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Genetic and Environmental Influences on Vocational Interests Assessed Using Adoptive and Biological Families and Twins Reared Apart and Together

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The present investigation was a step toward a more thorough explication of the amount of genetic and environmental variance in vocational interests than has been found in past research. A comprehensive behavioral genetics research design was employed, using previously collected data from twins reared together, twins reared apart, adoptive families, and biological families. The data consisted of item responses from the Strong Vocational Interest Blank/Strong Interest Inventory (SVIB/SII). All of the data were scored using the Hansen Combined Form Scales for the SVIB/SII (Hansen, 1982). Correlations were computed, and model fitting analyses were run to estimate additive genetic, nonadditive genetic, shared environmental, and nonshared environmental effects. The results suggested that, on average, the variance in a wide range of vocational interests can be attributed to 12% additive genetic and 24% nonadditive genetic effects and to 9% shared environmental and 55% nonshared environmental effects and measurement error.

Numerous researchers have made theoretical statements about the origins of vocational interests (e.g., Strong, 1943; Berdie, 1944; Darley & Hagenah, 1955). These researchers, who based their theories on the empirical work available to them at the time, embraced diverse conclusions such as vocational interests are (a) learned, (b) related to abilities, (c) an outgrowth of personality, (d) environmentally influenced, and (e) genetically influenced. The present investigation examined the development of interests using genetic and environmental models.

In vocational psychology, behavior genetics studies have been conducted on job satisfaction (Arvey, Bouchard, Segal, & Abraham, 1989), work values (Keller, Bouchard, Arvey, Segal, & Dawis, 1992), and vocational interests. Twin studies using twins reared together were conducted by Carter (1932), Vandenberg and Kelly (1964), Vandenberg and Stafford (1967), Roberts and Johansson, (1974), Loehlin and Nichols (1976), and Nichols (1978). Grotevant, Scarr, and Weinberg (1977) used an adoption and biological family design in their study. Moloney, Bouchard, and Segal (1991) used twins reared apart to investigate the genetic and environmental influences on vocational interests. Despite the differences in these studies (i.e., inventories or scales, designs, samples, analyses), some degree of genetic influence has been consistently reported.

Most of the studies of genetic influences on vocational interests have used monozygotic (MZ) and dizygotic (DZ) twins reared together (MZT and DZT), with the exception of the adoption and biological family study

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conducted by Grotevant, Scarr, and Weinberg (1977) and the MZ and DZ twins reared apart (MZA and DZA) study conducted by Moloney et al. (1991). Thus, the range of behavior genetic research designs used is limited. Moloney et al. (1991) discussed the inconsistencies between their findings using twins reared apart and previous findings. They reported similar correlations between MZA twins and MZT twins, but they reported discrepant correlations between DZA twins and DZT twins and biological siblings. The present investigation was unique in that it used a comprehensive data set, including twins reared together, twins reared apart, adoptive families, and biological families.

Recent investigations estimating genetic and environmental influences rely on model-fitting techniques as an approach to data analysis. Most of the previous studies of genetic influences on vocational interests used the classical twin method which multiplies the difference between MZ and DZ twins by two (Falconer, 1960). Only one of the previous studies has used a model-fitting analysis (Moloney et al., 1991). The model-fitting technique translates hypotheses about the genetic and environmental influences on behavior (e.g., vocational interests) into structural equations that are fit to a set of data (mean squares or correlations). The major advantages of model fitting are that it (a) estimates the degree of genetic and environmental influence and the errors of estimates; (b) tests the fit of the model; (c) allows the investigator to analyze multiple family relationships simultaneously, i.e., to aggregate results from numerous studies; and (d) makes the assumptions of a model explicit (Plomin, DeFries, & McClearn, 1990).

The purpose of this research was to expand on the previous work in this area by estimating the genetic and environmental influences contributing to vocational interests. Three aspects make this investigation unique: a comprehensive data set, model-fitting analyses, and a single measure of interests for all samples (the Hansen Combined Form Scales for the Strong Interest Inventory, Hansen, 1982).

