several institutions, particularly Minnesota for whites and Virginia and Tennessee for nonwhites, produced a disproportionate number of adopted and fostered cases.

Biological Status of the Children

Tables 6.2 and 6.3 give birthweight, gestational age, and neurological exam results broken down by group and adoption vs. fostering for white and nonwhite children respectively. Descriptive statistics from the entire NCPP population are also provided. The most striking result in the table is the prevalence of diagnosed neurological damage in foster children. Small differences between groups are seen for birthweight; no substantial difference exists for gestational age. The result of the one year neurological exam (graded on a 0, 1, 2 scale of increasing likelihood of damage) and birthweight will be used as indices of biological status in subsequent analyses.

Characteristics of the Biological Families

Tables 6.4 and 6.5 show means and standard deviations (SD's) for variables describing the biological parents of the three groups of

Table 6.2

Description of Biological Variables in Whites

	BWTx 1000	Gest Age (Wks)	1 Year Neurological % Normal	% Suspect	% Definite	Mean
Adopted						
Index						
MEAN	33.0	40.4	92.6	5.4	1.4	0.1
STD	4.9	2.8				
N	148	148				
Bio						
MEAN	33.6	40.1	93.9	4.7	1.4	0.1
STD	5.3	2.8				
N	148	148				
Adopt						
MEAN	33.1	40.3	93.9	2.7	3.4	0.1
STD	5.1	2.2				
N	147	148				
Fostered						
Index						
MEAN	31.7	40.3	80.7	12.3	7.0	0.3
STD	5.5	2.8				
N	57	56				
Bio						
MEAN	32.7	40.5	91.2	8.8	0.0	0.1
STD	5.5	2.4				
N	57	57				
Adopt						
MEAN	33.0	40.6	93.0	7.0	0.0	0.1
STD	5.4	2.3				
N	57	57				
Full NCPP						
MEDIAN	32.9*	40.1*	90.5	7.7	1.8	
STD						
N	18303	18212				

*From Broman, Nichols & Kennedy, 1975.

Table 6.3

Description of Biological Variables in Nonwhites

	BWTx 1000	Gest Age (Wks)	1 Year Neurological % Normal	% Suspect	% Definite	Mean
Adopted						
Index						
MEAN	29.5	38.3	89.4	6.4	4.3	0.1
STD	6.0	4.2				
N	47	46				
Bio						
MEAN	31.2	38.7	93.6	4.3	2.1	0.1
STD	4.6	4.1				
N	47	47				
Adopt						
MEAN	31.6	39.2	87.2	10.6	2.1	0.1
STD	4.9	4.0				
N	47	47				
Fostered						
Index						
MEAN	29.5	38.1	76.7	16.3	5.8	0.3
STD	6.7	3.6				
N	86	84				
Bio						
MEAN	29.9	38.6	89.5	9.3	1.2	0.1
STD	5.6	3.2				
N	86	86				
Adopt						
MEAN	30.8	38.8	88.4	10.5	1.2	0.1
STD	5.4	3.3				
N	85	86				
Full NCPP						
MEDIAN	30.9*	39.6*	91.1	7.1	1.8	
STD						
N	19567	19367				

*From Broman, Nichols and Kennedy, 1975.

Table 6.4

Description of Birth Variables in Whites

	Moms Educ	Dads Educ	Moms Occup	Dads Occup	Inc ome	SEI	Moms Age	Dads Age
Adopted								
Index								
Mean	11.0	11.0	3.8	4.5	4.3	42.2	22.9	28.0
Std	1.9	2.4	2.3	2.5	2.8	18.4	5.4	7.8
N	148	67	148	65	132	148	148	21
Bio								
Mean	10.9	10.2	3.6	4.4	4.2	41.8	23.3	27.4
Std	1.8	2.5	2.2	2.4	1.9	17.8	5.4	7.4
N	148	121	148	121	135	148	148	114
Adopt								
Mean	11.8	11.8	5.2	5.8	5.1	56.0	23.3	25.7
Std	1.8	2.3	2.7	2.7	2.2	20.1	5.2	5.3
N	138	126	140	128	125	140	148	126
Fostered								
Index								
Mean	9.6	10.1	3.0	3.5	3.9	35.8	24.0	29.1
Std	2.4	2.6	2.2	2.1	2.2	18.9	6.0	7.9
N	57	37	57	38	52	57	57	33
Bio								
Mean	9.6	9.6	3.8	3.7	4.3	36.5	24.2	28.4
Std	2.3	2.4	2.2	2.3	2.3	17.8	5.8	7.7
N	57	45	57	48	48	57	57	46
Adopt								
Mean	10.8	10.8	4.3	4.6	5.2	48.8	23.7	27.7
Std	1.8	1.9	2.4	2.6	2.4	29.4	5.7	6.4
N	52	45	52	48	48	53	57	46
Full NCPP								
Mean	11.3	11.9	5.1	5.5	5.0	57.0	24.9	28.3
Std	2.6	3.1	2.6	2.5	2.5	21.6	5.8	6.8
N	25619	23027	25680	23654	25728	25495	27753	22529

Table 6.5

Description of Birth Variables in Nonwhites

	Moms Educ	Dads Educ	Moms Occup	Dads Occup	Inc ome	SEI	Moms Age	Dads Age
Adopted								
Index								
Mean	10.0	10.6	2.3	4.0	3.0	29.4	20.9	28.0
Std	1.7	2.3	2.0	2.6	1.7	15.5	5.1	9.3
N	47	23	47	29	39	47	47	15
Bio								
Mean	10.1	10.0	2.4	3.1	3.2	29.6	21.1	26.5
Std	1.7	1.9	2.0	1.9	1.7	14.5	4.5	5.4
N	47	26	47	31	40	47	47	29
Adopt								
Mean	10.1	9.9	2.3	3.5	4.3	38.3	21.6	28.3
Std	2.3	2.7	2.5	2.2	2.1	16.5	4.7	7.6
N	44	28	43	31	39	47	47	31
Fostered								
Index								
Mean	9.2	9.0	2.3	3.3	3.2	26.9	22.9	30.0
Std	2.4	3.3	1.9	2.3	1.5	14.3	6.6	7.7
N	86	46	85	48	75	86	86	30
Bio								
Mean	9.4	9.4	2.0	2.9	3.5	28.2	23.1	28.7
Std	2.3	2.6	1.6	1.8	1.4	14.2	6.5	7.0
N	86	45	85	51	76	86	86	45
Adopt								
Mean	9.7	9.5	2.2	3.1	4.1	32.5	22.8	28.7
Std	2.1	2.8	1.8	2.0	1.8	16.5	6.3	7.0
N	80	53	77	60	61	76	86	57
Full NCPP								
Mean	10.0	10.2	2.9	3.8	3.8	38.4	23.8	28.6
Std	2.4	2.7	2.2	2.1	2.4	17.7	6.2	7.4
N	30841	22448	30851	23711	30871	30439	31636	20640

children and the full population at the time of the mother's registration in the study, for whites and nonwhites.

The biological parents of these children were not well educated, ranging from a mean of about nine grades for the parents of most groups of foster children to about twelve grades for the parents of the adoptive matches of the adopted white index cases. Mother's education in the biological matches was matched to that of the biological mothers of the index cases, thus no substantial differences are evident. Mothers of white adoptive matches were better educated than the two matched groups by about a grade, or half a standard deviation. Mothers of nonwhite adoptive matches were not substantially better educated than the biological mothers of the index cases. Mothers of white children were better educated than mothers of nonwhite children by about a grade. Mothers of adopted children were better educated than mothers of foster children, especially for whites.

Educational levels for biological fathers are available for about half of the index cases, and about three fourths of the two matched control groups. The available data follow a pattern roughly similar to that for biological mother's education, with several exceptions. For all but the the black foster children, fathers of index cases are somewhat better educated than fathers of biological matches, who were not matched for paternal education. Fathers of nonwhite adopted children were better educated than fathers of their adoptive matches.

In general, adopted and fostered children were not placed in vastly better educated environments than those provided by their biological parents. By the same token, only a small difference exists in the educational levels of the biological parents of the index cases and their adoptive controls. These differences are larger for whites than for nonwhites, whose educational level showed little or no increase as a result of adoption or fostering.

It might be thought that the youth of the biological mothers would confound educational levels as an index of intellectual ability, since the youngest mothers were still of school age. This does not seem to be the case, however. The correlation between age and education in index cases, biological and adoptive matches are -0.003, 0.003 and 0.002, respectively. The mothers of the biological matches gained only 0.33 of a grade between their childrens' birth and seventh birthday; mothers of adoptive matches gained 0.16 of a grade. The correlation between gain in education and age was -0.10 in the biological matches and .03 in the adoptive matches.

Occupation was scored on the 9 point scale given in Table 6.6. Again, parents of white index cases did not differ from parents of biological matches but were lower than parents of adoptive matches by about one SD. Among nonwhites, parents of adoptive matches did not have more prestigious occupations than parents of index cases or biological matches. The average father of a white index case was a machine operator; the average father of a black index case was a domestic worker. The average father of a white adoptive match was a

Table 6.6

Occupation Scale from Myrianthopulos and French (1968)

Occupational Category	Score
Professional and college	9
Proprietors and managers	8
Clerical	7
Sales	6
Craftsmen	5
Operatives	4
Domestic workers	3
Other service workers	2
Laborers and farmers	1
None	0

skilled craftsman; the average father of a black adoptive match was a domestic worker.

Family income was measured on an arbitrary 100 point scale in the NCPP, which was rescaled here to have the same standard deviation as mother's education at seven years. Family income ranged from about $2000 for the families of black index cases to about $4000 for families of white adoptive matches. Family SEI, which is a linear combination of education, occupation and income, showed a pattern similar to that of its components. Neither maternal nor paternal age varied significantly among the groups. White mothers were significantly older than nonwhite mothers.

Table 6.7 shows the marital status of the biological mothers at the time of registration in the study. The majority of biological mothers of index cases were unmarried, while a substantial majority of mothers of the matched controls groups were married.

Structure of SEI in Whites and Nonwhites

Five primary indicators of socioeconomic status are available for analysis: education of mother and father, occupation of mother and father, and family income. Table 6.8 gives correlations among these variables separately for whites and nonwhites, combining index cases with controls. The variables are more highly intercorrelated for whites than nonwhites, indicating the presence of a common factor of SEI for whites only. Although mother's and father's education are

Table 6.7

Marital Status of Biological Mothers

	Index		Bio		Adopt	
	N	%	N	%	N	%
Single	141	42	48	14	36	11
Married	101	30	247	73	284	84
Common-Law	3	1	0	0	1	0
Widowed	3	1	1	0	4	1
Divorced	34	10	7	2	4	1
Separated	56	17	35	10	9	3
Husband at Home	96	28	235	70	261	77

Table 6.8

Correlations Among Birth SEI variables in Study Sample*

	(1)	(2)	(3)	(4)	(5)
1) Mother's Education		.31 (221)	.17 (384)	-.02 (250)	.12 (330)
2) Father's Education	.60 (441)		-.00 (220)	.19 (214)	-.07 (198)
3) Mother's Occupation	.45 (599)	.37 (440)		.06 (248)	.08 (328)
4) Father's Occupation	.40 (445)	.46 (422)	.41 (447)		-.11 (223)
5) Family Income	.16 (540)	.14 (402)	.18 (540)	.12 (408)	

* Nonwhites above diagonal, whites below.

Table 6.9

Correlations Among SEI variables in NCPP Population*

	(1)	(2)	(3)	(4)	(5)
1) Mother's Education		.40 (19694)	.29 (26500)	.06 (10186)	.21 (24467)
2) Father's Education	.66 (25619)		.15 (18684)	-.02 (8824)	.13 (17803)
3) Mother's Occupation	.57 (25563)	.45 (22979)		.08 (10181)	.23 (24460)
4) Father's Occupation	.36 (10971)	.36 (10442)	.25 (10986)		.11 (9840)
5) Family Income	.62 (25383)	.28 (22104)	.31 (24434)	.19 (10770)	

*Nonwhites above diagonal, whites below.

correlated among nonwhites, correlations among other variables are not substantially different from zero, and are often negative.

An analysis of the full NCPP population of whites and nonwhites suggests that the above results reflect relationships among the variables in the NCPP population. These results are summarized in Table 6.9. As with the sample data, the five variables are substantially intercorrelated for whites, but not for nonwhites. Most noteworthy is that the two occupation variables are uncorrelated with education and income among nonwhites.

A composite of these five variables such as the additive SEI index used by the NCPP does not measure the same construct in nonwhites and whites. In fact, it is not clear what if anything the composite is measuring in nonwhites. Therefore, it was decided to omit the occupational variables from further analysis and use mother's education and family income as separate indicators of family background. In this way, the same measures can be used both for nonwhites and whites. Paternal education was not used for further analysis because of the high proportion of missing data, especially for fathers of index cases.

Neurologic and Psychiatric Conditions in the Parents

At the time of the child's birth, the biological mothers were rated for the presence or absence of a variety of neurological and psychiatric conditions. These are shown in Table 6.10. Though no

Table 6.10

Neurologic and Psychiatric Conditions in Biological Parents

	Index		Bio		Adopt	
	N	%	N	%	N	%
Mothers						
Convulsive Disorder	12	4	9	3	5	2
Convulsions During Pregnancy	2	1	1	0	1	0
Mental Retardation	11	3	2	1	0	0
Organic Brain Disease	1	0	2	1	0	0
Psychosis and Neurosis	46	14	17	5	15	5
Other Neurological	22	7	6	2	9	3
Alcoholism	3	1	1	0	0	0
Drug Addiction	1	0	1	0	1	0
Other Psychiatric	1	0	1	0	0	0
Mental Illness	31	9	8	2	4	1
Fathers						
Mental Illness	12	4	9	3	6	2
Mental Retardation	12	4	9	3	6	2
Any of Above	92	27	44	13	35	10

single condition was highly prevalent in any of the groups, mothers of index cases were more likely than mothers of the controls to be diagnosed with one of them.

