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Natural Cohorts:  
Family Similarity in  
Adult Cognition

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K. Warner Schaie,  
Robert Plomin,  
Sherry L. Willis,  
Ann Gruber-Baldini,  
and Ranjana Dutta  
*Pennsylvania State University*

### Introduction

There has been substantial evidence of cohort differences in cognitive abilities and cognitive styles, typically attributed to improvement in educational levels and life-styles or to favorable technological change. These differences have previously been studied primarily by comparing groups of genetically unrelated individuals who have in common nothing but a particular range of birth years and location of residence (Schaie, 1990b; Schaie, Labouvie, & Buech, 1973; Schaie & Strother, 1968; Willis, 1989). In these studies it has been observed that over the past half century there have been successively higher levels of performance for some abilities, noticeably Inductive Reasoning, Spatial Orientation, and Verbal ability. But other abilities

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(Number skills, Word Fluency) have shown curvilinear patterns with inflection points for cohorts born in the 1920s. Structural relationships among abilities are quite similar across cohorts, but the regressions of the measured markers of these abilities on their latent constructs have been found to vary across cohorts (Schaie, Willis, Jay, & Chipuer, 1989).

The Seattle Longitudinal Study (SLS) has followed many individuals over as long as 35 years (Schaie, 1958, 1983, 1988, 1989a, 1990a; Schaie & Hertzog, 1986; Schaie, Labouvie, & Buech, 1973; Schaie & Strother, 1968). This study has recently been expanded by assessing the adult offspring of many of our original study participants. Parent-offspring correlations have traditionally been studied in young adult parents and their children. In this chapter we will report the first longitudinal data on similarity of parents and adult offspring, considered specifically as a function of the age of the pairs when studied. Before attending to the cohort differences in level and intrafamily correlations, however, we need to demonstrate whether family similarity does extend to and persist throughout adulthood.

#### THE ROLE OF DEVELOPMENTAL BEHAVIOR GENETICS

The new interdisciplinary field of developmental behavioral genetics merges developmental and behavioral genetic theories and methods, offering exciting possibilities for understanding the origins of change and continuity in development (Plomin, 1986). The focus of developmental behavioral genetics on change, not just continuity, is novel and is often surprising to those developmentalists who tend to associate the adjectives *genetic* and *stable*. However, longitudinally stable characteristics do not necessarily have a hereditary base, nor are genetically influenced characteristics necessarily stable. Identifying genetic sources of developmental change is important because change prevails over continuity for most aspects of development. For this reason, a major task for developmental behavioral genetics is to explain longitudinal change as well as continuity. It should be emphasized that only longitudinal studies can assess genetic change and continuity.

A second issue receiving attention by developmental behavioral geneticists is nonshared environmental influence. In general, be-

havioral genetic research provides the best available evidence for the importance of environmental influences. Moreover, behavioral genetic research converges on the remarkable conclusion that environmental influences operate in such a way as to make individuals in the same family as different from one another as are pairs of individuals selected at random from the population. In other words, psychologically relevant environmental influences make individuals in a family different from, not similar to, one another (see Plomin & Daniels, 1987).

The relevance of this issue to our research lies in the usefulness of parent-offspring comparisons for identifying specific sources of nonshared environmental influence by relating experiential differences within pairs to behavioral differences within the pairs. The key question in environmental research is why individuals in the same family are so different from each other. This question can be addressed only by studies that include more than one individual per family (Plomin & Daniels, 1987).

#### DEVELOPMENTAL BEHAVIOR GENETICS AND ADULTHOOD

From a behavioral genetic perspective, next to nothing is known about the origins of individual differences in cognitive abilities, personality, and adjustment during the second half of the life span (Plomin & McClearn, 1990). As analyses from the SLS have demonstrated, there are vast individual differences in intellectual change across adulthood, ranging from early decrement for some persons to maintenance of function into very advanced age for others; a basic and fundamental research goal must therefore be to account for this individuality in aging. Nearly all behavioral genetics research in adulthood involves offspring in their late teens, typically toward the end of high school or at the time of military induction (see Plomin, 1986). In the handful of studies that include older adults, the average age of the sample is typically in the 20s or 30s, and the age range is so great that it is difficult to conduct cross-sectional analyses of family resemblance as a function of age.

The only systematic behavioral genetic study in middle and old age is a study organized by Franz Kallman and Gerhard Sander

(1948, 1949) in the 1940s. Over 1,000 pairs of twins in New York were studied biennially, with a primary emphasis on physical aspects of aging. Psychological tests were administered to 75 identical and 45 fraternal twin pairs between the ages of 60 and 89 years who were selected for cognitive testing on the basis of concordance for relatively good health, lack of institutionalization, and literacy (Kallman, Feingold, & Bondy, 1951). The twin results were analyzed in terms of intrapair differences rather than correlations; identical twins show significantly smaller intrapair differences than fraternal twins except on memory tests involving simple recall of recent material, suggesting the importance of genetic influence on individual differences in cognitive functioning later in life. Small samples of surviving twins were studied again in 1955 (Jarvik, Kallman, Falek, & Kleber, 1957) and 1967 (Jarvik, Blum, & Varma, 1971). In 1967, when the surviving intact pairs were from 77 to 88 years of age, 19 pairs—13 identical and 6 fraternal—were studied again using seven tests of cognitive abilities. This longitudinal sample, however, is so small as to vitiate the comparison of identical and fraternal twin correlations.

One behavioral genetic study of older adults has been initiated in Sweden with a sample of twins reared apart and matched twins reared together. In this project questionnaire data on personality and many other variables were collected for over 300 pairs of twins reared apart and matched pairs of twins reared together, with an age range from 50 to 80 (Pedersen, McClearn, Plomin, Nesselroade, Berg, & DeFaire, in press; Plomin, Pedersen, Nesselroade, & Bergeman, 1988). The second phase of this study involves individual biomedical and behavioral testing of 50 pairs each of identical and fraternal twins reared apart and matched pairs of identical and fraternal twins reared together. A second wave of testing has occurred after 3 years and a third wave, 6 years after initial testing, is in progress. Although the Swedish study will eventually be able to address issues of long-term change, there are currently no longitudinal behavioral genetic studies that extend over extensive portions of the second half of the life span.

By contrast, the research reported here capitalizes on the longitudinal design of the SLS to offer an "instant" longitudinal study of parents and offspring from young adulthood through middle age. Because parents and offspring share family environment as well as heredity, our family design cannot unambiguously disentangle the

contributions of heredity and shared environment on familial resemblance. The family design used here, however, has some important advantages over twin and adoption designs. Twins share environmental experiences to a much greater extent than do first-degree relatives; furthermore, twin studies estimate higher-order genetic interactions (i.e., epistasis) unique to identical twins. Thus the results of twin studies may not generalize to the usual case of first-degree relatives in terms of either environmental or genetic factors. Early-adopted individuals are rare, are difficult to find later in life, and may differ from nonadopted individuals in terms of the family environments they experience. Also, adoptees are often selectively placed into their adoptive families, which attenuates the separation of genetic and environmental influences using the adoption design (Plomin, 1983).

Family studies are valuable because first-degree relatives represent the population to which we wish to generalize the results of behavioral genetic investigations. Furthermore, family studies provide upper-limit estimates of genetic influence—that is, additive genetic influence cannot exceed estimates based on first-degree relatives. Although familial resemblance could reflect family environment as well as shared heredity—which is why estimates of genetic influence are called upper-limit estimates—it appears that shared environmental influences are of negligible importance for personality, psychopathology, and cognitive abilities after adolescence (Plomin, 1988; Plomin & Daniels, 1987). In other words, the important environmental factors in development are no more experienced in common by individuals in the same family than they are for pairs of individuals picked at random from the population. Thus, as a first approximation, it is not unreasonable to assume that familial resemblance later in life is primarily mediated genetically.

Our study is a reasonable first step in understanding the etiology of individual differences in functioning later in life even if a conservative interpretation is taken in the sense that familial resemblance is not interpreted as exclusively genetic in origin. The family design asks to what extent individual differences are due to familial factors, whether genetic or environmental, and it provides upper-limit estimates of genetic and shared family environmental influences.

The long-term longitudinal nature of the SLS provides a unique

opportunity to study relatives tested at roughly the same age; differences in same-age comparisons of sibling resemblance and parent-offspring resemblance as a function of year of birth yield a novel test of cohort effects. In addition to these same-age comparisons, the SLS data archives make it possible to trace parent-offspring resemblance forward in time by comparing "same-age" resemblance of parents and offspring to resemblance when the parents are 7, 14, 21, and 28 years older.