METHOD

Participants

Participants included twins reared together, twins reared apart, adoptive families, biological families, and spouses drawn from four separate data sets. There is strong evidence for the stability of interests within an occupation over 50 years, and societal changes seem not to have greatly affected the interests of women or men (Hansen, 1988). Therefore, the use of data collected at different points in time was warranted.

The majority of the participants were Caucasian. No information on race or ethnicity was reported for the twins reared together data set (Loehlin & Nichols, 1976; Roberts & Johansson, 1974). The twins reared apart were predominantly Caucasian and were primarily from the United States and the United Kingdom, although some participants were from other foreign countries (Bouchard, Lykken, McGue, Segal, & Tellegen, 1990). Both the adoptive and biological families data sets comprised only Caucasian families (Scarr & Weinberg, 1983; Grotevant & Cooper, 1985).

Twins reared together. The sample of twins reared together was obtained from the Center for Interest Measurement Research (University of Minnesota) archives; the stored data included Strong Vocational Interest Blank (SVIB) data collected in the 1965 National Merit Scholarship Qualifying Test twin study (NMSQT, Loehlin & Nichols, 1976; Nichols, 1978). The NMSQT included a question asking if the subject was a twin; if the subject responded yes, a possible twin match (sex, address, name) was sought. Physical similarity questionnaires were sent to subjects matched as twins to determine zygosity. The return rate for this questionnaire was 78% (Loehlin & Nichols, 1976). The subjects with a diagnosis of MZ or DZ were sent the SVIB roughly one year after they had graduated from high school (specific age information was not available; Roberts & Johansson, 1974). The return rate for the SVIB was approximately 80% (Roberts & Johansson, 1974). The sample used in this investigation consisted of 1960 pairs of MZ twins (1142 female pairs and 818 male pairs) and 1212 pairs of DZ twins (738 female pairs and 474 male pairs).

Twins reared apart. The sample of twins reared apart was obtained from the ongoing Minnesota Study of Twins Reared Apart (MSTRA; Bouchard et al., 1990). This study consists of a comprehensive medical and psychological assessment for twins separated at a young age and reared in different homes; it also includes spouses. The assessment takes approximately 50 hours and is conducted at the University of Minnesota. The Strong Interest Inventory (SII) is administered as part of the psychological assessment. The approximate mean age at separation is 5 months for the MZ twins and 11 months for the DZ twins. The approximate mean number of years spent apart prior to reunion is 29 years for the MZ twins and 39 years for the DZ twins. Zygosity diagnoses are based on analyses of eight blood group systems, four serum proteins, six red blood cell enzymes, fingerprint ridgecount, ponderal index, and cephalic index. The sample used in this investigation consisted of 57 pairs of MZ twins and 2 MZ triplets (36 female pairs, 21 male pairs, and 2 sets of male triplets), and 33 pairs of DZ twins (23 female pairs and 10 male pairs). Ninety-four pairs of spouses also were available. The sample included all subjects who participated in the MSTRA between 1979 and 1990. The mean age of the MZ twins and triplets was 38.9 years. The mean age of the DZ twins was 43.9 years.

Adoptive families. The sample of adoptive families was obtained from the Adolescent Adoption Study directed by Scarr and Weinberg (1983). Conducted in the mid-1970's at the University of Minnesota, the Adolescent Adoption Study was an investigation of intellectual, personality, interest, and attitudinal similarities in Caucasian adoptive families. Biological parents of adoptees were not included in this investigation. The adoptees had been placed in the adoptive family during the first year of life and had spent an average of 18 years in the family. All adoptive families were from Minnesota, and 62% were from the Twin Cities Metropolitan Area. As part of the testing battery, the subjects (adoptive parents and adoptees) were given the Strong-Campbell Interest Inventory (SCII) to complete at home and return by mail. The sample used in this investigation included 83 fathers with a mean age of 51.0 years, 87 mothers with a mean age of 49.0 years; 80 adopted sons with a mean age of 17.8 years, and 90 adopted daughters with a mean age of 17.7 years. Eighty-three pairs of spouses were available.