Time of Adoption or Fostering

Table 6.11 shows time of adoption or fostering of the index cases by race. The majority of all adopted children were placed in new homes during the first eight months. The majority of foster children were placed after the first year, and more than a third were placed after age three. Nonwhites were not placed substantially later than whites within the adopted or fostered groups.

Among whites, children of better educated mothers were adopted earlier. For adopted whites, the correlation between maternal education and time of adoption was -0.23 ($N = 148$, $p=.005$). For fostered whites, the correlation was also -0.23 ($N = 57$, $p = .0920$). For nonwhites, the correlations were -0.10 ($N = 47$, $p = .487$) and 0.00 ($N = 86$) for adopted and fostered, respectively.

Family Characteristics at 7 Years

Tables 6.12 and 6.13 show variables describing the seven-year families of adopted and fostered children and their matched controls for whites and nonwhites respectively. For the matched control

Table 6.11

Time of Adoption and Fostering by Race

	White				Nonwhite			
	Adopted		Fostered		Adopted		Fostered	
Age	N	%	N	%	N	%	N	%
Birth	23	16	7	12	23	50	9	11
0-8 Months	92	62	9	16	10	21	13	15
8 mos-4 yrs	31	21	21	37	11	23	32	37
after 4 yrs	2	1	20	35	3	6	32	37
Mean Yrs	0.58		2.91		0.78		3.10	
SD	0.92		2.35		1.44		2.35	

Table 6.12

Description of 7-Year Variables in Whites

	Moms Educ	Dads Educ	Moms Occup	Dads Occup	Inc ome	SEI	Moms Age
Adopted							
Index							
MEAN	11.9	.	1.4	6.2	5.8	67.1	38.7
STD	1.8	.	2.6	2.5	1.3	17.7	6.2
N	148	0	148	145	140	148	146
Bio							
MEAN	10.7	10.8	2.6	4.9	3.3	43.4	34.7
STD	1.7	3.1	2.5	2.2	2.2	21.7	7.1
N	142	98	145	103	145	148	98
Adopt							
MEAN	11.7	12.7	2.8	6.3	5.2	66.5	33.1
STD	1.8	2.6	3.0	2.3	1.8	19.3	6.2
N	148	143	147	145	146	148	145
Fostered							
Index							
MEAN	10.7	.	1.7	4.9	4.9	54.1	43.6
STD	2.0	.	2.0	2.6	1.7	19.1	10.7
N	57	0	57	56	54	57	57
Bio							
MEAN	9.8	10.1	2.7	4.3	3.5	39.6	35.4
STD	2.2	2.7	2.4	2.4	2.2	19.0	7.2
N	53	35	55	38	56	57	37
Adopt							
MEAN	10.5	11.5	3.6	4.6	4.7	54.1	35.0
STD	1.9	2.6	2.9	2.1	1.9	18.7	6.4
N	57	57	57	57	56	57	57

Table 6.13

Description of 7-Year Variables in Nonwhites

	Moms Educ	Dads Educ	Moms Occup	Dads Occup	Inc ome	SEI	Moms Age
Adopted							
Index							
MEAN	9.6	.	1.8	3.9	3.7	39.9	44.2
STD	2.6	.	2.8	2.6	2.0	18.5	8.7
N	47	0	47	42	45	47	47
Bio							
MEAN	10.0	9.8	2.3	3.3	2.5	30.7	34.8
STD	1.7	3.0	2.3	1.9	2.0	17.9	5.8
N	45	20	47	24	46	47	21
Adopt							
MEAN	9.9	10.1	2.9	3.8	3.1	38.9	34.3
STD	2.4	2.3	2.7	1.9	2.2	16.3	7.5
N	47	41	47	43	44	47	41
Fostered							
Index							
MEAN	9.5	.	1.3	3.6	3.9	39.8	49.5
STD	2.3	.	1.4	2.7	2.0	19.0	10.7
N	86	0	86	80	79	86	86
Bio							
MEAN	9.5	9.1	2.2	3.4	2.0	28.0	35.2
STD	2.2	2.7	1.9	2.1	1.5	15.8	8.5
N	84	32	84	36	83	86	31
Adopt							
MEAN	9.6	10.0	2.7	3.9	3.6	39.5	34.2
STD	2.1	2.5	2.0	1.9	1.9	18.3	8.0
N	86	72	86	77	82	86	76

groups, these families are the same as the birth families; for the index cases, these are adoptive or foster families.

Mothers of white index cases and adoptive matches, who were matched for seven year education, had completed 11.7 grades at the seven year exam. This represents an increase of .1 grade for the adoptive match mothers since the birth of their child. Mothers of biological matches to these children had just under 11 grades of education and showed no increase over the seven years. White mothers were better educated than nonwhite mothers. Adoptive mothers and mothers of children matched to adopted children were better educated than foster mothers and their matches. In addition, there were larger differences in education between adoptive and foster mothers among whites than nonwhites and greater differences among index cases and their biological matches for whites than nonwhites. The latter two findings suggest that white adopted children experienced a greater increase in environmental quality than did either white fostered or nonwhite adopted and fostered children.

No educational data were available for adoptive and foster fathers of index cases. Among the matched groups, white fathers were better educated than nonwhites, and fathers of children matched to adoptive index cases were better educated than fathers of children matched to foster index cases.

Mother's occupation followed a different pattern. Adoptive mothers of index cases had lower occupational levels than either biological or adoptive controls. This results from having more housewives (who have low occupational status on the scale used by the NCPP) in the index group than in the control groups. No differences in occupational level were found between whites and nonwhites or between adoptive and foster mothers. Father's occupation shows a pattern more similar to that of education. Fathers of index cases are higher in occupational status than fathers of biological matches, whites are higher than nonwhites, adoptive fathers and their matches are higher than foster fathers and their matches, this latter difference being greater for whites than nonwhites.

Family income of the index cases was higher than that of the biological matches, as expected, but was also slightly higher than the adoptive matches. Whites were higher than nonwhites, and showed greater income differences between biological and adoptive families.

Table 6.14 shows the seven year marital status of the mothers, broken down by group, race, and adoption vs. fostering. Almost all index cases live with a married adoptive or foster mother, although only 30% were born to married mothers. One half to two thirds of the mothers of the biological matches are married. Of the rest, most are divorced, still single, or described as "other." One effect of adoption, then, was to remove children from single parent households and place them with married parents.

Correlations among Seven Year Variables

Table 6.15 shows correlations among the five seven year SEI

Table 6.14

7-Year Marital Status by Race and Adoption vs. Fostering

	White				Nonwhite			
	Adopted		Fostered		Adopted		Fostered	
	N	%	N	%	N	%	N	%
Index Case and Adopt Match								
Single	0	0	0	0	1	2	0	0
Married	145	98	57	100	43	92	76	88
Widowed	0	0	0	0	2	4	7	8
Divorced	2	1	0	0	0	0	0	0
Other	1	1	0	0	1	2	3	4
Bio Match								
Single	0	0	2	4	4	9	11	13
Married	100	68	36	63	21	45	32	37
Common Law	0	0	1	2	1	2	0	0
Widowed	3	2	0	0	1	2	1	1
Divorced	19	13	7	12	2	4	11	12
Other	26	18	11	19	18	38	31	36

Table 6.15

Correlations Among 7-Year SEI Variables in Study Sample*

	(1)	(2)	(3)	(4)	(5)
1) Mother's Education		.37 (164)	.27 (394)	.09 (299)	.30 (376)
2) Father's Education	.61 (327)		.09 (163)	.17 (163	.29 (158)
3) Mother's Occupation	.13 (604)	.08 (327)		.03 (300)	.11 (378)
4) Father's Occupation	.42 (535)	.54 (331)	.03 (538)		.28 (284)
5) Family Income	.38 (587)	.34 (327)	.02 (591)	.12 (408)	

*Nonwhites above diagonal, whites below.

variables for nonwhites and whites. As with the same variables at the time of birth, they are more highly intercorrelated among whites than nonwhites, although the correlations for nonwhites are now all positive. Again, there does not appear to be any simple way to form a composite of the variables to measure the same construct in whites and nonwhites. Therefore, mother's education and family income were selected as separate seven year indicators of family environment.

Selective Placement

Correlations among SEI variables measured at birth and seven years are given in Table 6.16. As expected, there are high correlations between the natural parents of children at birth and seven years for education, but the occupational variables are not highly correlated within natural families across the seven year period; family income shows moderate correlations, somewhat higher in the adoptive than the biological matches. White children show evidence of selective placement for mother's education, but little if any selective placement for family income. Educational levels of adoptive and foster mothers of nonwhite children showed low correlations with educational levels of the biological mothers. Correlations for family income are low but positive.

Table 6.16

Correlation Between Birth and 7-Year Variables, by Race and Adoption vs. Fostering

Index Cases	Mother's Education	Father's Education	Mother's Occupation	Father's Occupation	Family Income
White					
Adopted	.29 (148)	*	-.04 (148)	.29 (64)	.10 (124)
Fostered	.29 (57)	*	-.05 (57)	-.18 (38)	.24 (49)
Nonwhite					
Adopted	.01 (47)	*	-.08 (47)	.36 (27)	.12 (38)
Fostered	.14 (86)	*	-.20 (85)	.30 (45)	.16 (72)
Bio Matches					
White					
Adopted	.88 (142)	.88 (86)	.24 (145)	.49 (91)	.24 (133)
Fostered	.85 (53)	.82 (30)	.24 (55)	.05 (34)	.16 (47)
Nonwhite					
Adopted	.87 (45)	.94 (14)	.23 (47)	.05 (19)	.22 (39)
Fostered	.81 (84)	.82 (20)	-.10 (83)	.30 (24)	.16 (73)
Adopt Matches					
White					
Adopted	.91 (138)	.79 (123)	.26 (139)	.57 (127)	.26 (124)
Fostered	.90 (52)	.76 (45)	.09 (52)	.52 (48)	.44 (47)
Nonwhite					
Adopted	.91 (44)	.86 (26)	.51 (43)	.32 (28)	.44 (37)
Fostered	.88 (80)	.65 (48)	.13 (77)	.09 (56)	.40 (58)

* Educational data for adoptive and foster fathers not available.

Cognitive Development of the Children

Five tests were selected for analysis of the cognitive development of the adopted and nonadopted children: combined mental and motor Bayley raw scores at eight months, Stanford Binet IQ at four years, verbal and performance IQ at seven years, and a combination of spelling, reading and arithmetic scores from the Wide Range Achievment Test at seven years. Bayley Mental and Motor scores were combined by summing them after multiplying the mental score by .737 to equalize the variances of the Mental and Motor components. Mental and Motor Scores were correlated 0.68 in the full sample. WRAT scores were added after multiplying the spelling score by 0.731 and the reading score by 0.368 to equalize variances of the components. WRAT spelling was correlated 0.89 with reading and 0.77 with arithmetic; reading and arithmetic were correlated 0.76. Tables 6.17 and 6.18 give means and standard deviations of the cognitive measures for adopted and fostered children and their two matched control groups for whites and nonwhites respectively. Standard deviations of the combined scores and the other cognitive measures are close enough to allow some comparison of the regression coefficients to be discussed below. No attempt was made to equalize the variances exactly in the full sample, because differences would have remained among subgroups in any case because of different degrees of selection. Variables could not be standardized within subgroups because variance differences among subgroups are an important part of the regression analyses to follow.

Table 6.17

Means of Test Results, Whites

	Bayley	Binet	VIQ	PIQ	WRAT
Adopted					
Index					
MEAN	126.9	103.5	98.7	103.3	53.9
STD	8.3	16.8	11.6	13.5	11.3
N	132	144	148	148	148
Bio					
MEAN	125.6	99.1	96.0	100.0	48.1
STD	11.0	13.5	13.8	14.5	10.5
N	123	132	148	147	147
Adopt					
MEAN	123.8	103.8	98.8	102.2	53.5
STD	14.4	15.3	12.0	14.5	10.7
N	115	132	146	146	145
Fostered					
Index					
MEAN	117.9	88.9	90.0	95.3	46.8
STD	16.0	19.6	15.4	15.7	13.9
N	42	48	54	54	53
Bio					
MEAN	123.9	100.2	96.8	99.9	52.7
STD	13.7	13.4	12.5	15.0	13.9
N	46	48	57	57	57
Adopt					
MEAN	125.2	100.2	99.3	101.6	55.2
STD	9.8	14.6	12.6	13.6	12.1
N	47	51	57	56	57

Table 6.18

Means of Test Results, Nonwhites

	Bayley	Binet	VIQ	PIQ	WRAT
Adopted					
Index					
MEAN	122.9	91.7	90.3	93.7	47.1
STD	12.0	13.9	13.2	16.0	9.6
N	43	46	47	47	46
Bio					
MEAN	120.5	87.9	86.9	89.9	49.0
STD	12.4	11.1	11.3	11.8	13.8
N	42	44	47	47	47
Adopt					
MEAN	121.3	89.8	92.6	93.8	50.3
STD	16.5	15.7	13.2	13.9	13.4
N	36	42	47	47	47
Fostered					
Index					
MEAN	118.9	87.2	83.6	85.7	44.1
STD	17.6	15.5	12.5	14.1	11.7
N	64	77	86	86	85
Bio					
MEAN	120.0	88.0	84.9	90.3	49.0
STD	14.0	13.2	11.3	14.6	17.3
N	64	79	85	85	86
Adopt					
MEAN	124.2	89.7	87.6	92.9	50.4
STD	12.2	12.6	10.7	13.9	12.8
N	66	74	86	86	85

As can be seen from the tables, whites scored higher than nonwhites on all tests. In general, adopted index cases scored higher than biological matches and as well as or better than adoptive matches. Fostered index cases performed considerably worse than either of their control groups. These trends are stronger in whites than nonwhites. Perhaps most noticeable about these tables is that no group of children scored particularly high on any of the measures. The highest mean IQ for any group is under 104.

Correlations Among Family and Developmental Variables.

Tables 6.19 through 6.22 show correlations among cognitive and family variables for index cases and matched control groups for white and nonwhite adopted and fostered children. These are presented for reference: subsequent modelling will allow for some simplification of the massive number of relationships apparent here.

