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The Inheritance of Cognitive Interest Styles Among Twins[1,2]

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Through twin studies, research in behavioral genetics has demonstrated significant genetic components in many personality traits. Less research has been done on inheritance of vocational interest preferences, partially because of the lack of a wholistic conceptual model for understanding the relationships among diverse occupational interests. With the development of scales for the Strong Vocational Interest Blank (SVIB) to measure the six cognitive interest styles propounded by Holland, a parsimonious and comprehensive mapping of the occupational world was available and lent itself to the study of measuring inheritance of vocational preferences among twins. Median intraclass correlations for 409 pairs of monozygotic males, tested with the SVIB, was $r = .50$; for 570 pairs of monozygotic females, $r = .55$; for 237 pairs of dizygotic males, $r = .27$; and for 370 pairs of dizygotic females, $r = .27$.

In recent years, interest in human behavioral genetics has focused on the inheritance of personality, and research in the area has demonstrated significant genetic components in many of the primary personality traits.

Cattell, Blewett, and Beloff (1955), and Cattell, Stice, and Kristy (1957) explored the question of genetic involvement in normal personality functioning with a multiple analysis of variance design and reported heredity to have a significant role in personality factors on Cattel's 16 PF test. Later, Vandenberg (1962) reported moderate to high heritability indices (ranging from .31 to .69) for several of Cattell's primary personality factors, adducing further evidence of a genetic component in some of the traits earlier proposed to have significant heritability by Cattell. Vandenberg also found heritability indices within the same range for scales on Thurstone's Temperament Schedule.

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Using factor analysis, Loehlin (1965) obtained a cluster of personality traits of appreciable heritability similar in kind to the traits reported by previous investigators: poised, outgoing, socially dominant, confident, well adjusted, adventurous, impulse control, temper, intelligent interests, likes to work with tools, likes physical work, and impatient.

Investigating another aspect of personality, Scarr (1966a,b) found evidence of a moderate genetic contribution in the area of activity motivation. In addition, Scarr provided evidence of a firm genetic basis for anxiety, apprehension, and *n* affiliation and moderate genetic control over the traits of patience, self-control, *n* exhibition, *n* autonomy, and *n* aggression.

Studying genetic contributions to normal personality functioning and social adjustment, Gottesman (1963) quantified the proportion of variance on the Minnesota Multiphasic Personality Inventory under genetic control and reported a significant genetic component for five of the ten standard scales (D, Pd, Pt, Sc, and Si). Results from a later study by Gottesman (1966), using the California Psychological Inventory, reaffirmed his earlier finding that some personality dimensions have a genetic substrate.

While extensive research has been conducted on the inheritance of personality, as reflected in the studies reported above, considerably less attention has been directed towards the inheritance of occupational interests, although the early investigations into this area have also revealed significant genetic components in vocational preferences.

Carter (1932), using the occupational scales of the Strong Vocational Interest Blank (SVIB), found a median correlation of .50 for monozygotic twin pairs and a median correlation of .28 for dizygotic twins. When using Holzinger's (1929) index of heritability H to calculate the proportion of scale variance due to heredity, he obtained values of .10 to .50 depending on the scale. Almost all of the *F* ratios on the within-pair variances were statistically significant indicating that heredity seemed to have an influence in determining vocational interest. Similar evidence that occupational scale scores on the SVIB are under some degree of hereditary control was found by Vandenberg and Kelly (1964).

Studying the inheritance of vocational preferences on scales for the SVIB that measure homogeneous types of interest, Johansson (1969) found scale correlations in the .20s for dizygotic twin pairs and in the .40s for monozygotic pairs. Holzinger's H values ranged from .10 to .52, with numerical, musical, writing, and mechanical interests having the highest proportions of a genetic component.

The above studies are reflective of the initial progress that has been made in the area of the inheritance of vocational interests. However, after reviewing the evidence for a genetic component in each of the specific scales of interest inventories, the question arises as to how these vocational preferences should be arranged to derive a meaningful understanding of the inheritance of interests in the vocational world. In comparison to the trait and type models employed in integrating specific personality responses, no wholistic conceptual model has been used in studying the genetic components of interests. The lag in research on the heritability of occupational preferences may be due in part to the absence of a conceptual model for understanding the relationship among the diverse vocations that comprise the job world. Thus, to achieve a wholistic understanding of the genetic component in interest measurement, a different approach to the problem is needed which can organize all of the vocational interests of the occupational world into a parsimonious classification system.