Biological families. The sample of biological families was obtained from the Family Process Project directed by Grotevant and Cooper (Grotevant & Cooper, 1985). The data were collected for this study between 1978 and 1980 at the University of Texas. The purpose of the study was to look at family processes associated with adolescent psychosocial development in terms of identity and social cognitive development (H. D. Grotevant, personal communication, July 9, 1991). The subjects in the Family Process Project were members of white, middle-class, two-parent families that included an adolescent who was a high school senior. As part of the data collection procedures, each family member was asked to complete an SCII and return it by mail. The sample used in this investigation included 114 fathers with a mean age of 45.8 years, 114 mothers with a mean age of 43.8 years, 78 sons with a mean age of 16.8 years, and, 90 daughters with a mean age of 16.7 years. One-hundred thirteen pairs of spouses were available.

Instrument

The instrument used to assess vocational interests was the Hansen Combined Form Scales for the Strong Interest Inventory (Hansen, 1982). These scales were developed by identifying those items that were common to every form of the SII and constructing a set of 26 scales (General Occupational Themes, Basic Interest Scales, Academic Comfort, and Introversion/Extroversion) based on those common items. Thus, these scales permit an investigator to combine data from various forms of the SII. Twenty-five scales were used for the analyses: Realistic, Investigative, Artistic, Social, Enterprising, Conventional, Nature, Mechanical, Science, Math, Medical Service, Music/Art, Art, Writing, Teaching, Social Service, Athletics, Public Speaking, Law/Politics, Merchandising, Sales, Business Management, Office Practices, Academic Comfort, and Introversion/Extroversion. The Adventure scale was not used in this investigation because it contains too few items and has a low internal consistency reliability.

As reported in Hansen (1982), a Coefficient of Equivalence was computed for the Hansen Combined Form Scales and the SII 1985 General Occupational Themes (GOT) and Basic Interest Scales (BIS); the correlations ranged from .86 for Realistic and Athletics to .99 for Academic Comfort and Introversion/Extroversion, with a median correlation of .92 and a modal correlation of .95. Two-week test–retest reliability correlations for these scales ranged from .73 for Public Speaking to .91 for Academic Comfort and Introversion/Extroversion (Hansen, 1982). The median and modal correlation was .81. The α coefficients based on the General Reference Sample of the Strong Interest Inventory ranged from .60 for Athletics to .88 for Artistic with a median of .79, and a mode of .70.

Analyses

Re-scoring data. All original sample data were re-scored on the Hansen Combined Form Scales (Hansen, 1982) yielding 25 vocational interest scale scores per person. For the twins reared together sample, original SVIB data (1966 men's form and 1946 women's form) were re-scored. For the twins reared apart sample, SII data (1981 SCII form and 1985 SII form) were re-scored. For the adoptive families sample, original SCII data (1974 form) were re-scored. For the biological families sample, original SCII data (1974 form) were re-scored.

Kinship correlations. Interclass correlations (Pearson product-moment coefficient) were computed for parent-offspring and opposite sex sibling pairs; intraclass correlations derived from oneway analysis of variance (Snedecor & Cochran, 1980) were computed for all twin and same sex sibling pairs. Interclass correlations from three sets of spouses were used to examine marital resemblance for vocational interests. For the spouses from the twins reared apart study, the median correlation for the GOT was .19 and for the BIS was .09. For the spouses from the adoptive family study, the median correlation for the GOT was .12 and for the BIS was .07. For the spouses from the biological family study, the median correlation for the GOT was .10 and for the BIS was .13. These spousal correlations suggested little marital resemblance for vocational interests. Consequently, marital resemblance and the spouse correlations were not used in further analyses.

χ^2 test for sex differences. A χ^2 statistic was used to test for any significant differences between correlations for matched separate sex samples (e.g., differences between female and male correlations for MZT twins). Four comparisons were computed using those kinship pairs with large sample sizes. The results suggested that for female MZT twins (N = 571) and male MZT twins (N = 409), only the correlations for the Nature scale

were significantly different. For female DZT twins (N = 369) and male DZT twins (N = 237), only the correlations for the Academic Comfort scale were significantly different. For adoptive father–son (N = 68), father–daughter (N = 70), mother–son (N = 70) and mother–daughter (N = 75) pairs, no significant differences between correlations were found. For the biological father–son (N = 76), father–daughter (N = 90), mother–son (N = 78), and mother–daughter (N = 88) pairs, correlations for the Art, Social Service, Public Speaking, and Introversion/Extroversion scales were significantly different. Few significant sex differences in the correlations were found when comparing opposite sex correlations. Therefore, the opposite sex samples were combined, which created larger samples and more stable correlations.