Because behavioral genetic data during the second half of the life span are virtually nonexistent, it is not possible to propose well-founded hypotheses that could be tested with our data. However, we can delineate four categories of hypotheses that we will address in this chapter.

1. *Family similarity in cognitive abilities will be found throughout adulthood, and the relationship will be stronger for verbal ability than for other cognitive abilities.* We expect that at least modest parent-offspring correlations will be found for all cognitive abilities. However, we also expect that greater similarity will be found for verbal ability. Although evidence is not good that any specific cognitive ability is more heritable than any other (DeFries, Vandenberg, & McClearn, 1976), there is some evidence that shared family environmental factors are greater for verbal abilities than for other cognitive abilities (Plomin, 1986). This hypothesis seems reasonable when the possibilities for training and modeling are considered—for example, for vocabulary compared with spatial ability. For this reason, we predict that familial resemblance will be greater for the two verbal tests of Verbal Ability and Word Fluency than for other abilities. Further, if this effect is due to shared family environment, we would expect that the effect will diminish with age.

2. *Familial resemblance for cognitive abilities will increase from early adulthood to middle adulthood.* It is generally assumed that nonnormative experiences increase in importance during development (Baltes, Reese, & Lipsitt, 1980), which would lead to the prediction that familial resemblance for cognitive abilities should decrease during adulthood. However, four recent behavioral genetic studies of adoptive siblings all indicate that shared family environmental influences that affect general cognitive ability are of negligible importance after adolescence (Plomin, 1986). This means that the environmental component of familial resemblance does not appear to change dur-

ing adulthood. In contrast, there is some evidence that genetic influence increases in importance during adulthood (Plomin & Thompson, 1987). If genetic influence increases, we are led to the counterintuitive (from an environmental perspective) hypothesis that familial resemblance for cognitive abilities increases later in life, decades after family members have left their shared family environment. To test this hypothesis, familial resemblance will be examined as a function of age.

3. *Familial influences will exert long-term effects on cognitive abilities throughout the adult life course.* If we assume that shared environmental influences are relatively unimportant in adulthood (implying that such influences do not contribute to familial resemblance), we would not expect to find—strictly from an environmental perspective—familial resemblance with either same-age or cross-age comparisons. However, there is increasing evidence that genetic influence on cognitive abilities shows substantial continuity throughout adulthood (Plomin & Thompson, 1987). For example, model-fitting analyses of adoption data have indicated that genetic effects in childhood are highly correlated with genetic effects in adulthood for IQ (DeFries, Plomin, & LaBuda, 1987). This leads to the prediction that long-term familial (presumably genetic) effects will produce familial resemblance for cognitive abilities even when one family member is assessed at a very different age than another. This hypothesis can be tested by assessing familial resemblance cross-sectionally over a wide range of ages, as well as longitudinally within the same data set. The simplest analytic approach to this problem is to test whether familial resemblance differs as a function of the interval at which the family members were assessed (also see Schaie, 1975, for alternative methods of analysis).

4. *Cohort effects will be seen in that parent-offspring correlations will be greater for earlier cohorts of adult offspring.* The striking finding that shared family environmental influence is negligible for cognitive ability after adolescence has been studied only in recent cohorts. Earlier cohorts will show greater shared family environmental influence if the influence of the family on cognitive scores has declined or if the importance of extrafamilial influences such as television has increased. Older and younger cohorts of parent-offspring relatives yield the same expectation of genetic similarity unless the magnitude of assortative mating has changed (cf. Gruber & Schaie, 1986).

**Table 1.**  
*Design of the Seattle Longitudinal Study*

1956	1963	1970	1977	1984
S <sub>1</sub> T <sub>1</sub> (N = 500)	S <sub>1</sub> T <sub>2</sub> (N = 303)	S <sub>1</sub> T <sub>3</sub> (N = 162)	S <sub>1</sub> T <sub>4</sub> (N = 130)	S <sub>1</sub> T <sub>5</sub> (N = 97)
	S <sub>2</sub> T <sub>2</sub> (N = 997)	S <sub>2</sub> T <sub>3</sub> (N = 420)	S <sub>2</sub> T <sub>4</sub> (N = 337)	S <sub>2</sub> T <sub>5</sub> (N = 204)
		S <sub>3</sub> T <sub>3</sub> (N = 705)	S <sub>3</sub> T <sub>4</sub> (N = 340)	S <sub>3</sub> T <sub>5</sub> (N = 225)
			S <sub>4</sub> T <sub>4</sub> (N = 612)	S <sub>4</sub> T <sub>5</sub> (N = 294)
				S <sub>5</sub> T <sub>5</sub> (N = 628)

As a test of the hypothesis of cohort effects, parent-offspring resemblance will be assessed as a function of year of birth.

As indicated earlier, so little is known about familial effects on individual differences in functioning in adult life that these hypotheses can be little more than speculations. Because we know so little, many of the questions addressed in this study are exploratory in that no reasonable a priori hypotheses can be offered. For example, do familial effects (or their interaction with age and cohort) differ for males and females or for same-sex versus opposite-sex pairs? Does familial resemblance for cognitive abilities in adult life differ as a function of time of measurement or demographic factors? Throughout these analyses, we are interested in differential effects on different primary mental abilities.

#### THE SEATTLE LONGITUDINAL STUDY

**The subject population.** Our inquiry into adult cognitive functioning began some 35 years ago by randomly sampling 500 subjects equally distributed by sex and age across the range from 20 to 70 years from the approximately 18,000 members of a health maintenance organization (HMO) in the Pacific Northwest (Schaie, 1983, 1989a; Schaie & Hertzog, 1986). The survivors of the original sample

were retested and additional panels were added at 7-year intervals. The sampling frame represents a broad distribution of educational and occupational levels, covering the upper 75% of the socioeconomic spectrum. The population frame from which we have been repeatedly sampling has grown to a membership of over 400,000 individuals, but the general characteristics remain very comparable to its structure at the inception of our study. The study design through the fifth wave is given in Table 1.

**The measurement variables.** Throughout the course of the SLS our primary focus has been investigating psychometric abilities within the Thurstonian (1938) framework. Through our fourth cycle this was accomplished by single markers, with multiple ability markers added in the fifth cycle. We have also collected data on rigidity-flexibility, life-styles, and some personality traits, as well as the health histories of our participants. Details of the measures included in the study reported here are given in the methods section below.

## Methods

### SUBJECTS

The participants in this study consist of the adult offspring (22 years of age or older in 1990) of members of the SLS panels and their target relatives. Those members who participated in the fifth cycle of the SLS had a total of 3,507 adult children. Of these, 1,416 adult children ( $M = 701$ ;  $F = 715$ ) resided in the Seattle metropolitan area.

The adult offspring were recruited in two ways: (1) A letter containing an update report on the SLS was sent to all study participants tested in 1983–1985. This letter also announced the familial resemblance study and asked panel members to provide names and addresses of siblings and offspring. A recruitment letter was then sent to all offspring thus identified. (2) We also searched the participating HMO records to identify offspring and siblings of longitudinal panel members who had dropped out owing to death or illness. Offspring of some panel members were also identified because they were included in their parents' service contracts. Surviving spouses

were identified in the same manner and were used as informants to obtain addresses for offspring of deceased panel members.

On writing this report we had successfully tested 531 adult offspring. Of these study participants 439 (82.7%) resided within the Seattle metropolitan area; the rest of 92 (17.3%) were scattered throughout the United States and Canada. Offspring, in 1990, ranged in age from 22 to 74 years (mean = 40.43;  $SD = 10.45$ ). Target parents ranged in age from 39 to 91 years at the time they were last tested, in 1984 (mean = 63.66;  $SD = 10.89$ ). All participants were community-dwelling individuals when tested. Table 2 provides a breakdown of parents and offspring by age and sex, using the 7-year cohorts conventionally employed in the SLS (cf. Schaie, 1983, 1988). This data set includes 99 father-son pairs, 211 mother-daughter pairs, 115 father-daughter pairs, and 106 mother-son pairs. Data on age and education by subset are provided in Table 3.

## MEASURES

**Primary mental abilities.** The test battery administered to the participants in this study included multiple measures of cognitive abilities that broadly sample higher-order constructs such as those espoused by Horn (1982). Thus fluid intelligence is represented by the abilities of Inductive Reasoning and Spatial Orientation, while Verbal Ability and Numerical Ability stand as representatives of crystallized intelligence; Perceptual Speed is examined as an ability marker for the speed domain.

Table 4 lists the measures, the primary abilities they mark, their sources, and their test-retest correlations over a 2-week interval for a group of 172 subjects (age range 64 to 95). A brief description of these abilities and their measures is given below.

**Verbal Ability.** Language knowledge and comprehension are measured by assessing the scope of a person's recognition vocabulary on the Primary Mental Abilities (PMA) Verbal Meaning test, which involves matching four synonyms to a stimulus word.