Within and Between Group Analysis of Cognitive Variables

The adopteees appear to show a small increase in IQ over a group matched for biological family background and to have achieved a level equivalent to a group matched for rearing environment. One hardly could have expected a more positive effect of adoption since the quality of the adoptive environment of the index cases is not radically superior to that provided by their biological parents.

Table 6.19

Correlations Among Cognitive and Family Variables for White

Adopted

N=148

Index Cases

1.00												NEUROLOGICAL EXAM
-0.10	1.00											BIRTHWEIGHT
0.11	-0.05	1.00										MOTHERS BIRTH EDUCATION
0.00	-0.06	0.03	1.00									BIRTH INCOME
0.04	-0.17	0.29	0.19	1.00								MOTHERS 7-YR EDUCATION
0.07	-0.06	0.26	0.10	0.50	1.00							7-YR INCOME
-0.07	0.03	-0.23	-0.02	-0.16	-0.10	1.00						AGE OF ADOPTION
-0.12	0.33	-0.09	0.01	-0.06	0.04	-0.05	1.00					BAYLEY
0.12	-0.06	0.23	0.03	0.05	0.02	-0.22	0.19	1.00				BINET
0.06	0.06	0.18	0.10	0.19	0.13	-0.14	0.18	0.37	1.00			VIQ
-0.01	0.17	0.17	-0.00	0.05	-0.01	-0.05	0.15	0.23	0.44	1.00		PIQ
0.04	0.07	0.24	-0.01	0.11	0.19	-0.08	0.15	0.15	0.42	0.42	1.00	WRAT

Bio Matches

1.00												NEUROLOGICAL EXAM
-0.11	1.00											BIRTHWEIGHT
-0.06	0.32	1.00										MOTHERS BIRTH EDUCATION
-0.01	-0.11	0.10	1.00									BIRTH INCOME
-0.12	0.29	0.88	0.10	1.00								MOTHERS 7-YR EDUCATION
-0.01	-0.06	0.16	0.24	0.20	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.31	0.27	0.07	-0.11	0.12	0.06	0.00	1.00					BAYLEY
-0.12	0.04	-0.02	-0.00	-0.02	0.13	0.00	0.11	1.00				BINET
-0.07	0.10	0.20	-0.03	0.20	0.27	0.00	0.16	0.34	1.00			VIQ
-0.01	0.04	0.26	0.04	0.26	0.29	0.00	0.06	0.25	0.65	1.00		PIQ
-0.04	0.05	0.17	-0.11	0.18	0.20	0.00	0.16	0.27	0.53	0.53	1.00	WRAT

Adopt Matches

1.00												NEUROLOGICAL EXAM
-0.11	1.00											BIRTHWEIGHT
0.01	0.05	1.00										MOTHERS BIRTH EDUCATION
0.19	0.03	0.17	1.00									BIRTH INCOME
0.04	0.04	0.91	0.22	1.00								MOTHERS 7-YR EDUCATION
0.07	-0.13	0.35	0.26	0.38	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.60	0.20	0.01	0.03	0.01	-0.01	0.00	1.00					BAYLEY
0.02	0.07	0.32	0.11	0.26	0.05	0.00	0.06	1.00				BINET
0.08	-0.04	0.41	0.01	0.43	0.11	0.00	-0.06	0.45	1.00			VIQ
0.05	0.01	0.30	0.02	0.31	0.16	0.00	-0.02	0.35	0.47	1.00		PIQ
-0.06	0.03	0.27	0.00	0.28	0.13	0.00	0.02	0.39	0.47	0.44	1.00	WRAT

Table 6.20

Correlations Among Cognitive and Family Variables for White Fostered

N=57

Index Cases

1.00												NEUROLOGICAL EXAM
-0.31	1.00											BIRTHWEIGHT
-0.20	0.13	1.00										MOTHERS BIRTH EDUCATION
-0.28	0.09	0.31	1.00									BIRTH INCOME
-0.08	0.14	0.29	0.14	1.00								MOTHERS 7-YR EDUCATION
0.14	0.00	0.22	0.24	0.28	1.00							7-YR INCOME
-0.01	0.08	-0.23	-0.24	-0.12	-0.20	1.00						AGE OF ADOPTION
-0.66	0.30	0.29	0.40	0.34	0.03	-0.25	1.00					BAYLEY
-0.67	0.12	0.42	0.16	0.40	0.00	-0.12	0.62	1.00				BINET
-0.35	0.15	0.41	0.18	0.43	-0.03	-0.12	0.43	0.72	1.00			VIQ
-0.44	0.25	0.31	0.23	0.40	0.13	-0.14	0.54	0.78	0.68	1.00		PIQ
-0.22	0.06	0.32	0.10	0.26	0.13	-0.19	0.50	0.58	0.66	0.49	1.00	WRAT

Bio Matches

1.00												NEUROLOGICAL EXAM
0.10	1.00											BIRTHWEIGHT
-0.38	-0.07	1.00										MOTHERS BIRTH EDUCATION
-0.11	-0.13	0.19	1.00									BIRTH INCOME
-0.20	-0.10	0.85	0.21	1.00								MOTHERS 7-YR EDUCATION
-0.34	-0.06	0.29	0.16	0.13	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.17	0.17	0.07	-0.21	0.11	0.01	0.00	1.00					BAYLEY
-0.09	-0.19	0.01	-0.02	-0.05	0.06	0.00	0.11	1.00				BINET
-0.30	-0.02	0.40	0.18	0.37	0.38	0.00	0.15	0.06	1.00			VIQ
-0.22	0.18	0.11	0.13	0.10	0.19	0.00	0.11	0.05	0.60	1.00		PIQ
-0.28	-0.05	0.15	0.13	0.07	0.25	0.00	0.16	0.04	0.72	0.50	1.00	WRAT

Adopt Matches

1.00												NEUROLOGICAL EXAM
0.07	1.00											BIRTHWEIGHT
-0.23	-0.01	1.00										MOTHERS BIRTH EDUCATION
-0.01	0.34	0.09	1.00									BIRTH INCOME
-0.26	0.09	0.90	0.15	1.00								MOTHERS 7-YR EDUCATION
-0.00	0.20	0.29	0.44	0.34	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
0.06	0.21	0.18	0.11	0.16	-0.07	0.00	1.00					BAYLEY
0.18	0.33	0.13	0.27	0.21	0.25	0.00	0.02	1.00				BINET
0.00	-0.03	0.18	-0.01	0.20	0.32	0.00	-0.33	0.25	1.00			VIQ
0.06	-0.01	0.23	0.22	0.20	0.45	0.00	-0.22	0.21	0.59	1.00		PIQ
-0.09	0.05	0.10	0.14	0.04	0.33	0.00	-0.05	0.16	0.30	0.47	1.00	WRAT

Table 6.21

Correlations Among Cognitive and Family Variables for Nonwhite

Adopted

N=47

Index Case

1.00												NEUROLOGICAL EXAM
-0.22	1.00											BIRTHWEIGHT
0.13	-0.13	1.00										MOTHERS BIRTH EDUCATION
0.15	-0.22	0.03	1.00									BIRTH INCOME
-0.18	0.04	0.01	0.02	1.00								MOTHERS 7-YR EDUCATION
-0.12	-0.09	0.16	0.12	0.33	1.00							7-YR INCOME
-0.10	-0.37	-0.10	0.20	0.16	0.06	1.00						AGE OF ADOPTION
-0.31	0.49	-0.11	-0.13	0.25	-0.22	-0.10	1.00					BAYLEY
-0.07	0.34	0.10	-0.14	0.08	0.11	-0.08	0.43	1.00				BINET
0.10	0.08	0.31	-0.12	0.01	0.29	0.03	-0.09	0.39	1.00			VIQ
-0.11	0.16	0.46	-0.18	-0.05	0.08	-0.07	-0.00	0.30	0.59	1.00		PIQ
0.10	0.14	0.31	-0.02	0.03	0.23	-0.05	-0.06	0.31	0.71	0.47	1.00	WRAT

Bio Matches

1.00												NEUROLOGICAL EXAM
0.02	1.00											BIRTHWEIGHT
-0.34	-0.15	1.00										MOTHERS BIRTH EDUCATION
-0.12	-0.14	0.18	1.00									BIRTH INCOME
-0.40	-0.14	0.87	0.30	1.00								MOTHERS 7-YR EDUCATION
-0.22	-0.00	0.35	0.22	0.50	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.20	0.47	-0.01	-0.19	-0.09	-0.24	0.00	1.00					BAYLEY
-0.03	0.19	0.22	-0.04	0.02	0.03	0.00	0.13	1.00				BINET
-0.11	0.21	0.09	-0.03	-0.04	-0.20	0.00	0.20	0.24	1.00			VIQ
-0.11	0.04	0.28	0.11	0.20	0.10	0.00	-0.01	0.30	0.52	1.00		PIQ
-0.17	-0.15	0.27	0.14	0.27	0.22	0.00	-0.02	0.39	0.22	0.46	1.00	WRAT

Adopt Matches

1.00												NEUROLOGICAL EXAM
-0.43	1.00											BIRTHWEIGHT
-0.18	0.08	1.00										MOTHERS BIRTH EDUCATION
-0.18	-0.09	0.43	1.00									BIRTH INCOME
-0.13	0.04	0.91	0.52	1.00								MOTHERS 7-YR EDUCATION
-0.05	-0.00	0.50	0.44	0.62	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.61	0.47	0.05	0.25	0.12	0.24	0.00	1.00					BAYLEY
-0.31	0.18	0.24	0.15	0.32	0.12	0.00	0.37	1.00				BINET
-0.33	0.09	0.01	-0.05	0.12	0.11	0.00	0.43	0.33	1.00			VIQ
-0.32	0.06	-0.01	-0.00	0.09	0.07	0.00	0.28	0.35	0.57	1.00		PIQ
-0.27	0.14	0.24	0.36	0.27	0.21	0.00	0.41	0.13	0.52	0.35	1.00	WRAT

Table 6.22

Correlations Among Cognitive and Family Variables for Nonwhite Fostered

N=86

Index Cases

1.00												NEUROLOGICAL EXAM
-0.28	1.00											BIRTHWEIGHT
-0.07	-0.04	1.00										MOTHERS BIRTH EDUCATION
-0.07	-0.04	-0.01	1.00									BIRTH INCOME
-0.04	0.09	0.14	0.17	1.00								MOTHERS 7-YR EDUCATION
-0.23	-0.02	-0.24	0.16	0.17	1.00							7-YR INCOME
-0.03	-0.15	-0.00	0.05	0.02	0.05	1.00						AGE OF ADOPTION
-0.54	0.40	-0.02	-0.05	0.10	-0.04	-0.05	1.00					BAYLEY
-0.03	0.02	0.01	-0.01	-0.10	0.19	-0.16	0.10	1.00				BINET
-0.24	0.06	-0.05	-0.00	0.08	0.17	-0.19	0.27	0.27	1.00			VIQ
0.06	-0.07	0.08	0.01	0.14	0.10	-0.16	0.00	0.29	0.47	1.00		PIQ
0.04	-0.04	0.02	0.10	0.23	0.10	-0.12	0.13	0.11	0.54	0.52	1.00	WRAT

Bio Matches

1.00												NEUROLOGICAL EXAM
-0.18	1.00											BIRTHWEIGHT
-0.05	0.04	1.00										MOTHERS BIRTH EDUCATION
-0.01	0.14	-0.05	1.00									BIRTH INCOME
0.08	0.09	0.81	0.01	1.00								MOTHERS 7-YR EDUCATION
0.11	0.07	0.08	0.16	0.12	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.39	0.40	-0.01	0.14	-0.03	0.03	0.00	1.00					BAYLEY
-0.28	-0.12	0.07	0.18	0.01	-0.11	0.00	0.21	1.00				BINET
-0.07	-0.11	0.15	-0.02	0.13	-0.09	0.00	0.10	0.44	1.00			VIQ
-0.09	-0.15	0.24	-0.06	0.24	-0.20	0.00	0.21	0.34	0.57	1.00		PIQ
-0.02	-0.04	0.34	0.12	0.31	-0.15	0.00	0.06	0.30	0.38	0.53	1.00	WRAT

Adopt Matches

1.00												NEUROLOGICAL EXAM
-0.25	1.00											BIRTHWEIGHT
-0.29	0.16	1.00										MOTHERS BIRTH EDUCATION
-0.03	-0.14	0.27	1.00									BIRTH INCOME
-0.18	0.11	0.88	0.22	1.00								MOTHERS 7-YR EDUCATION
0.08	-0.17	0.31	0.38	0.41	1.00							7-YR INCOME
0.00	0.00	0.00	0.00	0.00	0.00	0.00						AGE OF ADOPTION
-0.47	0.17	0.19	0.08	0.25	0.16	0.00	1.00					BAYLEY
-0.08	-0.00	0.16	0.12	0.05	0.02	0.00	0.10	1.00				BINET
-0.21	0.05	0.08	0.17	0.15	0.15	0.00	0.40	0.38	1.00			VIQ
-0.21	0.17	0.06	-0.01	0.01	0.08	0.00	0.28	0.13	0.22	1.00		PIQ
-0.20	0.14	0.16	-0.03	0.18	0.15	0.00	0.33	0.19	0.37	0.18	1.00	WRAT

Fostered children scored lower than the group matched for family background. Below, these group differences are combined with regressions of the cognitive tests on family variables in an attempt to determine the causes of the changes in the adopted children's performance.

As discussed in Chapter 5, this analysis proceeds by performing simultaneous regressions for index cases and the two matched controls, while constraining the regression solution to be equal across groups. This identifies family variables that covary with the cognitive measures within groups. The residuals of the test scores in each group are then compared. To the extent that group differences between adopted and fostered children and their matched controls remain after the effects of family variables have been removed, observed differences in performance arise from some unmeasured aspect of the children, their background or environment.

