Aging, health and competence
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CHAPTER 10

Longitudinal studies of family similarity in intellectual abilities

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Over the past three decades, the *Seattle Longitudinal Study* (SLS) has followed panels of multiple cohorts of adults to assess age changes in intellectual abilities over the adult life course. Study participants have been followed over as long as 35 years (Schaie, 1958, 1983, 1988, 1989a, 1990a; Schaie and Strother, 1968; Schaie and Labouvie-Vief, 1974; Schaie and Hertzog, 1986). This study has recently been expanded by assessing the adult offspring and siblings of many of our original study participants, thus allowing us to consider issues germane to the field of developmental behavior genetics.

For the purpose of this chapter we consider 'aging' to involve the systematic changes that occur in the behavior of individuals over time as they move from young adulthood to old age. Since the lapse of time by itself cannot cause behavioral changes, age becomes a surrogate for those causal variables that would directly explain behavioral change but that have not been identified.

Individual differences in rates of aging can only be investigated by means of longitudinal studies. Likewise, identification of possible genetic parameters that might explain aging processes will require the study of within family relationships. The context of our longitudinal study allows us all to compare family members at their most recently observed assessment point. However, we can also work backwards and examine relationships at distant observation points to vary age differences among pairs of family members.

Parent-offspring correlations have traditionally been studied in young adult parents and their children, while sibling studies have primarily involved children and adolescents. In this chapter we report some of the first data on similarity of parents and adult offspring and of sibling similarity in adulthood, considered specifically as a function of the age of the pairs when studied.

The role of developmental behavior genetics

The new interdisciplinary field of developmental behavioral genetics merges developmental and behavioral genetic theories and methodologies, 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.

The identification of genetic sources of developmental change is important because change is thought to prevail 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 are able to assess genetic change and continuity (cf. Plomin, 1986, p. 329; also see chapter 14).

A second issue receiving attention by developmental behavioral geneticists is that of non-shared environmental influence. In general, behavioral 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 and Daniels, 1987).

Developmental behavior genetics and aging

From a behavioral genetic perspective, very little is known about the origins of individual differences in cognitive abilities, personality, and adjustment during the last half of the life span (Plomin and 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 genetic research in adulthood involves family members in their late teens, typically towards 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 twenties or thirties 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 few behavior genetic studies covering middle and old age moreover were twin studies (cf. Kallman and Sander, 1949; Jarvik et al., 1972; Plomin et al., 1988). Because of the unusual circumstances of twins, results from these studies may therefore be difficult to generalize to the far more frequent case of family similarities involving non-twins. We note then, that there are currently no longitudinal family studies in the literature that extend over the last 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, and of siblings from young adulthood to old age. Because parents and offspring, and siblings, 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 in common 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 either in terms of environmental or genetic factors. Early-adopted individuals are difficult to find later in life, and they may differ from non-adopted individuals in terms of the family environments that they experience (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. The family design asks the extent to which individual differences are due to familial factors, whether genetic or environmental, and it provides upper-limit estimates of genetic and shared family environmental influences.

In this chapter, our primary objective is to show how a longitudinal data set can be used to gain insight on behavior genetic issues in family similarity. We will thus concentrate on two questions: (1) what is the extent of family similarity on intellectual abilities in parent-offspring and sibling pairs, and how does this similarity differ across various dimensions of intellectual functioning; and (2) what is the longitudinal stability of family similarity across age and time?

The first question is straightforward and is dealt with by obtaining the regressions of performance scores of offspring on their parents, and siblings upon their sibling who has been a member of the SLS panels, in both cases controlling for the age of the member of each pair. The second question is somewhat more complex. If we assume that shared environmental influences are relatively unimportant in adulthood implying that such influences do not contribute to family resemblance), one 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 and Thompson, 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 from another family member. This hypothesis can be tested by assessing family 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.

The Seattle Longitudinal Study

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 and 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 socio-economic spectrum. The population frame from which we have been sampling has grown to a membership of over 400 000 individuals, but the general characteristics of the HMO remain very comparable to its structure at the inception of the study. The study design through the fifth wave is given in table 1.