**Spatial Orientation.** Spatial orientation is the ability to visualize and mentally manipulate spatial configurations, to maintain orientation

**Table 2**  
*Age and Sex Distribution of Study Participants*

Age Range	Parents (1984)			Offspring (1990)		
	Male	Female	Total	Male	Female	Total
22-28	—	—	—	21	30	51
29-35	—	—	—	52	96	148
36-42	—	11	11	48	82	130
43-49	15	27	42	43	55	98
50-56	34	63	97	25	34	59
57-63	56	59	115	14	17	31
64-70	49	69	118	3	6	9
71-77	35	52	87	2	3	5
78-84	16	28	44	—	—	—
85-91	9	8	17	—	—	—
Total	214	317	531	208	323	531

**Table 3**  
*Age and Education of Parents and Offspring*

Variable		Total	Father-Son	Mother-Daughter	Father-Daughter	Mother-Son
Age of parents	Mean	63.66	65.63	62.70	63.76	63.62
	<i>SD</i>	10.89	11.38	11.04	9.42	11.51
Age of offspring	Mean	40.43	41.17	40.84	38.57	40.93
	<i>SD</i>	10.45	10.42	10.68	9.60	10.78
Education of parents	Mean	14.40	15.44	13.71	14.98	14.27
	<i>SD</i>	2.78	2.82	2.45	3.32	2.33
Education of offspring	Mean	15.54	16.11	15.25	15.42	15.69
	<i>SD</i>	2.38	2.40	2.46	2.17	2.37

with respect to spatial objects, and to perceive relationships among objects in space. This ability is measured by the PMA Space test. The study participant is shown an abstract figure and is asked to identify which of six other drawings represents the model in two-dimensional space.

**Inductive Reasoning.** Inductive reasoning is the ability to deduce

**Table 4**  
*Psychometric Intelligence Measurement Battery*

Primary Ability	Test	Source	Test-Retest Correlation
Inductive Reasoning	PMA Reasoning (1948)	Thurstone & Thurstone, 1949	.884
Spatial Orientation	PMA Space (1948)	Thurstone & Thurstone, 1949	.817
Numerical Ability	PMA Number (1948)	Thurstone & Thurstone, 1949	.875
Verbal Ability	PMA Verbal Meaning (1948)	Thurstone & Thurstone, 1949	.890
Perceptual Speed	Finding A's	Ekstrom, French, Harman, & Derman, 1976	.860
Word Fluency	PMA Word Fluency (1948)	Thurstone & Thurstone, 1949	.896

novel concepts or relationships. In the PMA Reasoning test, the study participant is shown a series of letters (e.g., a b c c c b a d e f f e) and is asked to identify the next letter in the series.

**Numerical Ability.** Numerical ability is the ability to understand numerical relationships and compute simple arithmetic functions. In the PMA Number test the study participant checks whether simple sums shown are correct or incorrect.

**Word Fluency.** The ability to recall words easily is measured by asking the study participant to recall freely as many words as possible according to a lexical rule within a 5-min period.

**Perceptual Speed.** Perceptual speed is the ability to find figures, make comparisons, and carry out other simple tasks involving visual perception with speed and accuracy (measured by the Finding A's test). In each column of 40 simple words, the subject must identify the 5 words containing the letter *a*.

**Rigidity-Flexibility.** The multiple dimensions of the rigidity-flexibility construct are measured by the Test of Behavioral Rigidity

(TBR; Schaie & Parham, 1975). The TBR was designed to measure the three dimensions of Psychomotor Speed (PS), Motor-Cognitive Flexibility (MCF), and Attitudinal Flexibility (AF; Schaie, 1955). The TBR yields seven scores from the following three subtests.

**The Capitals test.** Adapted from Bernstein's (1924) study of quickness and intelligence, this test represents the Spearman, or "functional" approach to perseveration or rigidity. Participants spend 2½ min copying a printed paragraph that contains some words starting with capital letters, others spelled entirely in capitals, and some starting with a lowercase letter and with the rest in capitals. In the second half of the test participants copy the paragraph again, but in reverse form, substituting capitals for lowercase letters and lowercase letters for capitals. A psychomotor speed score is the number of words correctly copied in the first series (copying speed, Cap). A motor-cognitive flexibility score (instructional set flexibility, Cap-R) results from taking the ratio of the number of words correctly copied in the second series to the number in the first.

**The Opposites test.** This test was constructed following the work of Scheier and Ferguson (1952). Subjects are given 2 min each to work on three lists of words (at a third-grade level of difficulty). The first list requires providing the antonym and the second list the synonym of the stimulus word. The third list contains selected stimulus words from the previous lists, to which the subject responds with an antonym if the stimulus word is printed in lowercase letters, but with a synonym if it is printed in capitals. The psychomotor speed score is the sum of correct responses in the first two lists (associative speed, Opp). There are two motor-cognitive flexibility scores representing the ease with which the subject shifts from synonyms to antonyms depending on whether the stimulus word is presented in uppercase or lowercase letters. The first score involves the proportion correct in List 3 (associative flexibility 1, Opp-R1), while the second assesses the ratio of correct responses under the perseveration condition in List 3 to the number of correct responses under the standard condition in Lists 1 and 2 (associative flexibility 2, Opp-R2). The first motor-cognitive flexibility score (associative flexibility 1, Opp-R1) is obtained by the formula:

$$\text{Opp-R}_1 = 100 - \frac{\text{Series 3 errors}}{\text{Series 3 total}} \times 100$$

The second score (associative flexibility 2, Opp-R2) involves the formula:

$$\text{Opp-R}_2 = \frac{\text{Series 3 correct}}{\frac{1}{2}(\text{Series 1 correct} + \text{Series 2 correct})} \times 100$$

**The TBR questionnaire.** The 75-item true-false TBR questionnaire contains 22 rigidity-flexibility items (attitudinal flexibility, R-scale) and 44 masking social responsibility items from the California Psychological Inventory (Gough, 1957; Gough, McCloskey, & Meehl, 1952; Schaie, 1959). It also contains 9 items suitable for adults obtained from the Guttman-scaling of perseveration scale first used by Lankes (1915), (behavioral flexibility, P-scale)

The TBR factor scores are formed as linear combinations of the standardized subtest scores, as follows:

$$\begin{aligned} \text{MCF} &= .25 \text{ Cap-R} + .35 \text{ Opp-R}_1 + .40 \text{ Opp-R}_2; \\ \text{AF} &= .50 \text{ R scale} + .50 \text{ P Scale}; \\ \text{PS} &= .60 \text{ Cap} + .40 \text{ Opp}. \end{aligned}$$

## PROCEDURE

Potential subjects who agreed to participate were scheduled by telephone for group assessment sessions. The groups ranged from 5 to 20 participants, depending upon the age of the subjects. The testing sessions lasted approximately 2½ hours plus a "take-home" package of questionnaires requiring approximately an additional hour of effort. Each session was conducted by a psychometrist aided by a proctor whenever more than 5 participants were tested simultaneously. Subjects were paid \$25 for participating.

## ANALYSES

**Multiple regression analyses.** Regression analyses were employed to analyze parent-offspring resemblance and to determine how much familial resemblance differs as a function of variables such as

age and testing interval, as well as other variables such as gender, time of measurement, and demographic factors (DeFries & Fulker, 1985; Ho, Foch, & Plomin, 1980; Zieleniewski, Fulker, DeFries, & LaBuda, 1987). This least-squares model fitting represents a straightforward approach to the analysis of such simple designs as the family design, in which we do not attempt to differentiate genetic and environmental components of variance. For example, we may regress out the effects of parent and offspring age to obtain net estimates of the parent-offspring correlations. Alternatively, we may ask whether family similarity differs as a function of offspring age. Using hierarchical multiple regression (Cohen & Cohen, 1975), we regress the parent's score on three predictors: the offspring's score, the offspring's age, and the interaction between offspring's age and performance. A significant standard partial regression coefficient for the interaction of offspring score and age indicates that family resemblance differs as a function of offspring age.

**Estimation of genetic parameters.** In addition to these straightforward analyses of familial resemblance and its interaction with other variables, genetic analyses can be conducted if we assume that shared environment does not contribute to familial resemblance—in other words, if we assume that familial resemblance is due solely to hereditary factors. As discussed earlier, this appears to be a reasonable assumption for cognitive abilities in adulthood; however, the novelty of this conclusion and the need for more data to confirm it limit the following genetic analyses to exploratory ventures rather than their resulting in precise estimates of genetic parameters.