Analyses are performed separately for each test to simplify the model testing and because different proportions of adopted and fostered children had been adopted or fostered at the time of each test. It would make no sense, for example, to test the effect of four year environment on the Binet scores of children who were not yet adopted. Tables 6.23 and 6.24 provide means and standard deviations for predictor variables and the combined Bayley for children adopted or fostered before eight months. Very few foster children were fostered by eight months, so only adopted children are included for subsequent analyses of the Bayley. Tables 6.25 and 6.26 provide

Table 6.23

Predictor Variables and Bayley Scores for Whites Adopted or Fostered by 8 Months

	BWTx 100	Neur Exam	Moms Birth Educ	Birth Income	Moms 7-Yr Educ	7-Yr Inc	Bayley
Adopted							
Index							
MEAN	33.2	0.1	11.2	4.3	12.1	5.9	127.7
STD	4.9	0.3	1.9	2.8	1.9	1.3	7.5
N	115	115	115	105	115	109	102
r w/Bayley	.32	-.15	-.11	-.10	-.11	.09	
Bio							
MEAN	33.9	0.1	11.1	4.3	10.9	3.4	125.5
STD	5.3	0.3	1.8	1.7	1.7	2.3	11.6
N	115	115	115	105	110	112	96
r w/Bayley	.32	-.28	.12	-.13	.20	.08	
Adopt							
MEAN	33.1	0.1	12.1	5.1	11.9	5.2	125.3
STD	4.9	0.3	1.8	2.2	1.9	1.7	10.2
N	115	115	107	98	115	113	88
r w/Bayley	.16	-.45	.05	.10	.02	.00	
Fostered							
Index							
MEAN	31.8	0.3	10.8	4.7	11.1	5.8	122.7
STD	5.0	0.7	2.7	2.9	1.6	1.2	13.8
N	16	16	16	13	16	16	12
r w/Bayley	-.71	-.67	.20	.56	-.05	-.46	
Bio							
MEAN	32.7	0.1	10.8	5.0	11.0	4.0	126.6
STD	5.1	0.3	2.5	2.3	2.3	2.2	5.8
N	16	16	16	14	16	16	14
r w/Bayley	.10	-.21	-.57	-.19	-.54	-.21	
Adopt							
MEAN	32.7	0.0	11.1	6.6	10.8	5.3	126.0
STD	5.3	0.0	1.4	3.4	1.7	1.6	8.6
N	16	16	15	14	16	15	13
r w/Bayley	.09	.00	.13	.02	.34	-.42	

Table 6.24

Predictor Variables and Bayley Scores for Nonwhites Adopted or Fostered by 8 Months

	BWTx 100	Neur Exam	Moms Birth Educ	Birth Income	Moms 7-Yr Educ	7-Yr Inc	Bayley
Adopted							
Index							
MEAN	30.0	0.2	10.0	2.8	9.2	3.4	125.1
STD	5.5	0.4	1.6	1.7	2.7	1.9	9.6
N	33	33	33	26	33	31	30
r w/Bayley	.57	-.40	-.03	-.37	.27	.03	
Bio							
MEAN	30.7	0.0	10.1	2.9	10.0	2.4	119.1
STD	5.0	0.2	1.7	1.7	1.8	2.0	13.5
N	33	33	33	29	31	33	30
	.48	-.26	-.19	-.29	-.30	-.41	
Adopt							
MEAN	32.2	0.1	9.8	4.2	9.6	2.8	122.0
STD	5.0	0.4	2.3	2.1	2.4	1.9	18.7
N	33	33	30	26	33	30	25
r w/Bayley	.50	-.76	-.01	.19	.09	.32	
Fostered							
Index							
MEAN	30.8	0.2	9.1	3.3	9.7	4.1	125.1
STD	6.6	0.5	2.5	2.1	1.9	1.8	13.3
N	22	22	22	17	22	20	17
r w/Bayley	.31	-.50	.00	.06	-.13	.30	
Bio							
MEAN	29.3	0.0	9.5	3.2	9.5	1.3	120.9
STD	4.5	0.0	2.3	1.7	2.2	1.3	11.7
N	22	22	22	18	22	21	17
r w/Bayley	-.09	0.0	-.28	.45	-.26	.11	
Adopt							
MEAN	29.6	0.0	9.8	4.0	9.7	3.9	125.9
STD	4.2	0.2	1.6	1.7	1.5	1.8	6.9
N	22	22	21	19	22	20	17
r w/Bayley	.00	-.13	-.14	.40	.25	.45	

Table 6.25

Predictor Variables and Binet Scores for Whites Adopted or Fostered by 4 Years

	BWTx 100	Neur Exam	Moms Birth Educ	Birth Income	Moms 7-Yr Educ	7-Yr Inc	Binet
Adopted							
Index							
MEAN	33.0	0.1	11.0	4.3	11.9	5.8	103.7
STD	5.0	0.3	1.9	2.8	1.8	1.3	16.7
N	146	145	146	130	146	138	143
r w/Binet	.33	-.12	-.09	.01	-.06	.04	
Bio							
MEAN	33.6	0.1	10.9	4.2	10.8	3.3	99.0
STD	5.3	0.3	1.8	1.9	1.7	2.2	13.5
N	146	146	146	133	140	143	130
r w/Binet	.29	-.31	.07	-.11	.12	.06	
Adopt							
MEAN	33.0	0.1	11.9	5.1	11.7	5.3	103.5
STD	5.0	0.4	1.8	2.2	1.8	1.8	14.6
N	145	146	137	124	146	144	130
r w/Binet	.20	-.60	.02	.03	.01	-.01	
Fostered							
Index							
MEAN	31.3	0.2	9.8	4.3	10.9	5.0	91.1
STD	5.0	0.6	2.4	2.5	1.8	1.7	18.3
N	37	37	37	34	37	37	32
r w/Binet	.14	-.46	.23	.45	.14	.11	
Bio							
MEAN	31.9	0.1	9.9	4.7	10.1	3.7	101.0
STD	5.4	0.2	2.3	2.0	2.1	2.1	15.6
N	37	37	37	33	37	36	32
r w/Binet	-.03	.06	-.24	-.40	-.06	-.32	
Adopt							
MEAN	33.2	0.0	10.9	5.5	10.8	4.6	102.5
STD	5.5	0.2	1.7	2.7	1.8	1.9	14.5
N	37	37	35	32	37	36	31
r w/Binet	.15	.00	.18	.19	.20	-.09	

Table 6.26

Predictor Variables and Binet Scores for Nonwhites Adopted or Fostered by 4 Years

	BWTx 100	Neur Exam	Moms Birth Educ	Birth Income	Moms 7-Yr Educ	7-Yr Inc	Binet
Adopted							
Index							
MEAN	30.0	0.2	10.1	3.0	9.5	3.8	92.0
STD	5.6	0.5	1.6	1.8	2.6	2.0	13.7
N	44	44	44	37	44	42	43
r w/Binet	.56	-.31	-.08	-.15	.26	-.19	
Bio							
MEAN	31.1	0.1	10.2	3.1	10.1	2.6	87.9
STD	4.7	0.3	1.7	1.7	1.7	2.0	11.3
N	44	44	44	38	42	43	41
r w/Binet	.48	-.19	-.05	-.22	-.13	-.23	.20
Adopt							
MEAN	31.6	0.1	10.2	4.3	9.9	3.1	90.2
STD	5.1	0.4	2.4	2.2	2.4	2.1	16.2
N	44	44	41	36	44	41	39
r w/Bayley	.46	-.59	.02	.25	.09	.24	
Fostered							
Index							
MEAN	29.4	0.3	9.2	3.1	9.3	3.6	88.7
STD	6.7	0.6	2.3	1.6	2.2	1.9	15.4
N	54	53	54	45	54	49	49
r w/Binet	.32	-.64	.04	.00	.02	.07	
Bio							
MEAN	29.9	0.1	9.5	3.3	9.6	1.8	86.5
STD	4.8	0.3	2.1	1.4	2.0	1.5	13.1
N	54	54	54	48	53	52	50
r w/Binet	.17	-.18	-.22	.30	-.20	.07	
Adopt							
MEAN	31.1	0.1	9.7	3.9	9.4	3.6	90.6
STD	5.2	0.3	2.2	1.8	2.1	1.7	11.9
N	54	54	51	39	54	50	47
r w/Binet	.23	-.30	.23	.27	.37	.44	

predictor variables and Binet scores for children adopted or fostered before four years. All adopted and fostered children are used for the analysis of seven year tests.

Initially, a single model was fitted for each test, including race and adoption vs. fostering as part of the model. However, different models are required to fit white and nonwhite, and adopted and fostered children. The analysis of each four and seven year test therefore involved four separate analyses, for white and nonwhite adopted and fostered children. The Bayley was analyzed only for adopted children. This resulted in a total of 18 analyses, four each for the Binet, VIQ, PIQ and the WRAT, and two for the Bayley.

Age of Adoption or Fostering

A first step in the analysis is to consider the role of time of adoption or fostering in the cognitive development of the index cases. If time of adoption or fostering is an important predictor of outcome, the multigroup analyses will be complicated because time of adoption or fostering is relevant only for children who were actually adopted or fostered. The multigroup regression analyses which follow depend on fitting the same prediction model in the index cases and the two matched control groups so residual means can be compared.

Therefore, the role of age of adoption or fostering first was examined in the index cases. When effects of other predictor variables were controlled by the regression model, age of adoption had a significant effect in only one analysis, the Binet for Nonwhite foster children. The analysis indicated that these children lost 0.88 IQ points for each year they remained in their biological home. Given this was the only analysis of 18 for which age of adoption had an independent effect, there is a considerable possibility that even this effect occurred by chance. Age of adoption was removed from all subsequent analyses, including the one to which it contributed a significant effect. As will be seen below, the analysis for this group does not fit the statistical model in any case.

Prediction of Cognitive Development

Table 6.27 summarizes the results of the three-group regressions of cognitive measures on family variables. Each row of the table can be read as an unstandardized regression equation. The first six columns in each row give the unstandardized regression coefficients of the six predictor variables. These have been forced to be equal across the three groups by the estimation procedure. The last three columns are the intercept terms of the regression equations for the three groups. These have been allowed to vary between groups, and can be interpreted as the residual mean of the dependent variable after the effects of the predictor variables have been controlled. For example, the prediction equation for the Bayley in white adopted children is given by the first row of the table as,

$$0.5 \text{xBWT} - 7.1 \text{xNeur} - 0.2 \text{xMed0} - 0.2 \text{xInc0} + 0.6 \text{xInc7} + U + I$$

Table 6.27

Regression of Cognitive Measures on Family Variables

	BWT	Neur Exam	Med0	Inc0	Med7	Inc7	Index Intcpt	Bio Intcpt	Adopt Intcpt
	Boldface indicates <------coefficient differs------> from 0, p < .05.						Boldface indicates <-intercepts differ---> from each other p<.05.		
Bayley									
White									
Adopt	**0.5**	**-7.1**	-0.2	-0.2	0.0	0.6	110.8	109.7	109.1
Nonwhite									
Adopt	**1.0**	**-10.6**	-0.4	0.1	0.3	-0.7	**101.7**	**92.8**	**95.2**
Binet									
White									
Adopt	0.0	0.0	**1.6**	0.2	-0.5	0.4	88.2	83.8	86.5
Foster	-0.1	**-17.1**	0.2	0.1	**0.8**	**1.3**	**78.7**	**88.0**	**87.2**
Nonwhite									
Adopt	**0.8**	-1.4	1.3	0.0	0.1	0.1	55.9	50.9	52.9
**Foster	0.1	**	0.8	1.0	-0.1	0.4	74.2	75.2	75.0
PIQ									
White									
Adopt	0.2	0.6	**1.3**	-0.2	0.4	**1.0**	73.3	72.9	71.8
Foster	0.3	**-7.9**	0.2	0.6	1.0	**1.4**	68.6	74.3	72.8
Nonwhite									
Adopt	0.2	-5.0	**2.3**	-0.5	-1.1	0.3	76.0	72.3	76.5
Foster	-0.1	-2.0	0.4	-0.4	0.7	-0.1	**81.4**	**85.5**	**88.5**
VIQ									
White									
Adopt	0.1	1.1	**0.9**	-0.1	**1.1**	0.6	70.1	70.3	70.0
Foster	0.0	**-6.2**	0.8	-0.1	**1.2**	**1.1**	**65.5**	**73.8**	**73.1**
Nonwhite									
Adopt	0.3	-2.2	1.2	-0.7	-0.5	0.4	76.8	73.4	79.4
Foster	-0.1	**-5.1**	-0.2	0.2	0.7	0.3	82.0	83.1	85.3
WRAT									
White									
Adopt	0.1	-0.6	**1.0**	-0.5	0.3	**0.8**	**35.1**	**31.5**	**34.6**
Foster	0.0	**-5.2**	0.8	0.2	-0.3	**1.4**	**36.8**	**43.3**	**43.1**
Nonwhite									
Adopt	0.2	-0.5	**1.5**	0.8	-0.2	0.8	23.0	25.2	25.3
Foster	0.0	-0.7	0.2	0.1	1.2	0.0	**30.6**	**35.2**	**36.4**

** Equivalent models could not be fit across groups. Coefficients were 3.0 for index cases, -25.9 for biological matches, and 9.1 for adoptive matches.

where U is a residual variance and I is an intercept term equal to 110.8, 109.7 and 109.1 for the index cases, biological and adoptive matches, respectively. Unstandardized regression coefficients significantly different from zero are printed in boldface; intercepts that are significantly different across the three groups are also printed in boldface across a row.

Predictor variables are not on the same scale, so magnitudes of regression coefficients are not comparable across variables. Birth and seven year income variables were rescaled to the scale of seven-year education across the entire sample by multiplying them by 1.27 and 0.83, repectively. Different degrees of selection within groups resulted in somewhat different variances in the groups used for analyses. Birthweight is in hundreds of grams, and neurological results were left in the 0, 1, 2 form in which they were originally recorded. All cognitive measures were left in the original units. The regression coefficients can be interpreted as test points per 100 grams of birthweight, test points per each degree of positive neurological diagnosis, and test points per grade of mother's education.

