Research Report

GENETIC AND ENVIRONMENTAL INFLUENCES ON RELIGIOUS INTERESTS, ATTITUDES, AND VALUES: A Study of Twins Reared Apart and Together

Niels G. Waller, Brian A. Kojetin, Thomas J. Bouchard, Jr., David T. Lykken, and Auke Tellegen

University of Minnesota, Minneapolis

Abstract—*The role of genetic and environmental factors in the expression of religious interests, attitudes, and values was examined using data from adult twins reared apart and adult twins reared together. The Religious Values scale of the Allport-Vernon-Lindzey Study of Values, a Religious Interest scale from the Strong Campbell Interest Inventory, the Wiggins Religious Fundamentalism scale from the MMPI, a Leisure Time Religious Interest scale, and a second measure of Occupational Religious Interest were administered to 53 identical and 31 fraternal twin pairs who had been reared apart. The Leisure Time Religious Interest Scale and the second measure of Occupational Religious Interest were also administered to 458 identical and 363 fraternal twin pairs who had been reared together. Biometric model fitting indicated that approximately 50% of the observed variance of all five measures is genetically influenced.*

In recent years, substantial empirical attention has been directed toward understanding the relative importance of genetic and environmental influences in the development (DeFries & Fulker, 1986; Plomin, 1986) and manifestation (Goldsmith, 1983) of individual differences. Few studies, however, have considered the influence of genetic factors in the formation of religious interests, attitudes, and values. The paucity of behavior-genetic research on these variables is perhaps due to the belief, prevalent in both lay and academic communities, that religiosity is primarily an environmentally influenced variable (Cavalli-Sforza, Feldman, Chen, & Dornbush, 1982). For example, Plomin (1989) in his recent review of the behavior genetic literature concluded that "Religiosity and certain political beliefs . . . show no genetic influence" (p. 107).

Although few twin or adoption studies have directly examined the degree of genetic and environmental influence on religiosity, this variable has sometimes been included in behavior genetic research as a control variable because of the presumption that religiosity is predominantly determined by common family environments rather than genetic influences (Goldsmith & Gottesman, 1977; Loehlin & Nichols, 1976; Pogue-Geile & Rose, 1985). These studies, however, have relied almost exclusively on young twins who may still have been strongly influenced by their families. In adults, genetic factors may play a more important role in the expression of religiosity. For example, Martin, Eaves, Heath, Jardine, Feingold, and Eysenck (1986), using a large cross national sample of adult twins, examined the heritability of several social attitudes, including attitudes towards sabbath observance, divine law, church authority, and Bible truth, and found that all of these religious attitudes had a significant genetic component.

The present investigation explored the role of genetic and environmental factors in the expression of religious interests, attitudes, and values using multiple and converging measures gathered from adult twins reared apart and adult twins reared together.

METHOD

Subjects

Our samples included 53 pairs of monozygotic twins reared apart (MZA) and 31 pairs of dizygotic twins reared apart (DZA) who participated in the Minnesota Study of Twins Reared Apart between 1979 and 1989. The mean age for the 40 male and 66 female MZA twins was 36.77 (SD = 12.99) and 41.65 (SD = 11.29) years, respectively; the mean age for the 18 male and 44 female DZA twins was 45.05 (SD = 14.44) and 42.50 (SD = 9.41) years. Details of the MZA and DZA twin recruitment are reported in Bouchard (1984, 1987) and references cited therein. The median age of separation was .24 years and ranged from birth to 4.5 years. Separation time was arbitrarily set at zero for twin pairs who were reared in different homes but who had periodic contact during childhood. The length of separation (number of years from separation until first contact) ranged from 0 to 69 years. Zygosity of the reared apart twins was determined by a procedure that results in a misdiagnosis rate of less than .001 (Lykken, 1978).

Data for two of our measures of religiosity (the Religious Leisure Time Interests scale and the Religious Occupational Interests scale) were also available from 1,642 twins who participated in the Minnesota Twin Registry. The 312 male MZTs and 604 female MZTs had mean ages of 35.86 (SD = 7.3) and 35.98 (SD = 7.31). The 246 male DZTs and 480 female DZTs had mean ages of 37.27 (SD = 7.57) and 37.72 (SD = 7.91). All DZT twins in this sample were same-sex pairs. Details of twin recruitment and zygosity determination by questionnaire for the reared together twins are reported elsewhere (Lykken, Bouchard, McGue, & Tellegen, 1989).