Throughout the course of the SLS our primary focus has been the investigation of psychometric abilities within the Thurstonian (1938) framework. We have also collected data on rigidity-flexibility, life-styles, 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.

Table 1. Design of the Seattle Longitudinal Study (S, sample; T, time of entry into study)

1956	1963	1970	1977	1984
S_1T_1 ($N=500$)	S_1T_2 ($N=303$)	S_1T_3 ($N=162$)	S_1T_4 ($N=130$)	S_1T_5 ($N=97$)
	S_2T_2 ($N=997$)	S_2T_3 ($N=420$)	S_2T_4 ($N=337$)	S_2T_5 ($N=204$)
		S_3T_3 ($N=705$)	S_3T_4 ($N=340$)	S_3T_5 ($N=225$)
			S_4T_4 ($N=612$)	S_4T_5 ($N=294$)
				S_5T_5 ($N=628$)

Methods

Subjects

The participants in this study consist of the adult offspring and siblings (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 3507 adult children. Of these, 1416 adult children (males = 701; females = 715) resided in the Seattle metropolitan area. They also had a total of 1999 siblings including 779 brothers and 1020 sisters.

The recruitment of the adult offspring and siblings began with a letter containing an update report on the SLS sent to all study participants tested in 1983–1985. This letter also announced the family resemblance study and requested that panel members provide names and addresses of siblings and offspring. A recruitment letter was then sent to all siblings and offspring thus identified. As of the writing of this report, we have successfully tested 531 adult offspring. This data set includes 99 father/son pairs, 211 mother/daughter pairs, 115 father/daughter pairs, and 106 mother/son pairs. 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).

We have thus far also tested a total of 304 siblings, resulting in 45 brother/brother pairs, 102 sister/sister pairs, and 157 brother/sister pairs. The newly assessed siblings, in 1990, ranged in age from 22 to 89 years (mean = 58.26; SD = 14.56). Target siblings ranged in age from 24 to 89 years when tested in 1984 (mean = 53.26; SD = 13.95). All study participants were community-dwelling individuals when tested.

Table 2 provides a breakdown of parents, offspring and siblings by age and sex, using the 7-year cohorts conventionally employed in the SLS (cf. Schaie, 1983a, 1988b).

Table 2. Age and sex distribution of study participants

Age range	Parents			Offspring			Siblings					
	(1984)			(1990)			(1984)			(1990)		
	M	F	T	M	F	T	M	F	T	M	F	T
22–28	–	–	–	21	30	51	3	9	12	1	2	3
29–35	–	–	–	52	96	148	16	9	25	5	17	22
36–42	–	11	11	48	82	130	9	26	45	10	20	30
43–49	15	27	42	43	55	98	16	22	38	10	28	38
50–56	34	63	97	25	34	59	20	26	46	15	20	35
57–63	56	59	115	14	17	31	29	30	59	18	29	47
64–70	49	69	118	3	6	9	23	23	46	24	39	63
71–77	35	52	87	2	3	5	13	18	31	21	27	48
79–84	16	28	44	–	–	–	1	3	4	5	12	17
85–91	9	8	17	–	–	–	1	2	3	2	4	6
Total	214	317	531	208	323	531	141	168	309	111	198	309

Measures

Primary mental abilities

The test battery administered to the participants in this study included multiple measures of cognitive abilities which 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 Numeric Ability stand as representatives of crystallized intelligence; Perceptual Speed is examined as an ability marker fór the speed domain.

A brief description of these abilities and their measures is given below. Test/retest correlations for the ability measures come from a study of 172 individuals tested over a 2-week interval. Similar values for the other measures represent test-retest correlations over a 7-year interval.

Verbal Ability Language knowledge and comprehension is measured by assessing the scope of a person's recognition vocabulary by matching one of four synonyms to a stimulus word (Thurstone and 1949; test-retest correlation = 0.890).

Spatial Orientation This is the ability to visualize and mentally manipulate spatial configurations, to maintain orientation with respect to spatial objects, and to perceive relationships among objects in space. 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 (Thurstone and Thurstone, 1949; test-retest correlation = 0.817).