The statistical significance of regression coefficients is not comparable across analyses (rows) because different numbers of subjects per group result in different degrees of power in the significance test. Little faith is to be placed in the exact values of the significance test in any case. Magnitude of the regression coefficients, rather than their statistical significance, is the best basis for comparison across analyses.

For the analysis of nonwhite foster children's Binet scores, a model could not be fit with the constraint of equal regression coefficients for neurological exam across groups. The model was fit with this coefficient allowed to vary across groups. This should not affect the interpretation of the other regression coefficients but does mean that the intercept terms are not comparable across groups.

Birth Variables

The only substantial predictors of Bayley scales, in whites and nonwhites, are birthweight and neurological diagnosis. Both are somewhat stronger predictors for nonwhites than whites. None of the socioeconomic predictors is independently related to Bayley scores. Results are different for the four year Binet and the other intellectual measures. Biological mother's education is a significant predictor of the intellectual measures for all but one of the small N adopted groups, for which the coefficient is of the same magnitude. Though consistently positive, biological mother's education is not a significant predictor in any analysis of the fostered groups. Conversely, the neurological exam is a significant predictor for all but two of the foster groups. The importance of mother's education and neurological status appear to be inversely related: the rank order correlation between the absolute values of the coefficients for biological mother's education and neurological exam, across 18 analyses, is -.59, 16 df, p=.01.

The effect of neurological status on the relationship between biological mother's education and the childrens' ability measures was further investigated by reanalyzing the white foster cases after removing all suspicious or definite cases of neurological impairment. For the Binet, this resulted in an increase in the regression coefficient for biological mother's education from 0.2 to 1.5. VIQ, PIQ and WRAT scores showed no increased relationship with birth mother's education when the neurological cases had been removed. There are two possibilities for the inverse relationship between the importance of neurological status and biological mother's education: either the relationship is coincidental, or the neurological exam did not identify all of the neurologically impaired children. If the latter is true, the relatively higher rate of diagnosed neurological impairment in foster children would reflect an even higher true rate, and removing diagnosed subjects would leave others undetected.

Seven Year Variables

The seven year variables are indices of the quality of the rearing environment of the children. Mother's seven year education and seven year income are moderately correlated. Their effects are therefore somewhat difficult to separate, and the most sense can be made out of them if they are considered together. One or both of the seven year variables are significant predictors of cognitive performance for both adopted and fostered white children on all but one test, white adopted children on the Binet. In every case they are more substantial predictors for fostered than adopted children. They are not significant for any group on any test in nonwhite children, though the magnitude of the coefficients is again higher for fostered than adopted children.

In summary, only biological variables predict infant Bayley scores. Mother's education predicts intellectual measures if the effect of neurological damage is not too great. Socioeconomic measures of rearing environment are important predictors for white children, especially foster children, but not for nonwhites. It should be remembered that SEI variables were more intercorrelated in whites than in nonwhites, indicating that whites have a more unitary index of socioeconomic status. We have seen little evidence that the construct of SES exists for nonwhites in this sample.

Partitioning of Variance

Tables 6.28 through 6.32 describe the variance of the developmental and cognitive measures explained by biological and family predictors. Each table, one for each of the cognitive measures, contains 6 rows for each of the 18 analyses, two rows for each of the three groups in the analysis. The first six columns in the first row for each group in each analysis contain the amount of variance of the cognitive measure explained by the six predictor variables. This was computed as the square of the unstandardized regression coefficient times the variance of the predictor variable. The seventh column, labelled "Cov's", contains the amount of variance of the cognitive measure explained by the 15 covariances among the predictor variables. The variation explained by each pair of predictor variables was computed as the product of their unstandardized regression coefficients multiplied by their covariance; these were summed across the 15 pairs of covariances. The eighth column, labelled "Total," is the sum of the first seven columns.

The last two columns in the first row for each group in each analysis show the predicted and actual variance of the cognitive measure. The column labelled "Pred Var" contains the total predicted variance of each variable, computed as the sum of the variance explained by main effects and covariances and the residual variance as estimated by LISREL. Because LISREL was forced to maintain equal regression coefficients across the three groups in each analysis, it sometimes misestimated the total variance to improve the overall fit of the model. In general, this misestimation reduced large variance differences among the groups. The column labelled "Actual Var" contains the actual sample variance of the variables. The second row for each group in each analysis, labelled with a percent symbol, contains the percentage of the <u>actual</u> variance explained by each predictor and the covariances. These percentages are simply the percentage of variance explained by each predictor in the model.

Table 6.28

Partitioning Variance of Bayley

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Cov's	Total	Pred Var	Actual Var
WRAT										
White										
Adopt										
Index	6.0	5.8	0.1	0.2	0.0	0.7	1.0	13.9	63.3	56.3
%	10.7	10.3	0.2	0.4	0.0	1.2	1.8	24.7		
Bio	5.0	6.8	0.1	0.1	0.0	2.1	-0.8	13.3	123.6	134.6
%	3.7	5.1	0.1	0.1	0.0	1.6	-0.6	9.9		
Adopt	5.8	6.0	0.1	0.2	0.0	1.1	-0.1	13.1	100.4	104.4
%	5.6	5.7	0.1	0.2	0.0	1.1	-0.1	12.6		
Foster										
Index										
%										
Bio										
%										
Adopt										
%										
Nonwhite										
Adopt										
Index	21.1	27.1	0.4	0.0	0.5	1.8	17.9	68.8	133.4	92.7
%	11.1	14.2	0.2	0.0	0.3	0.9	9.4	36.1		
Bio	3.2	22.4	0.5	0.0	0.2	2.0	-1.3	27.0	141.5	182.6
%	1.8	12.3	0.2	0.0	0.1	1.1	0.7	14.8		
Adopt	15.9	22.1	0.8	0.0	0.4	1.8	13.5	54.5	261.4	349.0
%	4.6	6.3	0.2	0.0	0.1	0.5	3.9	15.6		
Foster										
Index										
%										
Bio										
%										
Adopt										
%										

Table 6.29

Partitioning Variance of Binet

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Cov's	Total	Pred Var	Actual Var
Binet										
White										
Adopt										
Index	0.0	0.0	9.1	0.2	0.9	0.2	-1.4	9.0	275.2	278.9
%	0.0	0.0	3.3	0.1	0.3	0.1	-0.5	3.2		
Bio	0.0	0.0	8.6	0.1	0.7	0.7	-3.4	6.7	192.4	182.3
%	0.0	0.0	4.7	0.0	0.4	0.4	-2.0	3.7		
Adopt	0.0	0.0	8.6	0.1	0.9	0.4	-3.9	6.2	201.5	213.2
%	0.0	0.0	4.1	0.0	0.4	0.2	-1.7	2.9		
Foster										
Index	104.4	0.1	0.3	0.0	2.1	4.9	-6.5	105.3	265.3	334.9
%	31.2	0.0	0.1	0.0	0.6	1.5	-2.0	31.4		
Bio	16.0	0.1	0.3	0.0	2.8	7.2	14.0	40.4	311.2	243.4
%	6.6	0.0	0.1	0.0	1.2	2.9	5.7	16.7		
Adopt	8.2	0.1	0.1	0.0	2.2	6.0	9.3	25.9	221.6	210.3
%	3.9	0.0	0.1	0.0	1.0	2.9	4.4	12.3		
Nonwhite										
Adopt										
Index	0.4	17.7	4.1	0.0	0.0	0.0	-2.1	20.1	171.9	187.7
%	0.2	9.4	2.2	0.0	0.0	0.0	-1.1	10.7		
Bio	0.2	12.4	4.6	0.0	0.0	0.0	-1.1	16.1	132.4	127.7
%	0.2	9.7	3.6	0.0	0.0	0.0	-0.9	12.6		
Adopt	0.3	14.2	8.7	0.0	0.0	0.0	4.8	28.1	259.9	262.4
%	0.1	5.4	3.3	0.0	0.0	0.0	1.8	10.7		
Foster										
Index	3.4	0.5	3.4	1.5	0.0	0.7	-3.3	6.2	226.6	237.2
%	1.4	0.2	1.4	0.6	0.0	0.3	-1.4	2.6		
Bio	45.7	0.2	2.9	1.1	0.0	0.4	0.3	50.7	174.3	171.6
%	26.7	0.1	1.7	0.6	0.0	0.2	0.2	29.6		
Adopt	7.0	0.3	3.0	2.0	0.0	0.6	-1.8	11.0	136.5	141.6
%	4.9	0.2	2.1	1.4	0.0	0.4	-1.3	7.8		

Table 6.30

Partitioning Variance of PIQ

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Cov's	Total	Pred Var	Actual Var
PIQ										
White										
Adopt										
Index	0.0	0.8	6.1	0.3	0.6	1.7	2.9	12.3	189.8	182.3
%	0.0	0.4	3.4	0.2	0.3	0.9	1.0	6.7		
Bio	0.0	0.9	5.8	0.1	0.5	4.6	6.1	18.0	204.0	210.3
%	0.0	0.4	2.8	0.1	0.2	2.2	2.9	8.6		
Adopt	0.1	0.8	5.8	0.2	0.6	2.9	6.2	16.5	205.3	210.3
%	0.0	0.4	2.8	0.1	0.3	1.4	2.9	7.9		
Foster										
Index	20.6	2.0	0.1	0.9	3.7	5.6	11.8	44.8	216.0	246.5
%	8.4	0.8	0.1	0.4	1.5	2.3	4.8	18.2		
Bio	4.9	2.0	0.1	1.0	4.5	9.5	10.9	33.0	235.9	225.0
%	2.2	0.9	0.1	0.4	2.0	4.2	4.8	14.7		
Adopt	4.0	1.9	0.1	1.1	3.4	7.1	12.4	30.1	195.9	185.0
%	2.2	1.1	0.0	0.6	1.8	3.9	6.7	16.2		
Nonwhite										
Adopt										
Index	5.4	1.4	14.0	0.5	7.5	0.5	-4.4	24.7	219.9	256.0
%	2.1	0.6	5.5	0.2	2.9	0.2	-1.7	9.7		
Bio	3.1	0.8	14.7	0.5	3.3	0.5	-10.4	12.5	139.7	139.2
%	2.2	0.6	10.5	0.4	2.4	0.3	-7.4	9.0		
Adopt	4.3	0.9	26.6	0.7	6.1	0.5	-19.4	19.8	214.6	193.2
%	2.2	0.5	13.8	0.4	3.2	0.3	-10.1	10.3		
Foster										
Index	1.2	0.8	0.9	0.2	2.7	0.1	-0.6	5.3	198.9	198.8
%	0.6	0.4	0.4	0.1	1.3	0.0	-0.3	2.7		
Bio	0.5	0.6	0.7	0.2	2.4	0.0	1.7	6.2	199.4	213.2
%	0.2	0.3	0.4	0.1	1.1	0.0	0.8	2.9		
Adopt	0.5	0.5	0.6	0.4	2.2	0.1	0.9	5.3	198.3	193.2
%	0.3	0.3	0.3	0.2	1.2	0.0	0.5	2.7		

Table 6.31

Partitioning Variance of VIQ

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Cov's	Total	Pred Var	Actual Var
WRAT										
White										
Adopt										
Index	0.1	0.1	2.7	0.1	4.2	0.7	4.0	12.0	139.1	134.6
%	0.1	0.1	2.0	0.1	3.1	0.5	3.0	8.9		
Bio	0.1	0.1	2.6	0.0	3.5	2.0	7.2	15.6	190.2	190.4
%	0.1	0.1	1.4	0.0	1.8	1.0	3.8	8.2		
Adopt	0.2	0.1	2.6	0.1	4.3	1.3	8.7	17.3	138.1	144.0
%	0.1	0.1	1.8	0.0	3.0	0.9	6.0	12.0		
Foster										
Index	13.0	0.0	3.4	0.0	5.8	3.2	8.5	34.0	210.1	237.2
%	5.5	0.0	1.4	0.0	2.4	1.4	3.6	14.3		
Bio	3.1	0.0	3.2	0.0	7.1	5.5	18.9	37.8	152.4	156.3
%	2.0	0.0	2.1	0.0	4.5	3.5	12.1	24.2		
Adopt	2.5	0.0	2.0	0.0	5.3	4.2	13.3	27.2	177.7	158.8
%	1.6	0.0	1.2	0.0	3.3	2.6	8.4	17.2		
Nonwhite										
Adopt										
Index	1.1	2.4	3.8	1.0	1.9	0.5	-0.8	9.8	167.1	174.2
%	0.6	1.4	2.2	0.5	1.1	0.3	-0.4	5.6		
Bio	0.6	1.4	4.0	0.9	0.8	0.5	-2.9	5.3	125.7	127.7
%	0.5	1.1	3.1	0.7	0.7	0.4	-2.3	4.1		
Adopt	0.8	1.6	7.2	1.4	1.5	0.6	-6.3	6.9	174.1	174.2
%	0.5	0.9	4.1	0.8	0.9	0.3	-3.6	3.9		
Foster										
Index	8.2	0.4	0.4	0.1	2.4	0.3	0.1	11.9	156.0	156.0
%	5.2	0.3	0.2	0.1	1.5	0.2	0.1	7.6		
Bio	3.2	0.3	0.3	0.1	2.1	0.2	-2.4	3.8	128.5	127.7
%	2.5	0.2	0.2	0.1	1.7	0.1	-1.9	3.0		
Adopt	3.5	0.3	0.3	0.1	2.0	0.3	-0.6	5.7	109.8	114.5
%	3.0	0.3	0.2	0.1	1.7	0.3	-0.6	5.0		

Table 6.32

Partitioning Variance of WRAT

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Cov's	Total	Pred Var	Actual Var
WRAT										
White										
Adopt										
Index	0.0	0.1	3.4	1.1	0.2	1.1	1.2	7.2	126.0	127.1
%	0.0	0.1	2.6	0.9	0.2	0.8	1.0	5.6		
Bio	0.0	0.1	3.2	0.5	0.2	2.9	2.3	9.3	110.6	110.3
%	0.0	0.1	2.9	0.5	0.2	2.7	2.1	8.4		
Adopt	0.1	0.1	3.2	0.7	0.2	1.9	2.5	8.7	113.9	114.5
%	0.1	0.1	2.8	0.6	0.2	1.6	2.2	7.6		
Foster										
Index	8.9	0.0	3.7	0.1	0.4	5.7	1.6	20.4	191.0	193.0
%	4.6	0.0	1.9	0.1	0.2	2.9	0.8	10.6		
Bio	2.1	0.0	3.5	0.1	0.5	9.7	6.0	21.9	193.0	193.2
%	1.1	0.0	1.8	0.1	0.3	5.0	3.1	11.3		
Adopt	1.7	0.0	2.1	0.1	0.4	7.3	0.7	12.3	139.6	146.4
%	1.2	0.0	1.4	0.1	0.3	5.0	0.5	8.4		
Nonwhite										
Adopt										
Index	0.1	1.8	5.9	1.0	0.3	2.8	-0.8	11.1	88.5	92.2
%	0.1	1.9	6.4	1.1	0.3	3.0	-0.8	12.0		
Bio	0.0	1.0	6.2	1.0	0.1	2.6	1.6	12.6	185.6	190.4
%	0.0	0.5	3.3	0.5	0.1	1.4	0.8	6.6		
Adopt	0.1	1.2	11.3	1.6	0.2	3.1	7.7	25.2	180.3	179.6
%	0.0	0.7	6.3	0.9	0.1	1.8	4.3	14.0		
Foster										
Index	0.2	0.0	0.4	0.0	8.0	0.0	0.7	9.4	138.2	136.9
%	0.1	0.0	0.3	0.0	5.9	0.0	0.5	6.8		
Bio	0.1	0.0	0.3	0.0	7.2	0.0	2.3	10.0	279.0	299.3
%	0.0	0.0	0.1	0.0	2.4	0.0	0.8	3.3		
Adopt	0.1	0.0	0.3	0.0	6.7	0.0	3.0	10.1	167.0	163.8
%	0.0	0.0	0.2	0.0	4.1	0.0	1.8	6.2		

These are interpretable as an effect size, or as the square of the standardized regression coefficient for each variable.