Standardization of scores and age and sex correction. The vocational interest scores for the twins reared together, adoptive families, and biological families were standardized by sex due to general sex differences in vocational interests. Following this adjustment, separate sex samples were combined to derive a pooled correlation estimate. The combined sex groups included: MZT and DZT twins, adoptive parent–child and adoptive siblings, and biological parent–child and biological siblings. Age was not corrected due to homogeneous age groupings of these samples.

The twins reared apart sample data were age and sex corrected. If a trait is influenced by age and sex factors, estimates of twin similarity will be biased upward. This sample had a wide range of ages between subjects, unlike the other samples. Therefore, all vocational interest scores were age and sex corrected (using the entire sample from MSTRA, including twins, spouses, and other relatives) following the regression procedures discussed in McGue and Bouchard (1984).

Re-calculation of kinship correlations. Interclass correlations were re-calculated for parent–offspring; intraclass correlations were re-calculated for all twin and sibling pairs. The following eight relationships were used to calculate correlations: (1) 1960 MZT twin pairs, (2) 1212 DZT twin pairs, (3) 59 MZA twin pairs (including two sets of triplets), (4) 33 DZA twin pairs, (5) 283 adoptive parent–offspring pairs, (6) 63 adoptive sibships (including eight sets of three), (7) 332 biological parent-offspring pairs, and (8) 60 biological sibships (including two sets of three).

Model-fitting analyses. Model-fitting analyses were used to estimate the proportion of variance attributed to additive and nonadditive genetic effects and to shared and nonshared environmental effects. According to quantitative genetic theory, the phenotype of a trait (the portion that is observable) can be divided into four unobservable components that combine additively. The four unobservable components include additive and nonadditive genetic effects, and shared and nonshared environmental effects. Additive genetic effect refers to that portion of the genetic effect that is due to the influence of genes taken singly. Nonadditive genetic effect refers to departures from the additive model. In this model, nonadditive genetic effect equals dominance. Shared environmental effect refers to environmental influences that individuals in the same family have in common. Nonshared environmental effect refers to unique environmental influences that one individual does not have in common with others in the same family.

LISREL (Joreskog & Sorbom, 1989) was used to estimate the variance attributable to each of the four unobservable components. The LISREL estimates are regression coefficients (the square root of the variance component). The interpretable aspect of the estimate is the variance component of the phenotype, which comprises additive genetic, nonadditive genetic, shared environmental, and nonshared environmental effects.

LISREL modeling procedures were derived from Chipuer, Rovine, and Plomin (1990), using eight groups (MZT twins, DZT twins, MZA twins, DZA twins, adoptive parent–offspring, adoptive siblings, biological parent–offspring, and biological siblings). Eight available statistics (kinship correlations) were used to estimate the specified parameters, including additive genetic, nonadditive genetic, shared environment, and nonshared environment. The equations were derived from the predicted contributions of additive genetic, nonadditive genetic, shared environment, and nonshared environment to familial correlations.

There were minor variations in model fit for some of the 25 scales. The variations for these scales involved setting several parameter estimates to zero. The initial LISREL analysis estimated these parameters close to or at zero; LISREL does not provide standard errors for the scale if parameter estimates are near zero because the model appears to LISREL to be non-identified. Setting these parameter estimates at zero enabled LISREL to provide summary statistics for these scales. The model estimated four parameters for each scale: additive and nonadditive genetic effects, and shared and nonshared environmental effects. The variations involved setting the additive genetic parameter to zero for four scales (realistic, conventional, medical service, and office practices).

The maximum likelihood method was used to estimate the parameters. The statistical significance of each parameter estimate was evaluated by examining the standard error of estimate; a significant estimate was larger than twice the standard error. A goodness of fit index (Joreskog & Sorbom, 1989) was obtained for each of the eight groups for every scale. The goodness of fit index measures the extent to which the expected correlations based on the model agree with the observed correlations; the index should be close to 1.00. A χ^2 statistic provided a test of the fit of the model for each scale. A non-significant χ^2 indicated the model fit the data.