If we assume that shared environment does not contribute to familial resemblance for cognitive abilities, then doubling parent-offspring correlations provides estimates of heritability, the proportion of phenotypic variance that can be explained by genetic variance (see also Plomin & McClearn, 1990). If, for example, a same-age parent-offspring correlation of .30 was obtained for the PMA Spatial Orientation test, it would suggest a heritability of .60 if shared environment does not contribute to the parent-offspring similarity. The rest of the variance is nongenetic; some of the nongenetic variance involves error of measurement, and the remainder is due to non-shared environment. The regression analyses described above will provide estimates of heritability across ages, with interactions be-



tween familial resemblance and age defining age trends in heritability.

We should emphasize again that heritability is a descriptive statistic and thus will change as the relative contributions of genetic and environmental influences change in different populations or during development. These statistics imply no more precision than do other descriptive statistics; as for all descriptive statistics, standard errors of estimate need to be consulted to evaluate precision. Most important, heritability does not imply immutability: it simply refers to the proportion of observed interindividual variance in a population that is due to genetic differences among individuals.

## Results

We will present our results beginning with the findings on parent-offspring similarity in terms of the correlation of parents' performance with that of their offspring, as well as the adjusted coefficients when the regression of parent and offspring age on the dependent variables has been removed. We next consider the stability of parent-offspring correlations across time (and age). We then deal with the possible effect of shared environment by considering the correlation of intensity of current contact between parents and offspring. Age or cohort differences in the magnitude of parent-offspring correlation are also examined. Finally, we address the "natural cohort" issue directly. That is, we consider the magnitudes of generational differences in level within families, as well as changes in the magnitude of these differences for successive cohort groupings.

### PARENT-OFFSPRING CORRELATIONS

As shown in Table 5 and Figure 1, parent-offspring correlations for the total sample were statistically significant ( $p < .05$ ) for all variables studied except the trait measure of Social Responsibility. Among the ability measures, correlations were highest for Inductive Reasoning, Word Fluency, and the Intellectual Ability composite measure. They were lowest for the measures of Perceptual Speed

**Table 5**  
*Correlation of Parents and Offspring*

Variable	Total ( <i>N</i> = 531)	Father- Son ( <i>N</i> = 99)	Mother- Daughter ( <i>N</i> = 211)	Father- Daughter ( <i>N</i> = 115)	Mother- Son ( <i>N</i> = 106)
Verbal Meaning	.14**	.22*	.18**	.00	.09
Space	.24***	.10	.22**	.32***	.27**
Reasoning	.28***	.17	.32***	.34***	.40***
Number	.19***	.24*	.19**	.20*	.12
Word Fluency	.27***	.18	.33***	.20*	.19*
Finding A's	.10*	-.09	.20**	.12	.12
Intellectual Ability <sup>a</sup>	.26***	.13	.30***	.37***	.20*
Educational Aptitude <sup>b</sup>	.20***	.26*	.23**	.13	.16
Motor-Cognitive Flexibility	.29***	.07	.25***	.43***	.36***
Attitudinal Flexibility	.13**	.08	.09	.20	.21*
Psychomotor Speed	.21***	.17	.23***	.04	.36***
Social Responsibility	.00	-.07	-.02	.09	.06

<sup>a</sup>Weighted linear combination of first five mental abilities,  $IA = V + S + 2R + 2N + W$  (Thurstone & Thurstone, 1949).

<sup>b</sup>Estimate of Educational Aptitude,  $EA = 2V + R$ .

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

(the Finding A's test) and Verbal Meaning. Among the cognitive style measures, correlations were highest for Motor-Cognitive Flexibility and lowest for Attitudinal Flexibility.

Because of the wide age range among parents and offspring (and to model the assumption of equal ages), we partialled out the effects of parent and offspring age. The correlations adjusted for age at the most recent test are provided in Table 6 and Figure 2. After the age adjustment, all but the measures of Perceptual Speed and Social Responsibility remain statistically significant ( $p < .01$ ). The magnitudes of the correlations change somewhat, however, with Word Fluency and Verbal Meaning now displaying the highest ability correlations as well as the composite indexes of Intellectual Ability and

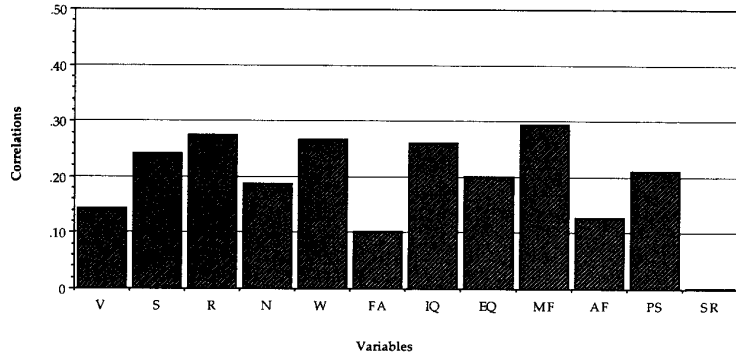


FIGURE 1. Parent-offspring correlations at most recent test occasion.

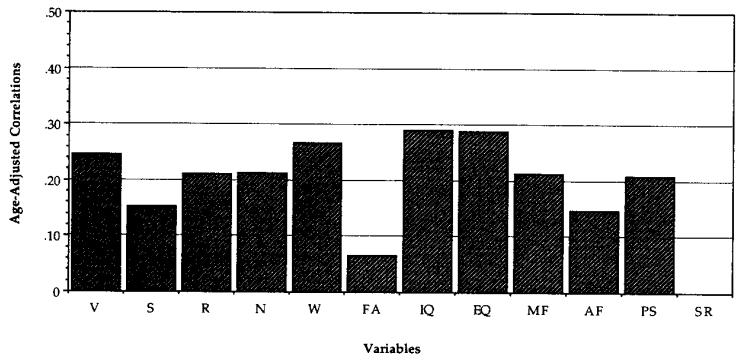


FIGURE 2. Parent-offspring correlations at most recent test occasions adjusted for age of parents and offspring.

Educational Aptitude. Both Motor-Cognitive Flexibility and Psychomotor Speed continue to show higher family resemblance than does Attitudinal Flexibility.

The correlational findings are not uniform across subsets. When raw parent-offspring correlations are examined (Table 5 and Figure 2), statistically significant correlations ( $p < .05$ ) between fathers and

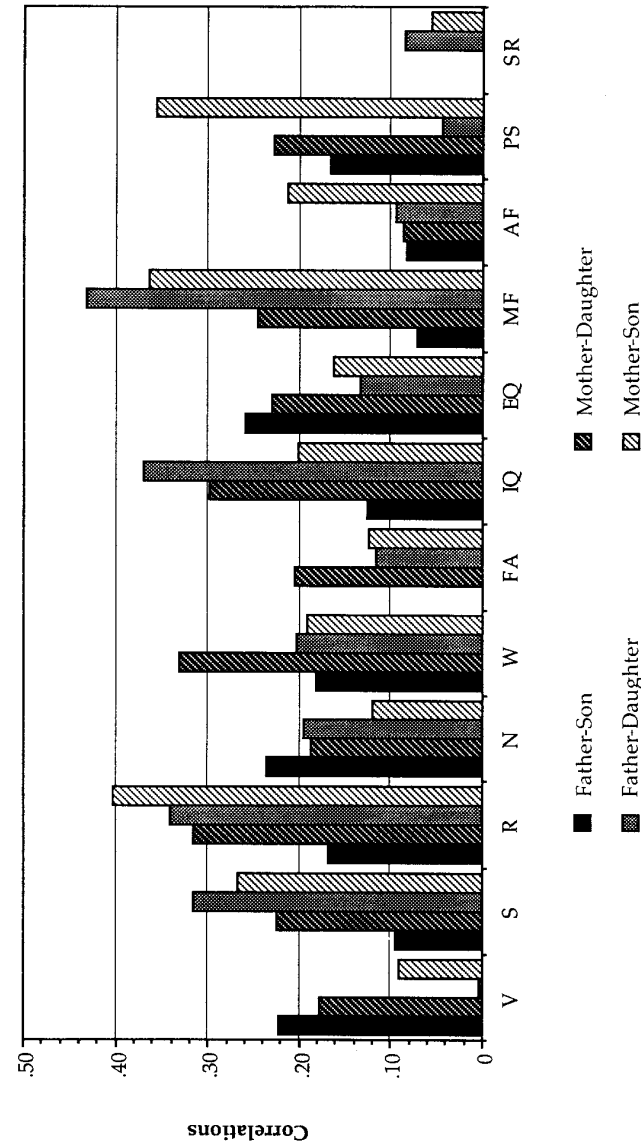


FIGURE 3. Parent-offspring correlations by gender pairings.