Inductive Reasoning This is the ability to educe novel concepts or relationships. 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 (Thurstone and Thurstone, 1949; test-retest correlation = 0.884).

Numeric Ability The ability to understand numerical relationships and compute simple arithmetic functions. The study participant checks whether additions of simple sums shown are correct or incorrect (Thurstone and Thurstone, 1949; test-retest correlation = 0.875).

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 (Thurstone and Thurstone, 1949; test-retest correlation = 0.896).

Perceptual Speed The ability to find figures, make comparisons and carry out other simple tasks involving visual perception, with speed and accuracy is measured by the Finding A's test. In each column of 40 simple words, the subject must identify the five words containing the letter 'a' (Ekstrom et al., 1976; test-retest correlation = 0.860).

Rigidity-flexibility

The multiple dimensions of this construct are measured by the Test of Behavioral Rigidity (TBR) (Schaie, 1955; Schaie and Parham, 1975; Schaie and Willis, 1991). The TBR was designed to measure the three dimensions of Psychomotor Speed (PS; test-retest correlation = 0.88), Motor-Cognitive Flexibility (MCF; test-retest correlation = 0.67), and Attitudinal Flexibility (AF; test-retest correlation = 0.84). Factor scores on these dimensions are estimated from linear combinations of the seven scores yielded by the following three TBR sub-tests:

The Capitals Test Adapted from Bernstein's (1924) study of quickness and intelligence, this test was designed to represent the Spearmanian, or 'functional' approach to perseveration or rigidity. Participants copy a printed paragraph that contains some words starting with capital letters, others spelled entirely in capitals, and some starting with a lower case letter and their remainder in capitals. In the second half of the test, the paragraph is copied again, but in reverse form, i.e., substituting capitals for lower case letters, and lower case letters for capitals. A psychomotor speed score is the number of words correctly copied in the first series (copying speed). A motor-cognitive flexibility score (instructional set flexibility), results from taking the ratio of the number of words correctly copied in the second series to that of the first.

The Opposites Test This test was constructed following the work of Scheier and Ferguson (1952). Subjects respond to 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 which are responded to with an antonym if the stimulus word is printed in lower case letters, but with a synonym if printed in capitals. The psychomotor speed score is the sum of correct responses in the first two lists (associative speed). Two motor-cognitive flexibility scores represent the ease of shifting from synonyms to antonyms depending on whether the stimulus word is presented in upper or lower case letters.

The TBR Questionnaire This is a 75-item true-false questionnaire that contains 22 rigidity-flexibility items (attitudinal flexibility) and 44 masking social responsibility items from the California Psychological Inventory (Gough et al., 1952; Gough, 1957; Schaie, 1959; Schaie and Parham, 1974). It also contains nine items suitable for adults obtained from the Guttman-scaling of perseveration scale first used by Lankes (1915) (behavioral flexibility).

Procedure

Potential subjects who agreed to participate were scheduled for group assessment sessions. Size of the groups ranged from 5 to 20 participants, depending upon the age of the subjects. The testing sessions lasted approximately 2.5 h plus a 'homework' package of questionnaires requiring approximately an additional hour of effort. Each session was conducted by a psychometrist aided by a proctor whenever more than five participants were tested simultaneously. Subjects were paid US$25 for their participation.

Analyses

Regression analyses were employed to analyze parent-offspring and sibling resemblance and to determine the extent to which familial resemblance differs as a function of other variables, such as age and testing interval, as well as other variables such as gender and time of measurement (Ho et al., 1980; DeFries and Fulker, 1985; Zielenewski et al., 1987). This least-squares model-fitting represents a straightforward approach to the analysis of simple designs such as the family design in which we do not attempt to differentiate genetic and environmental components of variance. For example, we regress out the effects of parent and offspring age to obtain net estimates of the parent-offspring correlations.