RESULTS

Correlations for the MZT, DZT, MZA, and DZA twins, adoptive parent–offspring and siblings, and biological parent–offspring and siblings are presented in Table 1. Intraclass correlations were estimated for all twin combinations. The median correlations for MZT twins were .48 for the GOT and .47 for the BIS. The median correlations for the DZT twins were .23 for the GOT and .21 for the BIS. The correlations for Academic Comfort (AC) were .54 and .24 for MZT and DZT, respectively. The correlations for Introversion/Extroversion (I/E) was .50 for MZT and .24 for DZT. The median correlations for MZA twins were .31 for the GOT, .33 for the BIS, .46 for the AC, and .52 for the I/E scales. The median correlations for the DZA twins were .07 for the GOT, .05 for the BIS, .46 for the AC, and .07 for the I/E scales, respectively. These results suggest a genetic influence on vocational interests based on greater MZ than DZ similarity.

Interclass correlations were estimated for all parent-offspring combinations and intraclass correlations were computed for all sibships. The median correlations for the adoptive parent–offspring combinations were .10 for the GOT, .08 for the BIS, .11 for the AC, and .06 for the I/E scales. The median correlations for the adoptive sibships were .11 for the GOT, .08 for the BIS, .04 for the AC, and .24 for the I/E scales. The median correlations for biological parent-offspring combinations were .15 for the GOT, .13 for the BIS, .21 for the AC, and .18 for the I/E. The median correlations for biological sibships were .15 for the GOT, .14 for the BIS, .22 for the AC, and .08 for the I/E. These results suggest a small shared environmental influence on vocational interests.

Eight data groups were simultaneously input using a LISREL model: MZT, DZT, MZA, and DZA twins, adoptive parent–offspring and siblings, and biological parent–offspring and siblings. The LISREL model estimated the additive genetic, nonadditive genetic, shared environmental, and nonshared environmental effects for the 25 Hansen Combined Form Scales (Hansen, 1982). The majority of the parameter estimates were significant (i.e., greater than twice the standard error): 14 of 25 scales for additive genetic (excluding Realistic, Social, Conventional, Mechanical Activities, Science, Medical Service, Writing, Social Service, Athletics, Sales, and Office Practices), 24 of 25 scales for nonadditive genetic (excluding Business Management), 24 of 25 scales for shared environment (excluding Mathematics), and all of the scales for nonshared environment. The Goodness of Fit indices ranged from .91 to 1.00. The χ^2 tests were non-significant for all but the mathematics and music/dramatics scales.

The proportion of variance attributed to additive genetic, nonadditive genetic, shared environmental, and nonshared environmental effects are presented in Table 2. These results suggest that, on average, the variance

TABLE 1
Correlations for Twins Reared Together, Twins Reared Apart, Adoptive Families, and Biological Families

Scale	MZT (N=1960)	DZT (N=1212)	MZA (N=59)	DZA (N=33)	A P-O (N=283)	A Sibs (N=63)	B P-O (N=332)	B Sibs (N=60)
General occupational themes								
Realistic	.49	.20	.20	.15	.17	.17	.11	−.10
Investigative	.46	.24	.39	.00	.11	.05	.19	.12
Artistic	.51	.29	.23	.17	.09	−.11	.19	.33
Social	.45	.20	.42	.04	.08	.10	.15	.17
Enterprising	.41	.25	.41	.04	.07	.23	.14	.11
Conventional	.49	.22	.24	.10	.12	.17	.00	.20
Median	.48	.23	.31	.07	.10	.11	.15	.15
Basic interest scales								
Nature	.47	.18	.28	.25	.01	.24	.20	.07
Mechanical activities	.49	.14	.33	.13	.05	.06	.12	−.06
Science	.47	.24	.43	−.11	.10	.10	.10	.14
Mathematics	.51	.11	.40	.49	.04	.08	.18	.16
Medical service	.45	.13	.38	.07	.12	.02	.09	.08
Music/dramatics	.51	.34	.30	.03	.10	−.12	.12	.27
Art	.47	.21	.17	.06	−.01	−.02	.12	.18
Writing	.47	.18	.36	.09	.11	.14	.22	.26
Teaching	.41	.21	.33	.05	.11	.07	.18	.35
Social service	.41	.18	.23	.05	.04	.00	.14	.10
Athletics	.49	.21	.45	−.03	.10	.16	.13	.01
Public speaking	.45	.20	.36	.18	.06	.24	.22	.24
Law/politics	.50	.24	.28	.02	.09	.16	.25	.10
Merchandising	.34	.22	.35	.01	.02	.10	.09	−.04
Sales	.29	.21	.13	.04	.04	.10	.04	.17
Business management	.32	.20	.35	−.08	.08	.06	.14	−.07
Office practices	.43	.27	.12	−.10	.12	.04	.09	.22
Median	.47	.21	.33	.05	.08	.08	.13	.14