**Table 6**  
Correlation of Parents and Offspring Adjusted for Age at Testing

Variable	Total	Father-Son	Mother-Daughter	Father-Daughter	Mother-Son
Verbal Meaning	.25***	.30***	.30***	.10	.21*
Space	.15**	.04	.10	.27**	.16*
Reasoning	.21***	.19*	.21**	.28***	.31**
Number	.21***	.25**	.22**	.24*	.11
Word Fluency	.27***	.22*	.35***	.21*	.13
Finding A's	.07	-.12	.15*	.11	.08
Intellectual Ability	.29***	.21*	.31***	.43***	.17*
Educational Aptitude	.29***	.34**	.32***	.18*	.25*
Motor-Cognitive Flexibility	.21**	.04	.16*	.39***	.22*
Attitudinal Flexibility	.15**	.10	.10	.11	.23*
Psychomotor Speed	.21***	.19*	.25***	.01	.26***
Social Responsibility	-.00	-.03	-.04	.11	.03

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

sons are found only for Verbal Meaning, Number, and Educational Aptitude. For the mother-daughter set, however, statistically significant correlations ( $p < .05$ ) are found for all variables except Attitudinal Flexibility and Social Responsibility. Correlations between fathers and daughters are statistically significant ( $p < .05$ ) for Spatial Orientation, Inductive Reasoning, Number, Word Fluency, the composite indexes, and Motor-Cognitive Flexibility. Finally, for the mother-son set statistically significant correlations ( $p < .05$ ) were found for Spatial Orientation, Inductive Reasoning, Word Fluency, Intellectual Ability, Motor-Cognitive Flexibility, and Psychomotor Speed.

When age of parent and offspring is controlled, further differences between subsets are observed (see Table 6 and Figure 4). Statistically significant correlations ( $p < .05$ ) between fathers and sons are now found for Verbal Meaning, Inductive Reasoning, Number, Intellectual Ability, Educational Aptitude, and Psychomotor Speed.

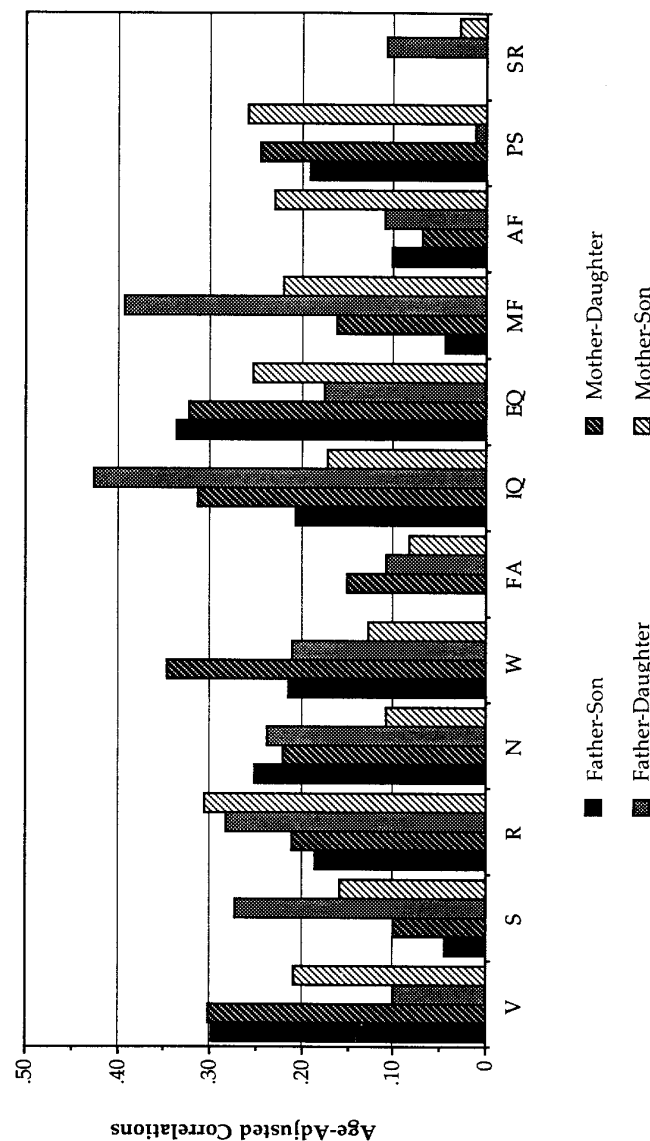


FIGURE 4. Parent-offspring correlations by gender pairings adjusted for age of parents and offspring.

For the mother-daughter set, however, statistically significant correlations ( $p < .05$ ) continue to be found for all variables except Spatial Orientation, Attitudinal Flexibility, and Social Responsibility. Correlations between fathers and daughters remain statistically significant ( $p < .05$ ) for the same variables as for the new correlations. For the mother-son set statistically significant correlations ( $p < .05$ ) are now found for Verbal Meaning, Spatial Orientation, Inductive Reasoning, the composite indexes, Motor-Cognitive Flexibility, Attitudinal Flexibility, and Psychomotor Speed.

#### STABILITY OF PARENT-OFFSPRING CORRELATIONS OVER TIME

One of the critical issues in studying family similarity in adulthood is to determine whether such similarity remains stable or changes as the distance in age (and time of assessment) between parent and offspring increases. To examine stability of correlations with a sufficiently large sample, we considered for this analysis only those parent-offspring pairs for whom at least four data points (1963, 1970, 1977, and 1984) were available for the parents, yielding a set of 162 participant pairs who were tested 6, 13, 20, and 27 years apart. Note that for the first data point, parents are close to the age at which their offspring were tested in 1990. The top of Table 7 and Figure 5 shows the stability results in terms of raw correlations. Note that there is good stability of parent-offspring correlations for all variables. For this data set, however, values reach statistical significance for Social Responsibility at no time point, for Attitudinal Flexibility only for the 1963 comparison, and for Number only for 1970 and 1984.

For comparability with the initial analyses, we also controlled for age in the stability analyses. Relevant data are reported in the lower part of Table 7 and Figure 6. The observed stability of parent-offspring correlations remains impressive. After age adjustment, values for Social Responsibility still fail to reach statistical significance. All values are now significant for Number, but Spatial Orientation is significant only for the 1963 and 1977 comparisons, while Motor-Cognitive Flexibility reaches significant levels only in 1977 and 1984 and Attitudinal Flexibility is significant only in the 1963 comparison.

**Table 7**  
*Parent-Offspring Correlations as a Function of Time*

Variable	Parents Tested in			
	1963	1970	1977	1984
Verbal Meaning	.24**	.22**	.19*	.20**
Space	.26**	.17*	.30***	.22**
Reasoning	.29***	.34***	.32***	.33***
Number	.13	.16*	.14	.20**
Word Fluency	.36***	.22**	.31***	.29***
Finding A's	—	—	.18*	.21**
Intellectual				
Ability	.24**	.25**	.23**	.25**
Educational				
Aptitude	.25**	.27**	.21**	.27**
Motor-Cognitive				
Flexibility	.14	.10	.27**	.23**
Attitudinal				
Flexibility	.16*	.12	.13	.11
Psychomotor				
Speed	.40***	.35***	.42***	.40***
Social				
Responsibility	.01	.09	.12	.07
Standardized Regression Coefficients Adjusted for Parent and Offspring Age				
Verbal Meaning	.26**	.26**	.23**	.26**
Space	.20*	.10	.26**	.13
Reasoning	.24**	.30***	.27**	.29**
Number	.15*	.17*	.18*	.24**
Word Fluency	.36***	.22**	.31***	.29***
Finding A's	—	—	.15*	.18*
Intellectual				
Ability	.25**	.26**	.26**	.28***
Educational				
Aptitude	.18*	.29**	.24**	.31***
Motor-Cognitive				
Flexibility	.10	.05	.23**	.20*
Attitudinal				
Flexibility	.15*	.11	.11	.12
Psychomotor				
Speed	.38***	.32***	.42***	.38***
Social				
Responsibility	.00	.08	.10	.06

Note. Offspring ages in 1990 are approximately equal to parent age in 1963; age differences increase for each successive data point.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