Estimation of genetic parameters
In addition to the straightforward analyses of familial resemblance and its interaction with other variables, genetic analyses can be conducted if the assumption is made that shared environment does not contribute to familial resemblance; that is, if it is assumed that familial resemblance is due solely to hereditary factors (Rowe and Plomin, 1981). As discussed earlier, this appears to be a reasonable assumption for cognitive abilities in adulthood (Plomin, 1987); 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 resulting in precise estimates of genetic parameters. If the assumption is made that shared environment does not contribute to familial resemblance for cognitive abilities, then doubling of parent-offspring or sibling correlations provides estimates of heritability, the proportion of phenotypic variance that can be explained by genetic variance (see Plomin et al., 1990).

If, for example, a sibling correlation or same-age parent-offspring correlation of 0.30 was obtained for the PMA Spatial Orientation test, it would suggest a heritability of 0.60 if shared environment does not contribute to the sibling or parent-offspring similarity. The rest of the variance is non-genetic; some of the non-genetic variance involves error of measurement and the remainder is due to non-shared environment. The regression analyses for which results are reported provide estimates of heritability across ages. It should again be emphasized that heritability is a descriptive statistic and thus

Table 3. Parent/offspring and sibling correlations

	Parent/offspring		Siblings	
	Raw	Age-adjusted	Raw	Age-adjusted
Verbal Meaning	0.143 **	0.247 ***	0.337 ***	0.256 ***
Space	0.242 ***	0.154 **	0.256 ***	0.150 **
Reasoning	0.276 ***	0.211 ***	0.470 ***	0.212 ***
Number	0.188 ***	0.213 ***	0.266 ***	0.262 ***
Word Fluency	0.268 ***	0.267 ***	0.270 ***	0.201 ***
Finding A's	0.102 *	0.065	0.068	0.032
Intellectual Ability [a]	0.261 ***	0.291 ***	0.351 ***	0.219 ***
Educational Aptitude [b]	0.201 ***	0.289 ***	0.381 ***	0.239 ***
Motor-Cognitive Flexibility	0.294 ***	0.214 **	0.316 ***	0.129 *
Attitudinal Flexibility	0.128 **	0.147 **	0.163 **	0.109 *
Psychomotor Speed	0.211 ***	0.209 ***	0.290 ***	0.138 **
Social Responsibility	0.001	−0.003	−0.044	−0.033

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Weighted linear combination of first five mental abilities, IA $= V + S + 2R + 2N + W$ (Thurstone and Thurstone, 1949).

[b] Estimate of educational aptitude, EA $= 2V + R$.

will change as the relative contributions of genetic and environmental influences change in different populations or during development. Most importantly, heritability does not imply immutability: it simply refers to the proportion of observed inter-individual variance in a population that is due to genetic differences among individuals.

Results

The presentation of our results begins with the findings on parent-offspring similarity in terms of the correlation of parental performance with that of their offspring, as well as the adjusted coefficients when the regression of parental and offspring age on the dependent variables has been removed. Similar analyses are presented for the sibling correlations. We then consider the stability of parent-offspring and sibling correlations across time (and age). Finally. we consider the effects of cohort differences in parent-offspring and sibling correlations.

Parent offspring correlations

As shown in table 3, parent-offspring correlations for the total sample were statistically significant ($p < 0.05$) for all variables studied except for the trait measure of Social Responsibility. Among the ability measures, correlations were highest for Inductive Reasoning, and Word Fluency, and the Intellectual Ability composite measure. They were lowest for the measures of Perceptual Speed (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 off-spring (and to model the assumption of equal ages), we partialled out the effects of parent and offspring age. The correlations adjusted for age at test are provided in the second column of table 3. Subsequent to the age adjustment, all but the measures of Perceptual Speed and Social Responsibility remain statistically significant ($p < 0.01$). However, the magnitudes of the correlations change somewhat, with Word Fluency and Verbal Meaning now displaying the highest ability correlations, as well as the composite indices of Intellectual Ability and Educational Aptitude. Both Motor-Cognitive Flexibility and Psychomotor Speed continue to show higher family similarity than does Attitudinal Flexibility.