Because twins are correlated perfectly for age, and same-sexed twins for sex as well, twin similarities can be positively biased if the twin pair differences on these variables are not partialled out of the variables of interest. In the present study, all data were age and sex corrected with a procedure described in McGue and Bouchard (1984).

Send correspondence and reprint requests to Niels G. Waller or Thomas J. Bouchard, Jr., Department of Psychology, University of Minnesota, Elliott Hall, 75 East River Rd., Minneapolis, MN 55455.

Instruments

Five measures were employed. The Religious Fundamentalism scale devised by Wiggins (1966) is composed of twelve items, taken from the Minnesota Multiphasic Personality Inventory (Hathaway & McKinley, 1951), that tap various facets of fundamental religious beliefs. The Religious Occupational Interests scale (Waller, Lykken, & Tellegen, in press) is a four-item factor analytically derived scale that measures interests in religious occupations, such as minister, priest, or rabbi, working as a missionary, or becoming a professional writer on religious subjects. Our Strong-Campbell scale is slightly modified from the Religious Activities Basic Interest scale from the Strong-Campbell Interest Inventory (Hansen & Campbell, 1985) and is composed of nine items (29, 83, 137, 177, 228, 239, 245, 266, 318) that measure interests in religious occupations, school subjects, and activities. The Religious Leisure Time Interests scale (Waller, Lykken, & Tellegen, in press) is a five-item, factor analytically derived scale that measures expressed interests in various religious leisure time activities, such as attending religious services, doing work for the church of synagogue, or pursuing religious studies. The Allport-Vernon-Lindzey Religious Values scale (Allport, Vernon, & Lindzey, 1960), one of six scales from the Allport-Vernon-Lindzey Study of Values, measures the salience of a religious value system. Table 1 presents the intercorrelations and the reliabilities of the five measures of religious interests, attitudes, and values.

Analytic Procedures

With data available from both identical and fraternal twins reared apart and reared together, the analysis of genetic and environmental influences can be accomplished in several ways. One method involves direct comparison of the intraclass correlations of MZA and MZT twins. Because MZA twins are genetically identical but share essentially no environmental influences, the MZA correlation is a direct estimate of heritability. The MZT twins share all of their genes and a common family environment, thus the difference between the MZA and MZT correlations estimates the influence of common family environment. A second method is based on the difference between the MZT and DZT intraclass correlations. Because MZ twins share all of their genes and DZ twins share 50% of their genes on average, the percentage of observed variance that is due to additive genetic influences (i.e., narrow heritability) can be estimated as twice the difference between the MZT and DZT correlations (Falconer, 1981). A third approach, and the one used in the present investigation, involves specification and comparison of alternative biometric models (Eaves, Eysenck, & Martin, 1989; Jinks & Fulker, 1970) applied to the within and between mean squares of all the twin data. This latter method provides maximum likelihood estimates of the genetic and environmental parameters as well as a chi-square test of the degree of fit of each model.

To obtain estimates of the genetic and environmental parameters, several biometric models were tested and evaluated for their ability to account parsimoniously for the observed data. The models examined were: (a) a purely environmental model, (b) a purely genetic model, and (c) a full model that included both environmental and genetic parameters. For the two scales on which we had data from all four twin groups, the Religious Leisure Time Interests scale and the Religious Occupational Interests scale, the environmental variance parameter was further broken down into shared-familial and non-shared environmental components. Our models assume (a) the MZA and DZA correlations are due entirely to genetic factors, (b) the DZA and DZT genetic correlations are half the MZA and MZT genetic correlations (i.e., we assume a complete additive model), (c) the absence of selective placement (for the reared apart twins), (d) the absence of assortative mating, and (e) no interaction effects. Selective placement does not appear to be a problem with our reared apart twins. All reared apart twins filled out the Family Environment scale (Moos & Moos, 1986), a widely used instrument designed to tap the major dimensions of the rearing family environment. The intraclass correlation for the Moral Religious Orientation scale of this inventory was .03 for the pooled sample, .09 for the MZAs and −.07 for the DZAs. The data from the twins reared apart suggests that there is positive assortative mating for religiosity (median spousal correlation on the five measures was .56); however, due to the small number of spouses available in our reared apart sample we did not include this parameter in our models. Failure to include assortative mating parameters in biometric modeling typically results in genetic estimates that are biased downward so that our genetic estimates are probably conservative. We are currently collecting spouse data for these traits on a much larger sample. Due to varying sample sizes for the five measures it was not possible to conduct a joint analysis of these measures to estimate a common phenotypic- or a common genetic-factor.