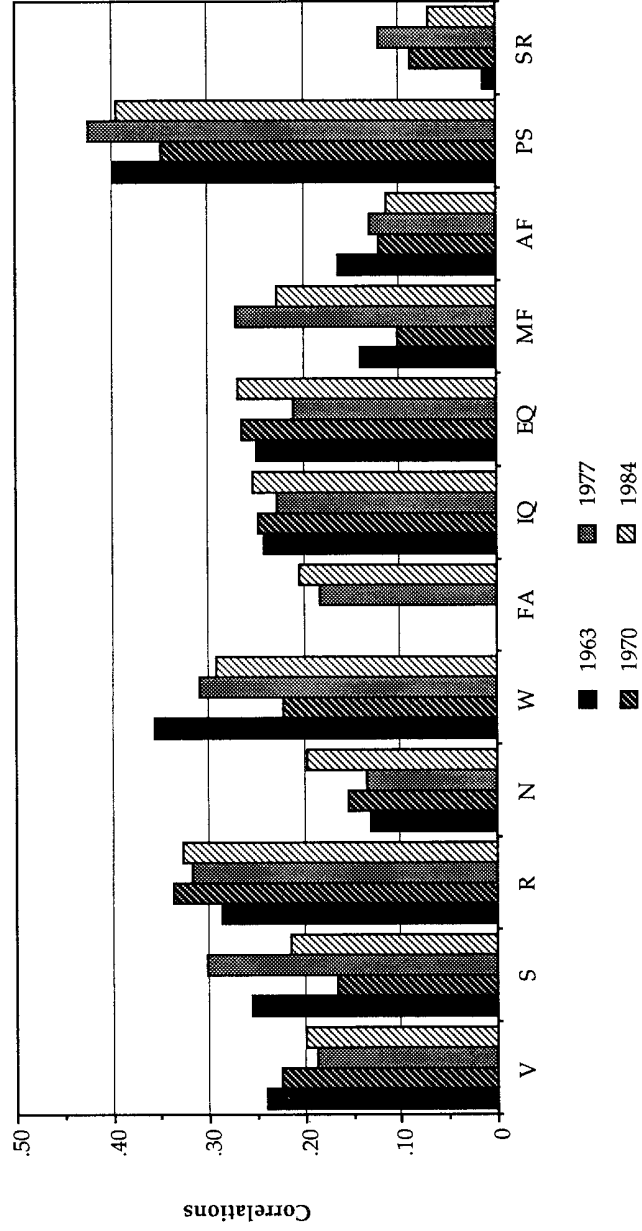


FIGURE 5. Stability of parent-offspring correlations over time (and age).

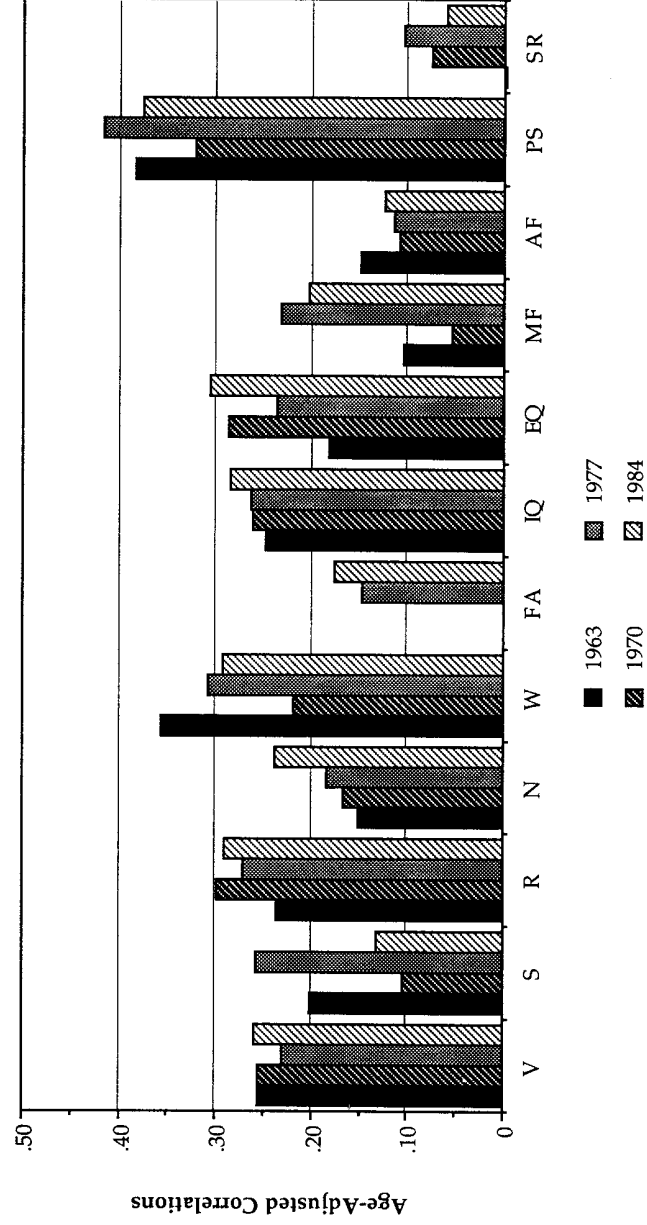


FIGURE 6. Stability of parent-offspring correlations over time (and age) adjusted for age of parents and offspring.

In sum, whether parent-offspring correlations are examined at the same age or at an average 20-year interval, the parent-offspring correlations remain virtually the same.

#### EFFECTS OF CURRENT FAMILY CONTACT

All offspring were asked to rate the intensity of their current contact with their parents on a multiple Likert scale questionnaire. As can be seen from Table 8, contact was slightly more intense for daughters than for sons; contact was greatest for the mother-daughter sets and lowest for the father-son sets; the last two sets differed significantly ( $p < .01$ ). Degree of contact, however, did not significantly correlate with the age of parent or offspring.

Magnitudes of parent-offspring resemblance, adjusted for age, were reexamined to consider the effect of contact. This analysis led to slight upward adjustment of some coefficients, but all significant regressions for intensity of contact were negative. That is, parent-offspring resemblance was greater with *less* contact. Significant statistical effects of contact ( $p < .05$ ) were found for the total sample only for Verbal Meaning, Spatial Orientation, Number, and Attitudinal Flexibility.

#### AGE/COHORT DIFFERENCES IN PARENT-OFFSPRING CORRELATIONS

We next consider the magnitude of parent-offspring correlations as a function of age/cohort membership. Because most of our participants (whether parents or adult offspring) were assessed at ages where stability of cognitive performance is the rule rather than the exception (cf. Schaie, 1983), it makes sense to organize these data by cohort rather than by age. For this reason we divided the total sample into a youngest cohort ( $N = 199$ ; birth years 1955 to 1968), a middle-aged cohort ( $N = 228$ ; birth years 1931 to 1954), and an oldest cohort ( $N = 104$ ; birth years before 1931).

As can be seen from Table 9 and Figure 7, there are substantial differences in pattern and magnitude of correlations. Parent-offspring correlations for the youngest cohort are statistically signifi-

**Table 8**  
*Contact of Parents and Offspring*

Variable	Total	Father-Son	Mother-Daughter	Father-Daughter	Mother-Son
Mean contact	19.01	17.81	19.72	19.17	18.51
SD	3.60	4.09	3.23	3.45	3.64

Note. Contact score is the sum of six Likert scale items; total sum can range from 0 to 41. Actual observed range: 2 to 28.

**Table 9**  
*Parent-Offspring Correlations as a Function of Cohort*

Variable	Cohort Grouping		
	Youngest 1955-1968	Middle-Aged (1931-1954)	Oldest (Before 1931)
Verbal Meaning	.21**	.23**	.05
Space	.22**	.16**	.11
Reasoning	.18**	.29***	.26***
Number	.18**	.25***	.16
Word Fluency	.26***	.29***	.25**
Finding A's	.12	.21**	.02
Intellectual Ability	.22**	.27***	.26**
Educational Aptitude	.25**	.25***	.11
Motor-Cognitive Flexibility	.14*	.06	.45***
Attitudinal Flexibility	.13	.16*	.07
Psychomotor Speed	.04	.36***	.04
Social Responsibility	.20**	.13*	.07

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .  $N = 199, 228, \text{ and } 104$ .

cant ( $p < .05$ ) for all variables but Perceptual Speed, Attitudinal Flexibility, and Psychomotor Speed, whereas for the middle-aged cohort correlations are statistically significant ( $p < .05$ ) for all variables except Motor-Cognitive Flexibility. For the oldest cohort, however, correlations are statistically significant ( $p < .05$ ) only for Inductive Reasoning, Word Fluency, Intellectual Ability, and Motor-Cognitive Flexibility. Correlations rise generally from the oldest to the youngest cohort, but they drop across cohorts for Inductive Reasoning