Sibling correlations

Similar data are provided for the sibling correlations. Here the performance of the target sibling is regressed upon the index case (the sibling assessed in 1990). The raw correlations are shown in the third column of table 3. Sibling correlations were statistically significant ($p < 0.01$) for all variables studied except for perceptual speed and the trait measure of Social Responsibility. Among the ability measures, correlations were highest for Inductive Reasoning, and Verbal Meaning as well as the composite measures. They were lowest for the measures of Perceptual Speed (the Finding A's test), Space and Word Fluency. Among the cognitive style measures, correlations were highest for Motor-Cognitive Flexibility and lowest for Attitudinal Flexibility.

Again adjustment is needed for the age of siblings to meet assumptions for heritability estimates. The standardized regression correlations adjusted for the age of both siblings is given in the last column of table 3. Subsequent to the age adjustment, all but the measures of Perceptual Speed and Social Responsibility remain statistically significant ($p < 0.05$). However, the magnitudes of the correlations change somewhat, with Verbal Meaning and Number now displaying the highest ability correlations. Correlations for the cognitive style measures are reduced and are now of about equal magnitude.

Stability of parent offspring correlations over time

In order 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, yielding a set of 162 participant pairs, who were tested 6, 13, 20, and 27 years apart, respectively.Table 4 shows the stability results in terms of the standardized regression coefficients adjusting for parent and offspring age. Note the substantial stability of correlations across time for Verbal Meaning, Reasoning, Number, Word Fluency, the composite indices and Psychomotor Speed. However, Spatial Orientation is significant only for the 1963 and 1977

Table 4. Parent-offspring correlations as a function of time adjusted for parent and offspring age

Variable	Parents tested in			
	1963	1970	1977	1984
Verbal Meaning	0.256 **	0.255 **	0.230 **	0.260
Space	0.202 *	0.105	0.258 **	0.131
Reasoning	0.236 **	0.298 ***	0.272 **	0.291 **
Number	0.151 *	0.166 *	0.185 *	0.238 **
Word Fluency	0.357 ***	0.219 **	0.309 ***	0.293 ***
Finding A's	–	–	0.147 *	0.177 *
Intellectual Ability	0.248 **	0.261 **	0.263 **	0.284 ***
Educational Aptitude	0.183 *	0.287 **	0.236 **	0.306 ***
Motor-Cognitive Flexibility	0.104	0.054	0.233 **	0.204 *
Attitudinal Flexibility	0.150 *	0.109	0.114	0.124
Psychomotor Speed	0.384 ***	0.322 ***	0.416 ***	0.375 ***
Social Responsibility	−0.001	0.076	0.105	0.060

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

comparisons, Motor-Cognitive Flexibility reaches significant levels only in 1977 and 1984, and Attitudinal Flexibility is significant only in the 1963 comparison.

Stability of sibling correlation over time

Regression coefficients adjusted for age of both siblings were also computed between the index sibling and the performance of the target sibling in 1963, 1970, 1977, and 1984. Because of the relatively small number of pairs for which all four data points were available ($N = 72$), the demonstration of stability is not quite as good as for the parent-offspring pairs. Relevant data are provided by table 5. There is strong evidence for the stability of sibling

Table 5. Sibling correlations as a function of time adjusted for age of both siblings

Variable	Target siblings tested in			
	1963	1970	1977	1984
Verbal Meaning	0.153	0.114	124	0.191 *
Space	0.107	0.204 *	0.169	0.303 **
Reasoning	0.157	0.239 *	0.244 *	0.043
Number	0.408 ***	0.276 **	0.388 ***	0.368 ***
Word Fluency	0.052	0.061	0.155	0.012
Finding A's	–	–	0.107	0.085
Intellectual Ability	0.177	0.176	0.235	0.164
Educational Aptitude	0.135	0.124	0.116	0.124
Motor-Cognitive Flexibility	−0.018	−0.039	−0.046	−0.075
Attitudinal Flexibility	0.115	0.070	0.211	0.022
Psychomotor Speed	0.304 **	0.259 *	0.357 ***	0.285 **
Social Responsibility	0.063	0.178	0.194	0.149

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 6. Parent-offspring correlations as a function of age/cohort