RESULTS

Table 2 reports the intraclass correlations, the between- and within-mean squares and the sample sizes for the five scales for each zygosity and rearing condition.

Table 1. *Intercorrelations of and internal consistency reliabilities for five measures of religious interests, attitudes, and values*

Scales	1	2	3	4	5
1. Religious Leisure Time Interests	.91				
2. Religious Occupational Interests	.64	.86			
3. Wiggins Religious Fundamentalism	.75	.45	.82		
4. Strong Campbell Vocational Interests Inventory: Religious Interests	.77	.67	.60	.89	
5. Allport-Vernon-Lindzey Religious Values	.67	.40	.69	.69	.93[a]

[a] The AVL Religious Values Scale is an ipsative scale, consequently an internal consistency reliability cannot be computed. The number reported is a test-retest reliability from the AVL manual (Allport et al., 1960) based on a sample of 53.
n = 75 to 155 twins reared apart.

Table 2. *Intraclass correlations, numbers of pairs of twins, between and within mean squares for five measures of religious interests, attitudes, and values*

	Intraclass Correlation		Mean Squares			
			MZ Twins		DZ Twins	
	MZ Twins	DZ Twins	Between	Within	Between	Within
Reared together						
Religious Leisure Time Interests	.60 (458)	.30 (363)	1.67	.42	1.23	.66
Religious Occupational Interests	.41 (458)	.19 (363)	1.45	.61	1.14	.78
Reared apart						
Religious Leisure Time Interests	.39 (32)	.04 (24)	1.27	.55	1.07	.99
Religious Occupational Interests	.59 (31)	.20 (25)	1.73	.45	1.05	.71
Wiggins Religious Fundamentalism	.55 (50)	−.22 (30)	1.45	.42	.78	1.23
Strong-Campbell Vocational Interests Inventory: Religious Interests	.49 (52)	.15 (31)	1.43	.49	1.13	.83
Allport-Vernon-Lindzey Religious Values	.55 (38)	−.08 (21)	1.69	.48	.82	.96

The MZA and MZT correlations are uniformly higher than the corresponding DZA and DZT correlations, suggesting that genetic factors play a significant role in the expression of this trait. The mean squares were used in the biometric model fitting, the results of which are reported in Tables 3 and 4. Based on the degree of statistical fit of the competing models it is clear that neither the purely environmental nor the purely genetic models account adequately for the observed data.

For four of the five measures the general model, whose parameters are reported in the tables, cannot be rejected. For the Wiggins Religious Fundamentalism scale, the negative DZA correlation is inconsistent with the assumptions of the additive model. However, the derived parameters are consistent with those estimated for the other four scales. Thus, our findings indicate that individual differences in religious attitudes, interests and values arise from both genetic and environmental influences. More specifically, genetic factors account for approximately 50% of the observed variance on our measures. For those variables whose environmental variance parameter is broken down into a shared-familial and a non-shared environmental component (Table 3), our data also suggest that the bulk of the environmental experiences that influence the expression of religiosity, like those that influence the expression of personality and temperament (Bouchard & McGue, in press; Plomin & Daniels, 1987; Tellegen, Lykken, Bouchard, Wilcox, Segal, & Rich, 1988), are experiences not shared by family members. In the case of the Religious Leisure Time Interests scale, twins reared together are considerably more similar than twins reared apart, suggesting an effect of shared family environment. The biometric model, however, assumes that such effects will in-