To this end, Holland's cognitive-interest-style model lends itself and was used in this research on the heritability of vocational interests. Analogous to the higher level conceptual schemes of organizing individual responses (type, trait, and primary factors) used in researching personality and intelligence, six cognitive-interest styles (realistic, investigative, artistic, social, enterprising, and conventional) were postulated by Holland (1966, 1970) as rendering a comprehensive mapping of the occupational world. According to Holland, the choice of a vocation was assumed to be the result of a complex interaction of environmental factors and these six cognitive styles.

Scales to measure Holland's six cognitive-interest styles have been developed on several interest inventories, including the SVIB. Recent research on the cognitive-interest-styles scales for the SVIB (Campbell and Holland, 1972; Hansen and Johansson, 1972; and Johansson, 1971) have found these scales to be a valid and useful scheme for classifying and understanding the vocational preferences of various groups of subjects.

The purpose of this study was to investigate the heritability of these cognitive-interest styles by comparing monozygotic and dizygotic twin pairs tested with the SVIB.

METHOD

The twin method provides a unique opportunity to study individual differences in cognitive-interest styles by comparing the genetic and environmental variances in scale scores of monozygotic (MZ) and dizygotic (DZ) twin pairs. Having identical hereditary endowment, variance between MZ twins is due solely to environmental factors, while variance between DZ twins is due to both environment and hereditary variables since DZ twins have only about 50% of their genes in common. The difference between the variance of MZ and the variance of DZ twin pairs is the variance that is genetically controlled and can be represented as the proportion of total variance due to heredity.

In March 1965, 800,000 eleventh grade students from across the country took the *National Merit Scholarship Qualifying Test.* The test included an item inquiring if the subject was a twin. Those subjects who responded "yes" were further studied for a possible twin match from the same high school who had taken the test, was of the same sex, same home address, and the same last name. The 6000 twins who met the above criteria were sent another questionnaire to determine zygosity. The questionnaire method for diagnosing zygosity based on reports of physical similarities was deemed appropriate for use in this study which involved an unusually large number of subjects that were widely dispersed geographically, and research by Nichols and Bilbro (1966) has proven that this method has a diagnostic accuracy comparable to diagnosis by blood typing.

Of the questionnaires returned, a firm diagnosis was made for 1299 pairs of MZ twins and 865 pairs of DZ twins ($N = 2164$ pairs). These 4328 twins were then sent the SVIB (Form T399 for males and Form TW400 for females) roughly one year after they had graduated from high school and approximately 80% were completed and returned (7% of the returned SVIBs were excluded from the final study sample because only one of a twin pair responded). The final study sample ($N = 3172$) consisted of 409 MZ male pairs, 237 DZ male pairs, 570 female MZ pairs, and 370 female DZ pairs.

The twins were scored on the cognitive-interest-style scales of the SVIB, and heritability indices were computed. First, the intra-class correlation coefficients for the MZ twins' scores and the DZ twins' scores on the cognitive-interest-style scales were analyzed. If the coefficients were significantly different across zygosity, then the inference that part of the scale variance was under genetic control could be made if the MZ twins resembled each other more significantly than DZ twins.

Once the extent of genetic involvement in the scales' variances was established, another statistic, Holzinger's H, was employed to provide an estimate of the amount of within-pair variance attributable to heredity for this sample. Holzinger's heritability index equals the difference between the within-pair variance of MZ and DZ twin pairs divided by the within-pair variance of DZ twin pairs. H underestimates the importance of heredity in the general population by a factor of about 2, since the genetic variance is estimated from genetic overlap between DZ twins which is about .5. Therefore, H should be interpreted as a lower limit of a scale's heritability. Finally, F ratios, the within-pair variance of DZ twins divided by the within-pair variance of MZ twins, were computed as a measure of the statistical significance of the heritability indices, or whether a significant proportion of the scale's variance was attributable to genetic factors.