Special scales								
Academic comfort	.54	.24	.46	.25	.11	.04	.21	.22
Introversion/extroversion	.50	.24	.52	.07	.06	.24	.18	.08

Note. N, Number of pairings; MZ, monozygotic twins; DZ, dyzygotic twins; MZT, MZ twins reared together; DZT, DZ twins reared together; MZA, MZ twins reared apart; DZA, DZ twins reared apart; A P-O, adoptive parent–offspring; A Sibs, adoptive siblings; B P-O, biological parent–offspring; B Sibs, biological siblings.

TABLE 2
Proportion of Variance Attributed to Additive Genetic, Nonadditive Genetic, Shared Environmental, and Nonshared Environmental Effects

Scale	Additive genetic	Nonadditive genetic	Shared environmental	Nonshared environmental
General occupational themes				
Realistic	.00	.36	.12	.52
Investigative	.17	.19	.10	.54
Artistic	.23	.16	.12	.49
Social	.13	.25	.08	.55
Enterprising	.15	.16	.11	.59
Conventional	.00	.38	.11	.51
Median	.14	.22	.11	.53
Basic interest scales				
Nature	.19	.22	.05	.54
Mechanical activities	.01	.42	.05	.52
Science	.03	.32	.12	.53
Mathematics	.16	.34	.00	.50
Medical service	.00	.39	.06	.55
Music/dramatics	.17	.20	.15	.49
Art	.14	.26	.07	.53
Writing	.13	.25	.09	.53
Teaching	.15	.16	.10	.59
Social service	.13	.21	.06	.59
Athletics	.03	.36	.10	.51
Public speaking	.22	.16	.07	.55
Law/politics	.18	.21	.12	.50
Merchandising	.18	.11	.06	.65
Sales	.04	.15	.11	.71
Business management	.15	.10	.08	.68
Office practices	.00	.26	.17	.57
Median	.14	.22	.08	.54
Special scales				
Academic comfort	.22	.24	.08	.46
Introversion/extroversion	.21	.22	.07	.50

in vocational interests can be attributed to: 12% additive genetic, 24% nonadditive genetic effects, 9% shared environmental, and 55% nonshared environmental effects.

DISCUSSION

The purpose of this study was to clarify and to expand the literature on the determinants of vocational interests by estimating the genetic and environmental influences contributing to vocational interests. Specifically, this study was designed to determine familial correlations among eight kinships and to estimate the proportion of observed variance in vocational interests that could be explained by genetic influences and environmental influences. Conclusions could be subsequently drawn about the importance of genetic and environmental influences on the development of vocational interests.

Correlational analyses of eight familial kinships support previous findings that genetic and environmental influences on vocational interests are important. Greater similarities are found for MZT than DZT twins and for MZA than DZA twins, which supports the interpretation of a genetic influence. Heritability estimates based on Falconer's method (twice the difference between the MZ and DZ twin correlations) for the reared together twin data suggest approximately 50% of the variance is associated with genetic factors. Environmental influences and measurement error account for the remaining 50% of the variance. Heritability estimates for the reared apart twin data suggest that 31% of the variance is attributable to genetic influence (the MZA twins correlation is a direct estimate of the variance accounted for by genetic factors). The twins reared apart correlations are, however, lower than the correlations obtained with the reared together twins sample. The DZA twins correlations are smaller than would be predicted (i.e., less than one-half the MZA twins correlation), although this could be attributed to the relatively small sample size. The discrepancy between the correlations for the reared together and reared apart twins suggests that shared environment contributes to increased similarity in the reared together twins sample. Furthermore, the adoptive parent–offspring and sibling correlations indicate that shared environment accounts for approximately 10% of the variance in vocational interests. Biological parent–offspring and sibling correlations are slightly larger than the adoptive family correlations because of genetic relatedness, but they are slightly smaller than the DZT twins.