The most striking fact about the explained variance of the developmental and cognitive tests is how little of it there is. Little more than 10% of the variance in cognitive ability is explained by the predictor variables for adopted children of either race. A somewhat higher percentage of the variance is predicted for foster children, but this is mainly due to large effects for neurological status. Birth mother's education explains about two to ten percent of the variance in the cognitive tests for adopted children. Seven year family variables explain about the same percentage in white, but not nonwhite children. The effects of the covariances show no consistent pattern. As often as not they reduce the predicted variance rather than adding to it. When covariances make a substantial contribution to the prediction of outcome, the reason is always the substantial correlation between birthweight and neurological status.

The other readily apparent characteristic of the explained variance is its instability across tests and groups. Although the regression models were constrained to be equal across groups, group differences in the variance of independent and dependent variables produce wide swings in the proportion of variance explained across groups. For example, consider the effect of seven year family income. This variable was a significant predictor of Binet, VIQ, PIQ and WRAT scores for white foster cases, and for the WRAT in White adopted cases. Although the regression coefficient was constrained to be equal across groups in each analysis, the amount of variance explained by seven year income was lower for the index cases than for the control groups in all five instances. This occurs because the variance of seven year income is lower for index cases, probably indicating greater selection for adequate income in adoptive and foster families.

Partitioning of Mean Differences

Tables 6.33 and 6.34 show the effect of within group relationships between biological and family variables and measures of cognitive development on between group differences in test scores. This partitioning differs from partitioning of variance in one important respect. Covariances among predictor variables have no effect on the mean of the dependent variable. That is, if *a* and *b* are the unstandardized regression coefficients of a cognitive measure on predictor variables *A* and *B*, the variance of the dependent variable predicted by A and B equals

$$a[Var(A)]+b[Var(B)]+2ab[Cov(AB)],$$

the mean equals simply

$$a[Mean(A)]+b[Mean(B)].$$

If a dependent variable is predicted by equivalent regression models in two groups, the *difference* between the means of the two

Table 6.33

Partitioning Group Means of Bayley, Binet and WRAT

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Model	Resid	Pred Diff	Actual Diff
Bayley										
White										
Adopt										
I-B	-0.2	-0.3	0.0	0.0	0.0	1.6	1.1	1.1	2.2	2.2
I-A	-0.2	0.0	0.2	0.1	0.0	0.4	0.5	1.8	2.3	2.4
Nonwhite										
Adopt										
I-B	-1.3	-0.7	0.0	0.0	-0.2	-0.7	-2.9	8.9	6.0	6.0
I-A	-0.6	-2.0	-0.1	-0.1	-0.1	-0.4	-3.3	6.5	3.2	3.1
Binet										
White										
Adopt										
I-B	0.0	0.0	0.1	0.0	-0.6	0.9	0.4	4.4	4.8	4.7
I-A	0.0	0.0	-1.4	-0.1	-0.1	0.2	-1.4	1.6	0.2	0.2
Foster										
I-B	-2.9	0.0	0.0	0.0	0.7	1.7	-0.5	-9.3	-9.8	-9.9
I-A	-3.4	0.1	-0.3	-0.1	0.2	0.5	-3.0	-8.5	-11.5	-11.4
Nonwhite										
Adopt										
I-B	-0.1	-0.8	-0.1	0.0	0.0	0.1	-0.9	5.0	4.1	4.1
I-A	0.0	-1.3	0.0	0.0	0.0	0.0	-1.3	3.1	1.8	1.8
Foster										
I-B	[Equivalent regression models not possible across groups]									
I-A										
WRAT										
White										
Adopt										
I-B	0.0	0.0	0.1	0.0	0.3	1.9	2.3	3.6	5.9	5.8
I-A	0.0	0.0	-0.8	0.3	0.1	0.4	0.0	0.5	0.5	0.4
Foster										
I-B	-0.9	0.0	0.0	-0.1	-0.3	1.9	0.6	-6.5	-5.9	-5.9
I-A	-1.0	0.0	-1.1	-0.2	-0.1	0.3	-2.1	-6.3	-8.4	-8.4
Nonwhite										
Adopt										
I-B	0.0	-0.4	-0.2	-0.1	0.1	1.0	0.4	-2.2	-1.8	-1.9
I-A	0.0	-0.5	-0.2	-0.8	0.1	0.5	-0.9	-2.3	-3.2	-3.2
Foster										
I-B	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.2	-4.6	-4.8	-4.9
I-A	-0.1	0.0	-0.1	-0.1	-0.2	0.0	-0.5	-5.8	-6.3	-6.3

Table 6.34

Partitioning Group Means of VIQ and PIQ

	Neur	BWT	Moms Birth Educ	Birth Inc	Moms 7-Yr Educ	7-Yr Inc	Model	Resid	Pred Diff	Actual Diff
PIQ										
White										
Adopt										
I-B	0.0	-0.1	0.1	0.0	0.5	2.4	2.9	0.4	3.3	3.3
I-A	0.0	0.0	-1.1	0.2	0.1	0.5	-0.3	1.5	1.2	1.1
Foster										
I-B	-1.4	-0.3	0.0	-0.2	1.0	1.9	1.0	-5.7	-4.7	-4.6
I-A	-1.5	-0.3	-0.2	-0.6	0.2	0.3	-2.1	-4.2	-6.3	-6.3
Nonwhite										
Adopt										
I-B	-0.3	-0.4	-0.2	0.1	0.5	0.4	0.1	3.8	3.9	3.8
I-A	0.0	-0.4	-0.3	0.5	0.3	0.2	0.3	-0.4	-0.1	-0.1
Foster										
I-B	-0.3	0.0	-0.1	0.1	0.0	-0.3	-0.6	-4.0	-4.6	-4.6
I-A	-0.3	0.1	-0.2	0.3	-0.1	0.0	-0.2	-7.0	-7.2	-7.2
VIQ										
White										
Adopt										
I-B	0.0	0.0	0.1	0.0	1.3	1.6	3.0	-0.3	2.7	2.7
I-A	0.0	0.0	-0.8	0.1	0.2	0.3	-0.2	0.0	-0.2	-0.1
Foster										
I-B	-1.1	0.0	0.0	0.0	1.2	1.4	1.5	-8.3	-6.8	-6.8
I-A	-1.2	0.0	-1.0	0.1	0.3	0.2	-1.6	-7.6	-9.2	-9.3
Nonwhite										
Adopt										
I-B	-0.1	-0.5	-0.1	0.1	0.2	0.4	0.0	3.4	3.4	3.4
I-A	0.0	-0.5	-0.2	0.7	0.2	0.2	0.4	-2.6	-2.2	-2.3
Foster										
I-B	-0.8	0.0	0.1	-0.1	0.0	0.5	-0.3	-1.0	-1.3	-1.3
I-A	-0.8	0.1	0.1	-0.2	-0.1	0.1	-0.8	-3.3	-4.1	-4.1

groups equals,

$$a[\text{Mean}(A_1)]+b[\text{Mean}(B_1)] - a[\text{Mean}(A_2)]+b[\text{Mean}(B_2)]$$

Or more simply,

$$a[\text{Mean}(A_1)-\text{Mean}(A_2)]+b[\text{Mean}(B_1)-\text{Mean}(B_2)].$$

Subscripts refer to the means of the two groups.

The two tables describing the partitioning of means contain two rows for each analysis. Rows labelled "I-B" refer to the difference between the mean of the index cases and the mean of the biological matches, and rows labelled "I-A" refer to the difference between index cases and adoptive matches. The first six columns in each row give the difference in the outcome measure between the index cases and the control group predicted by the difference in each predictor variable. The column labelled "Model" is the sum of the predicted differences. The column labelled "Resid" is the mean difference not predicted by the model. Differences between predicted and actual group means are introduced by rounding error.

As an example, consider the figure "2.4" in the sixth column of the first row of Table 6.34. This number means the model predicts that index cases should have a 2.4 point advantage in PIQ over biological matches on the basis of differences in seven year income between the two groups. The mean of seven year income, from Table 6.12 on page 84, is 5.8 for the index cases and 3.3 for the biological matches, so the difference is 2.5. The regression coefficient from seven year income to PIQ for white adopted children, from Table 6.27 on page 107, is 1.0. The predicted difference in PIQ on the basis of a 2.5 difference in seven year income is 2.5 x 1.0, or 2.5 points. Rounding error accounts for the difference between this figure and the tabled figure: the actual regression coefficient is 0.97, which has been rounded to 1.0 in the table; 2.5 x 0.97 equals 2.425.

Few of the group differences among index cases and their matched controls are predicted by within group relationships with biological and family variables. In 20 out of 34 cases, predicted differences are in the same direction as actual differences, but are smaller; in only a very few cases (White adopted children for VIQ and PIQ) are group differences well predicted by within group relationships. Residuals for adopted children are almost all positive, indicating that adopted children's test performance relative to controls is better than would be predicted on the basis of family variables. Residuals of fostered children are uniformly negative. The correlation between the mean differences predicted by the model (without the residual) and the actual mean differences was .29 across 34 analyses, $p > 0.1$, suggesting that the mean differences in outcome are not the result of mean differences in the predictor variables.

Justifying Between and Within Group Analyses

As has often been the case in the history of adoption studies, the between and within group analyses reported here seem to point in different directions. Adopted children do better on cognitive tests than children born to and reared by similar parents, but measured differences between the rearing families do not seem to be sufficient to explain the advantage.

As was discussed in Chapter 2, there are several methodological reasons why this discrepancy might occur. One is that comparisons of group means capitalize on the full range of differences between the groups, while within group correlational analyses select only a few variables for analysis. The rearing environments of index cases and biological matches are no doubt different in a myriad of ways, of which parental education and income are only two. Most of these differences are probably correlated with parental education and income, but if they nonetheless each make some small independent contribution to IQ, their cumulative effect may be substantial. Another possibility is that there may have been undetected differences among the groups at birth. These could have been characteristics of infants making them attractive for adoption, or uncontrolled differences between the biological families of index cases and biological matches. Below, several analyses are presented that may shed some light on the nature of the discrepencies between the mean difference and correlational results.

Uncontrolled Differences at Birth

Although birth characteristics of index cases were matched to biological controls, matching was necessarily incomplete and only partially successful. Uncontrolled differences among the groups may have contributed to mean differences in IQ. It has often been suggested that adopted children are selected for the absence of obvious impairment in infancy, leading to an increase in their mean IQ (Munsinger, 1975). In this study, obvious sources of biological advantage have been controlled. Adopted children show no advantage in birthweight and gestational age and are, if anything, more likely than controls to be diagnosed as neurologically impaired. Fostered children, however, were much more likely to be neurologically impaired and to show a marked decrement in IQ.

One can investigate the role of neurological status by removing neurologically suspect cases from the sample. If neurological status is largely responsible for the poor performance of fostered index cases, then the mean difference between index cases and biological controls should be reduced when neurological cases are removed. This does not appear to be the case: when neurological cases are removed from both samples, fostered white index cases perform 6.8, 2.9 and 7.5 points worse than biological controls on VIQ, PIQ and WRAT scores respectively, compared to 6.8, 4.7 and 5.9 points worse when neurological cases are included. Nonwhite fostered index cases perform 2.9, 8.2 and 7.7 points worse without neurological cases, and 1.3, 4.6 and 4.9 points worse with them.

Another uncontrolled source of differences between index cases and matched controls is the biological fathers. Index cases and controls were only matched for mother's education because data were not available for half of the biological fathers. An examination of Table 6.4 on page 71 and and Table 6.5 on page 72 shows that the known biological fathers of the index cases were better educated than the fathers of the biological matches by between half a grade to a grade. If the relationship of biological fathers' education to IQ is similar to that of biological mother's education to IQ (about 1.5 IQ points per grade among adopted children), this difference would contribute about one IQ point to the index cases' IQ's relative to biological controls.