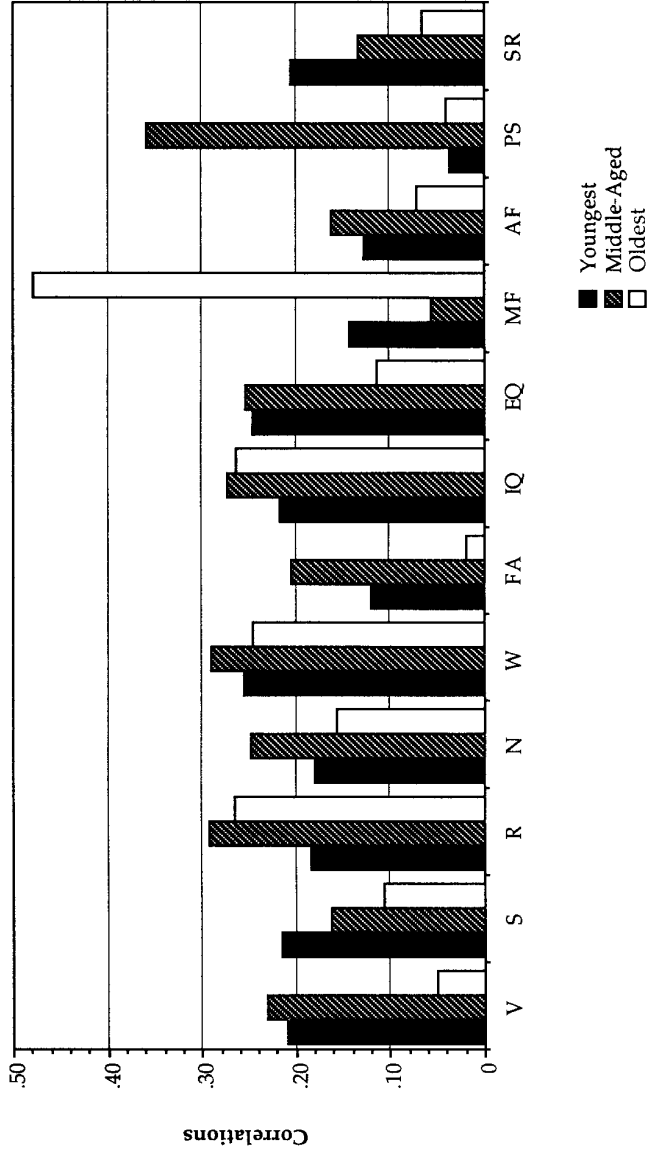


FIGURE 7. Parent-offspring correlation by cohort groupings.

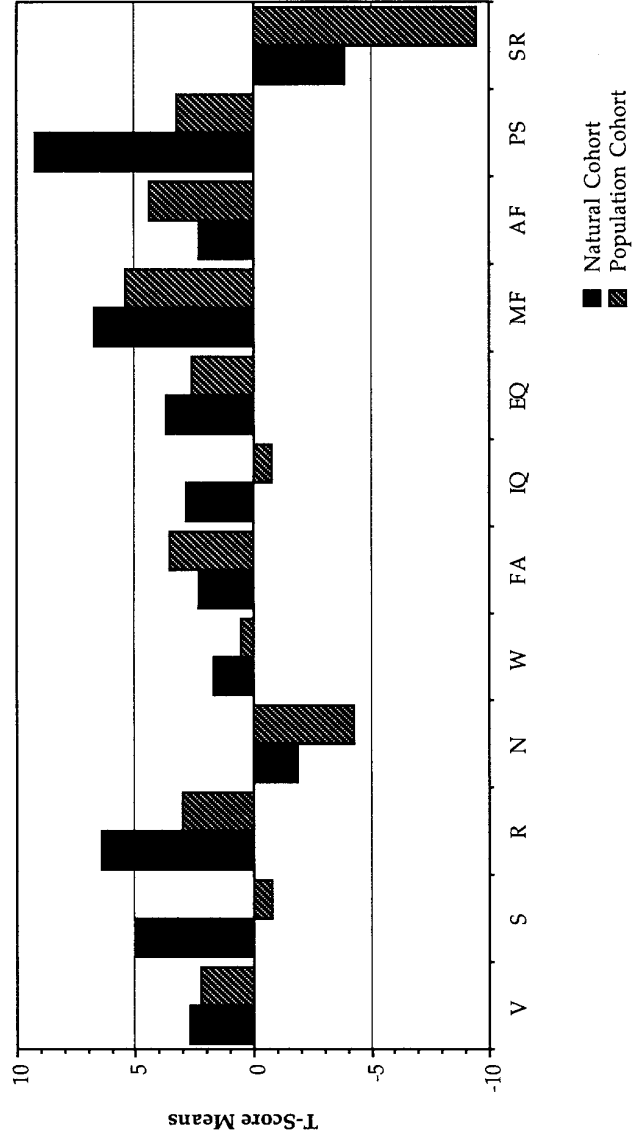


FIGURE 8. Difference in performance level within parent-offspring pairs. Positive differences favor the offspring.

and Motor-Cognitive Flexibility and show a curvilinear pattern for Psychomotor Speed.

In sum, it does not appear that there are significant differences between the youngest and the middle-aged cohort, but there might well be lower relationships for the oldest cohort, though the latter finding might be limited because the oldest group is smaller.

The effect of offspring age on family resemblance was tested directly in the total sample by regressing parent performance scores on the interaction of offspring age and offspring performance while controlling for the offspring performance and age main effects (hierarchical multiple regression; cf. Cohen and Cohen, 1975). Only two statistically significant interactions ( $p < .05$ ) were found. They suggest that older offspring showed greater resemblance in Perceptual Speed and Motor-Cognitive Flexibility.

#### "NATURAL" COHORT DIFFERENCES

We now shift to the analysis of level differences between parents and offspring. To permit comparison with previously determined population values, we standardized mean level scores to T scores (mean = 50,  $SD = 10$ ). We then computed the average parent-offspring differences in T-score points (see Table 10). Note first that there are statistically significant level differences ( $p < .001$ ) for all variables. Raw differences are in favor of the offspring, except differences for Number and Social Responsibility, which favor the parents.

Because of average within-subject age changes it is necessary to adjust the raw differences before comparison with population cohort differences is appropriate. We did this by computing the average within-subject age changes found over the range of mean ages for our parents and offspring (using the relevant information provided in Schaie, 1983). These values are found in the second column of Table 10, with adjusted net differences in the third column. After the age adjustment, differences are no longer statistically significant for Spatial Orientation, Word Fluency, and the index of Intellectual Ability. The direction of differences in the remaining variables remains as before the age adjustment.

The fourth column of Table 10 provides population cohort differences over the mean birth years represented by our parents and off

**Table 10**  
*Parent-Offspring Generational Differences in Performance Level*

Variable	Parent-Offspring Difference	Expected Age Difference	Net Difference	Population Difference
Verbal Meaning	2.75***	1.01	1.74**	2.28**
Space	5.06***	1.31*	3.75***	-0.78
Reasoning	6.45***	1.77**	4.68***	2.99***
Number	-1.83***	3.04***	-4.87***	-4.26***
Word Fluency	1.73***	2.46**	-0.73	-0.56
Finding A's	2.36***	9.06***	-6.70***	3.55***
Intellectual Ability	2.86***	1.52*	1.34	-0.79
Educational				
Aptitude	3.73***	1.95**	1.78**	2.67***
Motor-Cognitive				
Flexibility	6.73***	-0.53	7.26***	5.43***
Attitudinal				
Flexibility	2.33***	2.03**	0.30	4.42***
Psychomotor Speed	9.19***	3.15***	6.04***	3.22***
Social Responsibility	-3.89***	0.23	-4.12***	-9.43***

*Note.* Positive values are in favor of the offspring. All values are T scores with a population mean of 50 and standard deviation of 10, computed on the basis of 3,442 study participants at first test, except for Finding A's, which is based on 1,628 participants.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

spring (also obtained from Schaie, 1983). Inspection of the third and fourth columns of Table 10 (and Figure 8) therefore allows us to compare population cohort difference estimates with those found for our "natural" cohort. The cohort difference estimates are quite comparable, except for four noteworthy exceptions: (1) Spatial orientation provides a significant cohort difference in the present study, but not in the population for similar birth years. (2) Perceptual speed in the natural cohort favors the offspring, but in the population estimate it shows an advantage for older cohorts. (3) We find no significant difference in Attitudinal Flexibility in this study, but population values argue for an advantage for younger cohorts. (4) The Social Responsibility difference favoring the older cohort is less than half the value estimated for the population.

We finally address the question whether parent-offspring per-



formance differences might be affected by cohort groupings. Using the cohort subsets described earlier, we report raw mean differences in Table 11 and Figure 9. As would be expected, because of the increase in age of the parents for the groups, differences here are least for the youngest cohort and greatest for the oldest. Nevertheless, even in the youngest group, differences in favor of the offspring remain significant for Spatial Orientation, Inductive Reasoning, Number, Perceptual Speed, Motor-Cognitive Flexibility, and Psychomotor Speed, while differences in Verbal Meaning, Number, and Social Responsibility favor the parents. For the middle group all variables favor the offspring except Number (nonsignificant difference) and Social Responsibility, which favor the parents. For the older cohort all differences except Perceptual Speed and Social Responsibility significantly favor the offspring.