Most of the data (twins reared together, twins reared apart, and adoptive families) used in this study have been previously analyzed using correlational analyses. Therefore, the correlations found in this study are similar to those reported in Roberts and Johansson (1974) for twins reared together, in Moloney et al. (1991) for twins reared apart, and in Grotevant, Scarr, and Weinberg (1977) for adoptive families. The data for biological families have not been reported previously. The correlations found in this study for biological parent–offspring are similar to the parent–offspring correlations of .17 for father-son, .23 for mother–daughter, .13 for father–daughter, and .16 for mother–son reported in Grotevant, Scarr, and Weinberg (1977). The correlations found for biological siblings, however, differ from the sibling correlations of .36 for same sex and .08 for opposite sex siblings reported in Grotevant, Scarr, and Weinberg (1977). The differences could be due to the use of separate sex versus combined sex samples. Overall, the previous studies that relied on correlational analyses suggest that roughly 30–50% of the variation in vocational interests is due to genetic variation. The results from the correlational analyses in this study are consistent with these findings. Correlations from twins reared together suggests that 50% of the variance can be attributed to genetic influence and correlations from twins reared apart suggests that 31% of the variance can be attributed to genetic influence.

Model-fitting analyses indicate that, on average, the variance in a wide range of vocational interests can be attributed to 12% additive genetic and 24% nonadditive genetic effects for a total of 36% genetic variance. The evidence for shared environmental effects is modest; only 9% of the variance in vocational interests is attributed to shared environment. A small shared environmental effect is found in the adoptive correlations and in the contrast between the MZT twins and the MZA twins. Shared environment, however, is not likely to account for much more than 10% of the variance in vocational interests. Conversely, the evidence for the importance of nonshared environment is strong; 55% of the variance in vocational interests is attributable to nonshared environmental effects (including measurement error). This finding is consistent with Plomin and Daniels' (1987) conclusion that the most important source of environmental variation in a wide range of behaviors (e.g., personality, psychopathology, cognition) was nonshared environment.

Of the previous studies in this area, only Moloney, Bouchard, and Segal (1991) used model fitting analyses. They reported that 45–50% of the variance in vocational interests was associated with genetic variation, and 50% of the variance was accounted for by environmental differences and measurement error. The present investigation found that 36% of the variance in vocational interests is attributable to genetic variation, and 64% of the variance is attributable to environmental variation. These apparent discrepancies result from methodological differences; Moloney et al. (1991) used three measures of vocational interests in their study. They reported a range of heritabilities based on these measures: .35 for the General Occupational Themes and .37 for the Basic Interest Scales of the Strong Interest Inventory; .44 for the Jackson Vocational Interest Survey; and .50 for a set of 10 vocational interest factors. Thus, the results from the present investigation in which scales from the Strong Interest Inventory were used are consistent with the findings of Moloney, Bouchard, and Segal (1992) for the Strong Interest Inventory. The findings that arise from the use of alternative measures of interests leads to the question of why different measures of interests produce discrepant results.

This investigation is not without limitations. The data used in this study are archival data that have been previously reported and reanalyzed. The data are also from the Strong Interest Inventory, which has been the dominant measure of vocational interests in this area. The literature on genetic and environmental influences on vocational interests would be enhanced by an investigation based on independent data from multiple measures of vocational interests. Despite these limitations, the results of this research indicate that interests are multiply determined. One-third of the variance associated with vocational interests is genetically influenced and two-thirds of the variance associated with vocational interests is related to environmental sources and measurement error. Most of the environmental variance is nonshared environmental influences. Therefore, a comprehensive theory of interests must address the multiple ways in which interests develop, acknowledging genetic and environmental influences and the mechanisms through which they affect vocational interests.

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