Mother's Marital Status

Most adopted and fostered children were placed in homes in which the mother was married and the father living at home. Many of the biological matches remained in homes with single mothers. Table 6.35 shows the seven year cognitive measures broken down by the seven year marital status of the mothers of the biological matches. If removal from unmarried families is contributing to the advantage of the adopted children, one would expect a larger differences between index cases and biological matches when the mother of the biological match is unmarried. This only appears to be the case for the white adopted children. The advantages of white adopted children over their biological matches for VIQ, PIQ and combined WRAT scores are 1.5, 2.4 and 5.2 points respectively if the mothers of the biological matches

Table 6.35

Seven Year IQ by Marital Status of Biological Match

	Married			Not Married		
	Index	Bio	Adopt	Index	Bio	Adopt
White						
Adopted						
VIQ	98.7	97.2	100.0	98.5	93.6	96.1
PIQ	104.0	101.6	102.4	101.7	96.8	101.9
WRAT	53.9	48.7	54.5	54.1	48.7	51.4
N	100	100	100	48	48	48
Fostered						
VIQ	90.7	96.1	99.7	88.6	97.9	96.1
PIQ	95.3	99.2	99.5	95.2	101.1	105.1
WRAT	46.0	52.1	55.3	48.2	53.8	54.9
N	36	36	36	21	21	21
Nonwhite						
Adopted						
VIQ	92.1	86.0	93.1	88.8	87.6	92.1
PIQ	97.1	88.2	92.0	91.0	91.2	95.3
WRAT	47.5	50.7	54.0	46.8	47.5	47.3
N	21	21	21	26	26	26
Fostered						
VIQ	81.7	82.6	86.3	84.7	86.2	88.3
PIQ	83.6	85.5	90.9	86.9	93.0	94.0
WRAT	45.2	43.7	48.9	43.5	52.1	51.3
N	32	32	32	54	54	54

are married and 4.9, 4.9 and 7.3 points if they are not. For other groups, mother's marital status appears to make little difference.

Rescued Children

One way to examine the relationship between correlational and mean difference results is intentionally to amplify mean differences using an extreme group design. Therefore, index cases "rescued" from poor environments and placed in much better ones were selected for analysis along with their matched controls. Table 6.36 shows seven year IQ for children whose biological mothers completed nine grades of school or less and whose adoptive mothers had at least 12 years of education.

There is little evidence that the large improvement in rearing environment had much effect on the adopted children. White adopted "rescued" index cases show the same three or four point advantage in IQ relative to biological matches that was seen in the full sample and lag well behind the adoptive matches whose biological mothers are selected for high education. Nonwhite adopted index cases who were "rescued" show a deficit relative to biological matches. The large improvement in rearing environment does seem to have some effect in the fostered groups. Although neither the white nor the nonwhite foster cases show a substantial advantage relative to biological matches, the deficit that was seen in the full sample does not appear to exist for these children.

Table 6.36

7-Year IQ of Children with Biological Mothers Education < 10

and Adoptive Mothers Education 12 or Greater

	Index Case			Bio Match			Adopt Match		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
White									
Adopted									
VIQ	95.1	10.6	23	92.5	12.9	23	105.2	11.6	23
PIQ	97.3	13.8	23	94.3	11.8	22	102.7	15.6	23
WRAT	48.6	10.0	23	44.2	9.6	22	54.6	9.1	23
Mom Educ (0)	8.0	1.3	23	8.2	1.3	23	11.9	1.5	20
Mom Educ (7)	12.4	0.9	23	8.7	1.1	22	12.2	1.3	23
Fostered									
VIQ	94.0	17.4	13	91.7	13.3	13	98.2	14.0	13
PIQ	96.1	14.2	13	99.2	15.2	13	98.2	11.9	13
WRAT	48.0	12.6	13	47.1	11.4	13	49.4	12.0	13
Mom Educ (0)	7.6	1.7	13	7.7	1.6	13	11.7	1.2	12
Mom Educ (7)	12.5	1.1	13	8.5	1.8	11	12.2	1.3	13
Nonwhite									
Adopted									
VIQ	80.7	15.0	7	85.0	8.1	7	95.3	13.0	7
PIQ	81.7	20.8	7	84.4	13.3	7	96.9	17.1	7
WRAT	44.5	13.9	6	49.9	20.1	7	57.1	6.6	7
Mom Educ (0)	8.3	1.0	7	8.4	1.8	7	12.3	1.7	7
Mom Educ (7)	13.0	1.7	7	9.0	2.3	7	12.9	1.9	7
Fostered									
VIQ	86.5	11.0	10	84.5	11.6	10	90.0	5.4	10
PIQ	84.3	12.8	10	91.0	15.8	10	93.1	16.5	10
WRAT	48.6	9.4	10	46.4	17.1	10	51.2	11.3	10
Mom Educ (0)	7.9	1.1	10	8.2	1.1	10	10.7	1.8	9
Mom Educ (7)	12.2	0.6	10	9.4	1.8	10	11.8	0.9	10

Relatively Poor Adoptive Environments

The unusually low socioeconomic level of the adoptive and foster families in this sample permits an analysis opposite to the one described above. Index cases were selected whose biological mothers had at least a high school education but whose adoptive or foster parents had at most a high school education. Table 6.37 shows the seven year IQ scores of these children and their matched controls. Results are similar to the previous analysis. White adopted index cases perform slightly better than biological matches despite being reared by slightly more poorly educated mothers. Sample sizes make the results for the other groups difficult to interpret. Nonwhite adopted index cases perform substantially better than biological matches. Once again, the fostered index cases showed more evidence of an environmental effect. Both white and nonwhite foster cases in this analysis showed an even larger decrement in IQ relative to biological matches than was the case in the entire sample.

Table 6.37

7-Year IQ of Children with Biological Mothers Education

12 or Greater and Adoptive Mothers Education 12 or Less

	Index Case			Bio Match			Adopt Match		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
White									
Adopted									
VIQ	98.8	12.0	47	97.1	12.7	47	97.5	11.7	47
PIQ	103.7	13.5	47	102.6	11.3	47	104.1	14.1	47
WRAT	54.2	9.9	47	49.3	9.3	47	52.9	10.6	47
Mom Educ (0)	12.1	0.6	47	11.9	0.9	47	11.5	1.1	46
Mom Educ (7)	11.8	0.7	47	12.0	1.0	46	11.6	0.9	47
Fostered									
VIQ	94.5	18.4	6	107.8	15.9	6	108.3	15.8	6
PIQ	97.5	20.1	6	104.8	17.8	6	113.0	16.7	6
WRAT	57.2	14.0	6	64.5	21.6	6	66.0	15.1	6
Mom Educ (0)	12.7	1.0	6	12.7	1.0	6	11.5	0.8	6
Mom Educ (7)	11.5	0.8	6	12.7	1.0	6	11.2	1.3	6
Nonwhite									
Adopted									
VIQ	93.5	11.2	10	86.9	14.8	10	91.9	15.9	10
PIQ	100.5	13.4	10	93.2	7.6	10	93.2	16.6	10
WRAT	51.8	7.7	10	52.5	16.4	10	46.4	7.6	10
Mom Educ (0)	12.0	0.0	10	11.6	0.5	10	10.1	1.7	9
Mom Educ (7)	9.6	1.6	10	11.7	1.2	9	86.2	10.6	9
Fostered									
VIQ	81.2	16.7	9	89.3	5.5	9	86.2	10.6	9
PIQ	86.3	18.9	9	95.7	11.4	9	90.7	16.8	9
WRAT	43.7	8.1	9	58.5	16.3	9	51.0	8.5	9
Mom Educ (0)	12.3	0.7	9	12.1	0.3	9	8.8	1.9	8
Mom Educ (7)	8.9	2.7	9	12.2	0.7	9	9.2	2.3	9

CHAPTER 7: DISCUSSION

When one appreciates the problem of nature and nurture in its true complexity, it comes as no surprise that the results of adoption studies are ambiguous and difficult to interpret. This study is no exception. The most striking result, perhaps, has been that neither the imperfect measures of nature or nurture determined IQ's of children to any great extent. The majority of the variance in the IQ's of these children was, according to this research design and the measurement instruments available, random. That is to say, most of the differences among the IQ's of these children was determined not by the education of their biological mothers or the wealth of their rearing family, but by the individual and unmeasured course of their lives.

In this light, it is not surprising that neither nature nor nurture predominated as an influence on intellectual development. Both were required for even the minimal level of prediction that was possible. While the study did not find indications of powerful effects of any kind on the IQ, the effects that were detected were consistent across groups of children and types of tests and appeared to form a coherent pattern. One is left with the impression of having detected significant and perhaps substantial relationships in the presence of a great deal of noise that makes specification of details extremely difficult.

The most important results of the study are enumerated below. The implications of the study and its results will then be considered.

1. IQ scores of adopted children are higher than those of a group of nonadopted children born at about the same time in the same hospital to parents of the same race and similar SES and about as high as those of children born in the same hospital to parents of the same race, but of an SES similar to the adopted children's adoptive homes.

2. In similar comparisons, foster children performed substantially worse than both control groups.

3. Age of adoption was negatively related to IQ, but this relationship appears to have been a spurious consequence of the tendency for children with higher SES, better educated mothers to be placed earlier.

4. Infant Bayley scores were related to birthweight and neurological diagnosis but not to biological mother's education or SES of the rearing family.

5. Foster children were much more likely to be diagnosed as neurologically impaired than any other group, and neurological diagnosis was the most powerful predictor of their IQ.

6. Biological mother's education was an important predictor of IQ in adopted but not foster children. This appeared to be related to the high prevalence of neurological impairment in the foster children. Family income at the child's birth was not an important predictor of outcome in any group, suggesting that the effect of biological mother's education may reflect largely genetic rather than socioeconomic factors.

7. SES of the rearing family is an important predictor of IQ for whites but not for nonwhites. This appears to reflect racial differences in the structure of SES.

8. Within group effects of birthweight, neurological status, mother's education at birth and seven years, and family income at birth and seven years are insufficient to explain between group differences among adopted and foster children and controls.

9. The IQ advantage relative to controls of children adopted from the poorest biological environments into much better ones is no greater that the IQ advantage enjoyed by the full sample of adopted children. Foster children adopted from very poor environments into much better ones show a much smaller deficit in IQ than the full sample of foster children.

Characteristics of the Study Design

The decision to focus the study only on children for whom relatively complete data were available and for whom two matched controls could be found resulted in a loss of over half of the originally available subjects. The consequences of this loss are difficult to assess. Certainly, enough difficulty was encountered in interpreting the outcome of even these relatively simple cases to justify elimination of those for whom missing data or other problems would have created even greater complications and attendant error variance. The disadvantage of eliminating these subjects was that the sample size, which at the outset had seemed virtually unlimited, had by the completion of the study dwindled to the point where some groups of subjects (for instance nonwhite adopted) were difficult to analyze with confidence.

One source of subject loss of particular concern is the requirement that each index case be exactly matched by two controls. This requirement was intended to simplify group comparisons between adopted and nonadopted children. Several unanticipated factors, such as differences on relevant but unmatched variables, resulted in imperfect group matching despite the stringent requirements imposed. Statistical procedures were selected to allow for comparison of group means on IQ while controlling statistically for these remaining differences. If index cases and controls had not been matched at all the statistical procedures would still have been able to control for the greater group differences that would have resulted. One could question, then, whether the relatively greater group equality achieved by the matching procedure justified the loss of subjects it entailed. This question can only be answered by returning to the full sample of subjects for further analysis.

Characteristics of the Available Data

The data used in this study were not originally intended for an analysis of family effects on IQ. This was both an advantage and a disadvantage. On the positive side, the children studied here were unselected in a way that children of families agreeing to participate in an adoption study cannot be. On the other hand, several measures that would have added to the analysis were not available. Chief among these is parental intelligence. Genetic transmission of IQ is poorly measured by parental education. Education has the additional disadvantage of being as much an indicator of SES, and thus rearing environment, as it is of intelligence. Separation of genes and rearing environment is never possible in intact families, but a good IQ measure does the job better than amount of education, which is rife with social influences.

Available environmental measures, though far from ideal, were closer to the usual measures employed in adoption studies. Recent adoption studies, particularly the Colorado Adoption Project, include detailed measures of rearing environment; it remains to be seen if these additional measures will bear fruit. The availability of multiple environmental measures in this study did allow for comparison of their interrelationships in different groups, with some interesting results.

Characteristics of the Adopted Children

As has been discussed earlier, adopted children are to varying degrees unusual in that their rearing environments are both different than and uncorrelated with the genetic level of their biological parents. Different samples of adopted children achieve these characteristics to different degrees. In the sample reported here, the correlation between the rearing environments of adopted children and characteristics of their biological parents was typical or perhaps a little high, in the range of 0.2 to 0.3. This sample was quite unusual, though, in that the level of the adoptive homes was on the whole not very much greater than that of the homes out of which the children were adopted: for white children the difference was about half of a standard deviation, and for nonwhite children there was practically no difference at all. Close to twenty percent of the adopted children, in fact, were adopted into homes of lower SES than those of their biological parents.

Structure of Environmental Variables

Indicators of SEI showed low intercorrelations, particularly among nonwhites. This does not appear to be an idiosyncratic characteristic of the sample. Rather, it seems to reflect the absence of a meaningful single construct describing family environment, particularly among nonwhites.

Nam and Powers (1965) examined racial differences in the structure of SES. Working with the U.S. Bureau of the Census index on which the NCPP index was based, they assigned "consistency scores" to whites and nonwhites based on the degree of congruence among levels of education, income and occupation. Whites and nonwhites living in or near urban areas showed about the same degree of consistency, but rural blacks showed substantially less consistency than rural whites. The NCPP population, however, is mostly urban. A meta-analysis of the relation between SES and academic achievement by White (1982) found a correlation of -0.3 between the SES-Achievement correlation and the percent of minorities included in the study sample.

One can think of many reasons why SES would be a less unified construct in blacks than whites. Limitations of opportunity for completing school, obtaining a job and earning money would tend to make an SES measure less dependent on the ability and initiative of individuals. Restriction of opportunity may be reflected in the fact that the variances of occupation and income are consistently larger for whites than for nonwhites in this study; variation in education is slightly less for whites than nonwhites, reflecting the high percentage of whites completing exactly 12 years of education.