RESULTS

Table 1 presents the intra-class correlation coefficients, heritability indices, and the F ratios for MZ and DZ twins according to sex. All of the

TABLE 1

Genetic Influence on Cognitive Interest Styles

	Males						
	Monozygotic 409 pairs		Dizygotic 237 pairs		z ratio		F
Scales	r_{MZ}	V_{MZ}	r_{DZ}	V_{DZ}	r_{MZ}-r_{DZ}	H	V_{DZ}/V_{MZ}
Realistic	.50	86.23	.21	139.31	4.08[b]	.38	1.6156[b]
Investigative	.50	82.99	.31	132.58	2.77[b]	.37	1.5976[b]
Artistic	.53	91.13	.27	136.36	3.80[b]	.33	1.4964[b]
Social	.50	84.57	.27	114.61	3.30[b]	.26	1.3551[b]
Enterprising	.37	80.58	.25	101.98	1.61	.21	1.2655[a]
Conventional	.52	88.30	.31	134.15	3.10[b]	.34	1.5192[b]
Median r	.50		.27				

	Females						
	Monozygotic 570 pairs		Dizygotic 370 pairs		z ratio		F
Scales	r_{MZ}	V_{MZ}	r_{DZ}	V_{DZ}	r_{MZ}-r_{DZ}	H	V_{DZ}/V_{MZ}
Realistic	.56	70.64	.20	124.51	6.42[b]	.43	1.7626[b]
Investigative	.53	101.25	.26	153.44	4.84[b]	.34	1.5154[b]
Artistic	.57	82.97	.34	129.22	4.39[b]	.36	1.5574[b]
Social	.49	82.21	.24	130.85	4.34[b]	.37	1.5917[b]
Enterprising	.47	91.10	.29	120.56	3.15[b]	.24	1.3233[b]
Conventional	.57	78.50	.28	128.97	5.37[b]	.39	1.6431[b]
Median r	.55		.27				

[a] $p < .05$. [b] $p < .01$.

intra-class correlations were significant. Also, the correlations of the MZ twin pairs were statistically larger ($p < .01$) than the correlations of the DZ twins for all comparisons except the enterprising scale for males. The median intra-class correlation for MZ twins was .50 for males and .55 for females, and for DZ twins the median was .27 for both males and females.

The heritability indices indicated that for both male and female samples realistic, investigative, artistic, and conventional cognitive-interest styles showed one-third or more of the within-pair variance due to genetic factors. The social scale had between one-fourth and one-third of its variance caused by genetic influence for males and females, and the enterprising scale manifested about one-fifth of the within-pair variance attributable to heredity for both male and female twin pairs in the study sample. All the F values were significant at the .05 level indicating that a significant proportion of the variances of all six scales was due to heredity.

DISCUSSION

For both male and female twin pairs the realistic cognitive-interest-style scale demonstrated the highest heritability, and the enterprising cognitive-interest style showed the lowest. The high heritability on realistic was consonant with previous research findings in the psychological literature which consistently reveal high genetic involvement in the domain of motor responses and manual skills (Vandenberg, 1966).

However, considerably more impressive than the range of heritability indices found was their similarity. When the heritability indices of the same scale were compared between the male and female twin pairs, all H values fell within a couple hundredths of a point of each other. Thus, with one exception (social), there was a negligible sex difference in the heritability of cognitive-interest styles. Homogeneity also characterized interscale comparisons of H values for the six cognitive-interest-style scales. Among the male twin pairs, all heritability values for the six diverse cognitive-interest styles fell within .17 points of each other, and among the female twin pairs all the H values were within the range of .19 points. This resemblance among the six Holland scales in the proportion of scale variance due to heredity indicated that there was similarity in the inheritance of diverse cognitive-interest styles—all phenotypes were about equally inheritable. This finding was in contrast to the wide range of heritability indices (.00 to .90) typically found among the primary intelligence factors or differing personality traits.

SUMMARY

The purpose of this research was to investigate the proportion of genetic influence on six cognitive-interest styles by comparing the scale scores of MZ twin pairs with DZ twin pairs. The results indicated that:

1. Intra-class correlations for all scales (realistic, investigative, artistic, social, enterprising, and conventional) were significant.
2. MZ female twins were significantly more alike than DZ female twins on all scales, while MZ male twins were more alike than DZ twins on all scales except enterprising.
3. The median intra-class correlation for MZ twin pairs was .50 for males and .55 for females. For DZ twins the median correlations were .27 for both male and female twin pairs.
4. Realistic, investigative, artistic, and conventional scales showed at least one-third of the scale variance attributable to genetic factors for both the sample of male and female twins and lesser proportions for social and enterprising scales.
5. The genetic component in all scales was statistically significant at the .05 level or less.

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