Variable	Age/cohort grouping		
	Youngest 1955–1968	Middle-Aged 1931–1954	Older Before 1931
Verbal Meaning	0.209 **	0.230 **	0.051
Space	0.216 **	0.163 **	0.106
Reasoning	0.184 **	0.292 ***	0.265 ***
Number	0.181 **	0.248 ***	0.157
Word Fluency	0.256 ***	0.290 ***	0.247 **
Finding A's	0.121	0.206 **	0.020
Intellectual Ability	0.217 **	0.274 ***	0.263 **
Educational Aptitude	0.246 **	0.254 ***	0.114
Motor-Cognitive Flexibility	0.144 *	0.057	0.479 ***
Attitudinal Flexibility	0.128	0.162 *	0.071
Psychomotor Speed	0.037	0.359 ***	0.041
Social Responsibility	0.205 **	0.133 *	0.066

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. $N = 199$, 228, and 104.

concordance for Number and Psychomotor Speed. Stable trends seem to prevail also for Space, Reasoning and the composite indices.

Age / cohort differences in parent offspring correlations

We next consider the magnitude of parent-offspring correlations as a function of age/cohort membership. For this purpose, we divided the total sample into a youngest cohort ($N = 199$; birthyears 1955–1968), a middle-aged cohort ($N = 228$; birthyears 1931–1954), and an older cohort($N = 104$; birthyears before 1931). As can be seen from table 6, there are substantial differences in pattern and magnitude of correlations. Parent-offspring correlations for the youngest cohort are statistically significant ($p < 0.05$) for all variables but Perceptual Speed, Attitudinal Flexibility and Psychomotor Speed, while for the middle-aged cohort correlations are statistically significant ($p < 0.05$) for all variables except for Motor-Cognitive Flexibility. For the oldest cohort, however, correlations are statistically significant ($p < 0.05$) only for Inductive Reasoning, Word Fluency, Intellectual Ability, and Motor-Cognitive Flexibility. Correlations rise generally from the older to the youngest cohort. However, the correlations drop across cohorts for Inductive Reasoning, the intellectual ability composite, and Motor-Cognitive Flexibility, and show a curvilinear pattern for Psychomotor Speed.

Summary and conclusions

Our presentation began by suggesting that a longitudinal data set provided an ideal basis for investigating family similarity in adult and aging individuals and by providing some of the relevant considerations from the literature in developmental behavior genetics. We then examined our data to test the proposition that family similarity in intellectual abilities is not found only at early ages but is maintained throughout adult life.

Whether for parent-offspring or sibling pairs, substantial adult family similarity could be documented. The two exceptions to this finding were the attitudinal trait of Social Responsibility and the measure of perceptual speed, neither of which seems to display heritable characteristics. In general, parent-offspring and sibling correlations were of similar magnitude. However, after controlling for age, sibling correlations were somewhat lower than those observed for the parent-offspring pairs. The magnitude of the correlations for the ability measures are comparable for those found between young adults and their children in the only other family study using similar variables (Defries et al., 1976).

If shared environmental influences are relatively unimportant in adulthood then similarity within parent-offspring and sibling 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. However, similar stability data for the siblings could be strongly confirmed only for the variables of Number and Psychomotor Speed. Trends comparable to those observed for the parent-offspring pairs for other variables probably failed to reach significance because of the limited power of the longitudinal sibling sample.

It could be argued that cohort effects in parent-offspring correlations should yield higher correlations for earlier-born (older) cohorts, because of a decline in shared environmental influence attributed to an increase in extra-familial 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 and Parham, 1974). For the cognitive abilities, once again counter-intuitively, there seems to be stability or even an increase in family similarity for more recent cohorts. As in the population estimates (Schaie, 1990b), and in other studies (cf. Sundet et al., 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 intra-familial differences in level of education from our oldest to our youngest cohort grouping. Limited sample size precluded replication of the cohort findings for the siblings.

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 is more complex. Similarity differs by cohort membership and as we have reported elsewhere also by gender pairings (cf. Schaie et al., 1991). Hence we need to remain mindful in interpreting our findings as bases for heritability estimates that such estimates are bounded by the historical period, the societal circumstances, and the gender membership 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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