Age of Adoption

Under an environmental hypothesis, it seems reasonable that children adopted early into good homes should do better than children who are adopted later. Selective placement is the major difficulty in studying this effect: even if there is little selective placement for children across all ages, it is hard to eliminate the tendency for more attractive children to be adopted before the less attractive children with whom they are competing for placement.

Many adoption studies have naively reported a negative relationship between age of adoption and intellectual outcome without considering confounding variables. Speer (1940), for example, found that children placed before 2 had a mean IQ of 102.5 following adoption, while those placed after the age of 12 had a mean of 79.2. Scarr and Weinberg (1976) reported a correlation of -0.36 between age at adoption and IQ scores of black and interracial adopted children. But age of adoption was also correlated -0.34 with natural mother's education, -0.27 with natural father's education, -0.1 with adoptive mother's education, and -0.27 with adoptive father's education. Early adopted children were adopted from the best homes to the best homes; independent effects of age of adoption were not reported. Freeman, Holzinger and Mitchell (1928) reported that the IQ's of early adopted children were about 13 points higher than late adopted children, but the same (undocumented) possibilities of selection remain.

In the present study, age of adoption was consistently negatively correlated with performance on cognitive measures and quality of birth and adoptive families. When the effects of other variables were removed from the effect of age of adoption, however, the result was an insignificant relationship in all but one of 18 analyses. The failure to find age of adoption results was one of several analyses for which significant environmental effects were not corroborated by results that would seem to follow from them. One of two possibilities must be considered: either the environmental effects were spurious, caused not by environmental differences but by some unmeasured variable, or the available measures of the environment were sensitive enough to detect gross environmental effects but insufficient for detecting more subtle effects.

Effect of Biological Variables

Birthweight and neurological diagnosis were the only substantial predictors of performance on infant development scales. Neurological diagnosis continued to be an important predictor of foster childrens' performance on cognitive tests at four and seven years. Birthweight, however, was unimportant for all but one group by the time of the four year assessment and became completely unimportant by the seven year exam. This finding is consistent with other reports. Wilson (1985) showed birthweight and gestational age to be correlated around 0.5 with infant development scores at 6 months. By the time the same children were six years old, the correlation had shrunk to under 0.2. Precisely the opposite pattern obtained for mother's education and SES. It is well established that standard infant development scales largely measure something other than intelligence.

Effect of Family Background

Historically, the most consistent finding in this controversial field is that adopted children's IQ's are correlated with the intelligence of the biological mothers with whom they were not raised. It is surprising, then, that mother's education did not predict IQ in close to half of the groups in this study. Foster children, who were more likely to be neurologically impaired than other groups, and for whom neurological diagnosis was by far the most important predictor of cognitive outcome, showed no relationship between mother's education and foster child's IQ.

The negative relationship between the importance of neurological status and genetic effects has not been specifically reported before. It makes sense, however, that the genetic relationship between parent and child IQ would be compromised in the presence of nongenetic neurological damage. One is reminded of Snygg (1938), in which a seemingly miniscule correlation was found between the IQ's of foster children and their biological mothers. These mothers had a mean Binet IQ of 78; 30% of them had IQ's under 70. Although there is no way of knowing for certain, it seems plausible that a substantial percentage of them might have been afflicted with some type of neurological damage.

Effect of Rearing Environment

White adopted and fostered children showed a consistent independent effect of the quality of their rearing environment, with foster children showing a stronger effect than adopted. Nonwhite adopted children showed no effect at all for rearing environment; nonwhite foster children showed some positive effect for all analyses, but the effects were not statistically significant. As has already been discussed, it appears that socioeconomic variables do not measure a valid construct among nonwhites in this sample, and this might well result in an attenuation of measured socioeconomic effects.

In both birth and seven year families, mother's education and family income are correlated, so their effects are difficult to separate empirically. It is interesting to note, however, that income at birth was not a significant predictor of IQ in any of the 34 analyses, while seven year income was significant as often as maternal education and was frequently the stronger predictor of the two. This suggests that the effect of birth mother's education was in fact primarily genetic and, therefore, better indexed by mother's education than by family income. Socially mediated environmental effects at seven years, on the other hand, are indexed equally well by either the educational or income level of the rearing environment.

Effect Sizes and Predictability of IQ

None of the effects reported here is large. Most of the variability of the IQ's of the study children remains unexplained. Why are the IQ's of the children in this study so difficult to predict?

One answer is that the means of reporting results employed in this study has emphasized the low percentages of variance explained. Many studies, especially recent ones, emphasize the fit of an explanatory model to the data, rather than the overall predictability of childrens' IQ's. Goodness of fit of a model and percentage of variance explained are not the same thing. A very high, indeed perfect fit can be achieved for very small relationships between independent and dependent variables. Often, the percentage of IQ variance explained by genetic and environmental variables is left unreported, unless a multiple regression is undertaken for some other reason.

Heritabilities reported by path analytic adoption studies are model-based magnifications of smaller empirical relationships. A heritability is the proportion of phenotypic variance explained by genotype. Genotypes are of course unmeasured. Path analyses assume on the basis of genetic theory that children's genotypes are correlated 0.5 with the genotype of each parent. The correlation between both parental and child genotypes and their respective phenotypes is equal to h, the square root of heritability. A correlation between a biological parent and an adopted away child, then, equals $.5h^2$. The heritability is therefore equal to twice the unsquared correlation between biological parent and adopted child, while the proportion of phenotypic variation in the child explained by the parent's phenotype is equal to the undoubled square of the correlation, a considerably smaller value.

This consideration, combined with the substitution of parental education for intelligence, explains the apparently low levels of transmission between parent and child in this study. In analyses in which parental education appeared to play a significant role, the unstandardized regression coefficient between parental education and child IQ was generally about 1.0. Education has a standard deviation of a little less than three in most analyses; the standard deviation of IQ was usually a little less than 15. The standardized regression coefficient would be roughly equal to the ratio of these two standard deviations, or about .2. If one assumes the correlation between parental education and parental IQ to be 0.7, the total path between parental education and child's IQ would equal (.7)(.5)(h)(h). Setting this quantity equal to 0.2 results in a value of 0.57 for h^2.

Ignoring the difference between heritabilities and percentage of phenotypic variance explained can lead to confusion about results of adoption studies. Snygg (1938), for example, which has been widely interpreted as evidence for zero heritability, reported a correlation of 0.13 between biological mothers and adopted children. According to the above analysis, and allowing a generous .9 for the reliability of the IQ test, this correlation is consistent with a heritability of .32. Taylor (1979), in an attack on Scarr's adoption studies, asserts that the various family variables account for "only" 35% of the variance in phenotypic IQ. The bottom line is that randomness is a necessary consequence of genetic transmission: "only" 50% of phenotypic variance in offspring is explained by one parent's characteristics even for a perfectly heritable additive trait.

Two earlier adoption studies have reported proportion of phenotypic variance explained by measured predictor variables. Burks (1928) regressed foster children's IQ on foster father's mental age and vocabulary, mother's vocabulary, and income. A little over 12% of the variance was predicted for foster children and a little more than 25% for children raised by their own parents. Scarr and Weinberg (1976) regressed IQ's of black children on 12 characteristics of their biological and adoptive homes, predicting 35% of the variance in the natural families, and 16% in the adoptive families.

Several large family studies of natural families have reported the percentage of phenotypic IQ variance explainable by family variables. Mercy and Steelman (1982) used family variables similar to those employed here, the ordinal position of the child in the family, and several variables describing childrens' daily activities, and explained 29% of the variance of Wechsler vocabulary scores, and 13% of Wechsler block design. Yeates et al. (1983) explained 18% of the variance in the Binet IQ's of four year olds using maternal IQ, maternal education, and HOME scales.

It is difficult to compare these percentages across studies because of the wide range in the number and type of predictors used. Nonetheless, it is clear that the present study is lower than most. In most analyses, between five and ten percent of phenotypic variance was explained and is sometimes as low as three percent. When biological variables are important they explain a large amount of variance, and the percentage explained is more in the range of 20-30 percent. Several reasons can be cited for the poor prediction.

One reason is the absence of IQ data for either parent and the omission of fathers from the analyses. Another, possibly, is the absence of detailed descriptors of the rearing environment, which are often asserted to be superior to broad SES measures as predictors of cognitive outcome. Difficulties with the IQ tests themselves is another possibility. Correlations among the tests are almost all unusually low. For example, for nonwhite adoptive matches, VIQ and PIQ are only correlated 0.22 [c.f. a norm of .60 for 7 year olds (Wechsler, 1949)], and VIQ and combined WRAT scores only 0.19 [c.f. norms of .68, .70 and .73 for WRAT reading, spelling and arithmetic scores, respectively (Jastak and Jastak, 1965)]; for white fostered biological matches, Binet scores are correlated 0.06, 0.05 and 0.04 with VIQ, PIQ and combined WRAT, respectively. Item and subtest analyses will be required for a complete understanding of why such low correlations exist.

Mean Differences

The central idea behind the design and statistical analysis of this study was that correlational analyses of the effects of biological, genetic, and family variables on IQ could be conducted together with analyses of mean differences in IQ between groups of adopted and nonadopted children, and that the results of each type of analysis would shed light on the interpretation of the other. Results of the analyses do not suggest a simple comprehensive explanation for the divergent histories of correlational and mean difference adoption studies. They do, however, point to some reasons why the two types of analyses disagree and help to rule out a number of others.

The mean difference analysis showed the IQ's of adopted children to be slightly (about 4 points) higher than the IQ's of nonadopted children born to similar biological families and just as high as the IQ's of children born into homes similar to the adopted childrens' adoptive homes. Foster children's IQ's were substantially lower than either their biological or adoptive matches.

The advantage enjoyed by adopted children has been reported many times, beginning with Skodak and Skeels. The magnitude of the effect was not as large as that reported in studies of children "rescued" from particularly bad circumstances, such as Skodak and

Skeels or the Schiff studies in France. Although many of these children were adopted out of very poor homes, they do not appear to have been "rescued" in the same sense: the mean IQ of the nonadopted children was not highly impaired, generally around 90. By the same token, the socioeconomic level of the adoptive homes was not particularly high. The adopted children, then, experienced a small to moderate increase in SES as a result of their adoption and showed a small to moderate increase in their IQ, apparently as a result.

The decrease in the IQ's of the foster children has not been reported before. It is somewhat disturbing in that these children were selected from a larger group of foster children on the basis of having only one foster placement and not being in an institution, which one would expect to be relatively favorable conditions. Foster children were more than ten points lower than biological controls on the Stanford Binet at four years, and about eight points lower on the WRAT and Wechsler tests.

Justification of Between and Within Group Relationships

The finding that significant mean IQ differences between adopted or fostered children cannot be explained in terms of known relationships between family variables and IQ recapitulates the history of adoption studies of IQ. Traditionally, mean differences and correlations have not been computed for the same children in the same study. Doing so emphasizes the need for a unified explanation.

Some variables other than those included in the regressions must be accounting for the unexplained group differences. The essential question is whether these variables are preexisting characteristics of the adopted and fostered children, in which case the mean IQ differences are attributable to selection, or whether they are unmeasured characteristics of the rearing environment.

The adoptive environments of the adopted children accounted for some, but not all, of their advantage in IQ. Increasing their environmental advantage in an extreme group design did not increase their IQ advantage; reducing or even eliminating their environmental advantage reduced their IQ advantage only slightly. Their biological fathers seem to have been better educated than the fathers of the control groups. All of these considerations point toward selection as an explanation of their advantage in IQ. Birthweight and neurological diagnosis have been controlled, so the selection must be have been made on some other basis. The selection would not have to have been very great, however, to account for the two or three IQ points that remain to be explained once biological fathers have been considered.

The foster children present a more difficult problem. It seems clear that foster children were at a considerable biological disadvantage from the outset. Foster children without a neurological diagnosis did no better than the full sample relative to controls. In addition, foster children reared in high SES homes did better relative to controls than those raised in low SES homes. But socioeconomic considerations cannot account for the IQ disadvantage of the foster children either because, in terms of SES, foster homes were as high as or higher than biological match homes in all respects.

It seems, then, that the foster children were at a biological disadvantage that was exacerbated by rearing in low SES foster homes. The exact nature of the environmental disadvantage is unknown. Within foster homes, it appears to be correlated with SES, though the mean SES of the foster homes is not unduly low. Further examination of the large number of foster children who were not studied because of multiple placements or placements with family members may shed more light on this issue.

The Question of How

The implementation and analysis of this study has kindled in its author a deep appreciation of the complexities and ambiguities inherent in the study of mental development. It is necessary to turn from the question of, "How much?" to the question of, "How?" not because the "How much?" question has been answered, opening the door to more subtle analyses, but because the question of "How much?" cannot be answered unambiguously. Fixed quantities of genetic and environmental determination of IQ are impossible to compute because they vary-- both meaningfully and randomly-- from population to population. In this study, we have shown variation in the determination of IQ between whites and nonwhites, normal and neurologically impaired children, and fostered and adopted children.

There is little reason to believe this list to be anything near complete.

The question of, "How much?" was really an effort to show that genes or environment or both had some influence on IQ. The necessity of including both domains is by now well established. Two central problems remain. The first is an analysis of the conditions under which genetic or environmental considerations are particularly important. Our analysis of the relationship between neurological impairment and genetic influence is an example of this kind of consideration. The second is the determination of the mechanisms by which genetic and environmental factors manifest their effect on intellectual development. Little has been accomplished in this regard. In this study, we have demonstrated an effect of environmental change but have been largely unable to specify exactly what it is about environments that retards or facilitates development.

The most significant contribution of this study, perhaps, has been the demonstration that regression analyses can be carried out simultaneously in experimental and control groups, and the results used to explain mean differences among the groups. If nothing else, this method highlights the inadequacies of the available environmental measures and quantifies the amount of additional data that will be required before group differences can be understood fully. Something, after all, causes adopted children to score higher than controls and foster children lower. The small number of environmental variables included in this analysis did not capture these unknown causes and left us to speculate about them. Simply including as much environmental data as possible in future analyses seems a wise course, because the effect of the environment seems to be spread across such a wide range of imperfectly correlated variables.

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