## Summary and Conclusions

We now return to the sets of hypotheses formulated in the introductory section to explore how the findings reported above bear on these propositions. Our first hypothesis dealt with whether family similarity could be observed in adulthood and whether there were differing ability patterns in such similarity. Significant family similarities were observed for our total sample for all ability measures, except Perceptual Speed, and for the cognitive style measures.

The magnitude of correlations for the ability measures are comparable for those found between young adults and their children (DeFries et al., 1976). Similar to the DeFries study, we also found differences in resemblance across subsets. For example, same gender pairs showed higher correlations on Verbal Meaning, Number, and Word Fluency but opposite-gender pairs on Spatial Orientation, Inductive Reasoning, and Motor-Cognitive Flexibility. Also, greater similarity was found between mother-offspring pairs than father-offspring pairs on Inductive Reasoning and Psychomotor Speed. Moreover, higher parent-offspring correlations were found for daughters than for sons, suggesting at least the possibility that females may experience greater shared environmental influences than males. Our first hypothesis also argued for the possible effect of early shared environment upon offspring performance on Verbal

**Table 11**

*Performance Differences Between Parents and Offspring as a Function of Cohort Grouping*

Variable	Cohort Grouping		
	Youngest (1955–1968)	Middle-Aged (1931–1954)	Oldest (Before 1931)
Verbal Meaning	–1.83**	3.83***	9.82***
Space	4.49***	4.57***	7.48***
Reasoning	3.73***	7.56***	9.49***
Number	–5.43***	1.37	2.43**
Word Fluency	–0.74	3.22***	3.89**
Finding A's	2.40*	2.73**	1.40
Intellectual Ability	–0.58	3.85***	7.68***
Educational Aptitude	–0.48	4.98***	10.10***
Motor-Cognitive Flexibility	4.38***	7.06***	10.18***
Attitudinal Flexibility	–0.49	2.70***	7.30***
Psychomotor Speed	6.09***	10.75***	11.99***
Social Responsibility	–6.11***	–3.60***	0.13

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .  $N = 199, 228, \text{ and } 104$ . Values in  $t$  scores (see note to Table 10).

Meaning and Word Fluency. After age adjustment, these were indeed the abilities that showed the highest parent-offspring similarity.

Our second hypothesis proposed that if shared environmental influences are relatively unimportant in adulthood, then similarity within parent-offspring pairs should remain reasonably constant in adulthood across time and age. Our examination of this issue with a longitudinal sample ranging over a 21-year period strongly supports this proposition for all of those variables that displayed significant parent-offspring correlations. Indeed, parent-offspring correlations measured at approximately the same age of parent and offspring and when those ages were 20 years apart had similar magnitudes.

The third hypothesis asked whether family similarity would decrease with age because of the increasing amount of nonnormative, nonshared environment expected as adult life progresses. Counter-intuitively, no such decrease in similarity could be observed. Indeed, for two variables there was evidence for increasing similarity as a function of offspring age. This finding makes good sense for our Perceptual Speed variable. Most of our younger offspring typically

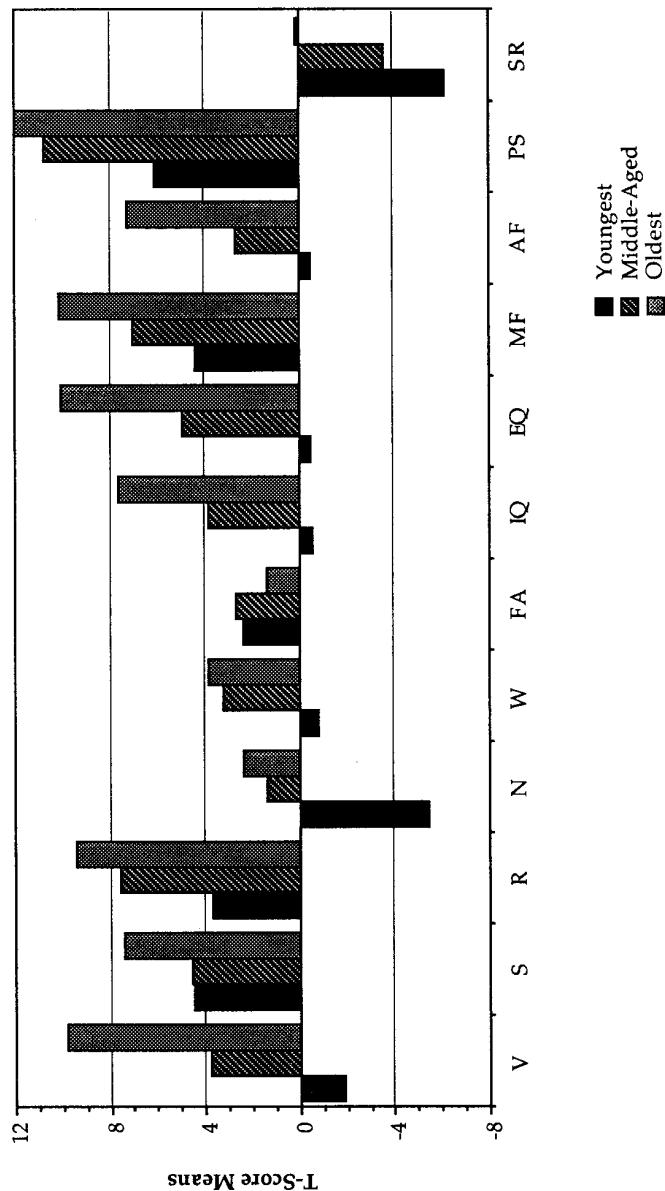


FIGURE 9. Difference in performance level within parent-offspring pairs by cohort groupings.

have not yet experienced age-related decline on this variable, whereas some of their parents have. Both older offspring and parents may have experienced sufficient decline so that once again their observed similarity is increased. The other variable showing an age effect was Motor-Cognitive Flexibility. In this instance our cross-sectional data may confound substantial cohort effects that could have spuriously inflated the offspring age effect.

Further evidence supporting the absence of shared environmental effects upon family similarity is provided by our analyses of the intensity of current parent-offspring contact. All of the few observed significant but very modest effects of contact upon parent-offspring resemblance in performance (for Verbal Meaning, Spatial Orientation, Number, and Attitudinal Flexibility) were in a negative direction.

Our fourth hypothesis argued that cohort effects in parent-offspring correlations would result in higher correlations for earlier cohorts, because of a decline in shared environmental influence attributed to an increase in extrafamilial influences in more recent cohorts. This proposition could be supported only for the attitudinal trait of Social Responsibility (systematic cohort differences on this variable have previously been reported; e.g., Schaie & Parham, 1974). For the cognitive abilities, once again counterintuitively, there seems to be stability or even an increase in family similarity for more recent cohorts. And as in the population estimates (Schaie, 1990b), and in other studies (cf. Sundet, Tambs, Magnus, & Berg, 1988) non-linear cohort trends are also observed. One plausible explanation for the increase in family similarity in successive cohorts might be the decrease of intrafamilial differences in level of education from our oldest to our youngest cohort grouping.

Finally, we asked whether level differences within families equaled or approximated differences found for similar cohort ranges within a general population sample (cf. Schaie, 1990b; Willis, 1989). Comparable differences were found to be the rule, but there were some noteworthy exceptions. Thus the population estimates were found to underestimate the advantage of the offspring cohort for Spatial Orientation and Psychomotor Speed but to overestimate that advantage for Perceptual Speed. On the attitudinal trait of Social Responsibility, however, the estimated cohort difference in favor of the parent cohort was far greater in the population than was observed in

the natural cohort. When broken down by cohort groupings, it became clear that cohort differences became generally smaller for the more recently born parent-offspring pairs, with the exception of increasing differences in favor of the parent generation for Number and Social Responsibility.

We believe this study has demonstrated that family similarity is maintained throughout the adult life span and that the evidence for stability of such family similarity over time is substantial. As in studies of family similarity in early life, it seems clear that the effects of shared environment upon parent-offspring correlations is minimal. But the story may be even more complex. Parent-offspring resemblance differs by gender pairing and possibly by cohort membership. Hence in interpreting our findings as bases for heritability estimates we need to remain mindful that such estimates are bounded by the historical period, the societal circumstances, and the gender of the population studied. Nevertheless we feel that with this study we have come a long way in beginning to understand the dimensions of family similarity within the cognitive domain, but much work remains.

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