Table 3. *Genetic and environmental variance estimates from the full model biometric model fitting using the four group design*[a]

		Environmental		*p* value for test of		
Scale	Genetic	Non Shared	Shared Familial	General Model	No Genetic Effect	No Environmental Effect
Religious Leisure Time Interests	.47 (.07)	.42 (.03)	.11[b] (.07)	.600	<.001	<.001
Religious Occupational Interests	.41 (.03)	.59 (.03)	.00[c]	.782	<.001	<.001

[a] Standard errors of parameter estimates in parentheses.
[b] The estimated shared familial variance component is not significantly different from zero. Setting this parameter to zero and recomputing the genetic and non-shared environmental variance parameters yields values of .59 (.03) and .42 (.03), respectively.
[c] Boundary estimate, standard error not computed.

Table 4. *Genetic and environmental variance estimates from the full model biometric model fitting using the two group design*

Scale	Genetic	Environmental	*p* value for test of: General Model	No Genetic Effect	No Environmental Effect
Wiggins Religious Fundamentalism	.46 (.19)	.54 (.19)	.019	.004	<.001
SCV-II Religoius Interests	.48 (.11)	.52 (.11)	.844	.011	.035
Allport-Vernon-Lindzey Religious Values	.52 (.13)	.48 (.13)	.354	.011	.046

crease equally the similarities of DZT twins and MZT twins, causing the DZT twins to be more than half as similar as the MZTs, yet they are not. If one assumes instead that family influences toward convergence of interests or attitudes are proportional to the initial genetically based divergence, then our data would be compatible with the view that shared family environments tend to make siblings (but not MZ twins) more similar in their tendency to devote leisure time to religious activities. Due to the small sample sizes, our DZA correlations are neither significantly greater than zero nor significantly less than half the MZA correlations. It may be that the genetic contribution to religiosity is "emergenic" (Li, 1987; Lykken, 1982) that is, involves a configural, nonadditive combination of genetic effects.

Scarr and Weinberg (1981) explored the relation of I.Q. to socio-political attitudes and found that the genetic variance of their attitudinal measures could be accounted for, in large part, by their I.Q. measures. We determined similarly the relation of our five measures of religious interests, attitudes and values to I.Q. by correlating scores from the religiosity measures with WAIS Verbal, Performance, and Full scale scores in the Twins Reared Apart sample. Thirteen of the fifteen correlations were negligible and not significant. The Wiggins Religious Fundamentalism scale correlated $-.26$ ($p = .003$) with Performance scores and $-.21$ ($p = .015$) with full scale WAIS scores. Thus, I.Q. as measured by the WAIS cannot account for the significant genetic component of our religiosity measures.

DISCUSSION

Our findings lend additional support to the small body of literature (Martin et al., 1986) suggesting that social attitudes are in part genetically influenced. To the extent that these findings can be replicated and extended to additional social attitudes, they have strong implications for the study of the transmission of cultural and social attitudes and values. It will no longer be possible to interpret parent-child correlations, sibling correlations, or other familial correlations as merely reflecting the impact of common family environments. Nor will it be possible to generalize from findings based on adolescents and college students to data obtained on adults. Social scientists will have to discard the a priori assumption that individual differences in religious and other social attitudes are solely influenced by environmental factors.

Acknowledgments—This research has been supported by grants from the University of Minnesota Graduate School, the Pioneer Fund, the Seaver Institute, the Koch Charitable Foundation, the Spencer Foundation, the National Science Foundation (BNS-7926654), and the Harcourt Brace Jovanovich Publishing Company. We thank Leonard L. Heston, Elke D. Eckert and Nancy Segal, our co-principal investigators, for their help in conducting the study of twins reared apart and the following people for the time and effort they have given to testing the twins: Crista Carmichael, Margaret Keyes, Daniel Maloney, Jeff McHenry, Mary Moster, Elizabeth Rengel, Ellen Rubin, Susan Resnick, Joy Fisher, Jan Englander, and Ann Riggs. We owe special thanks to Matt McGue for his valuable advice and assistance.

REFERENCES

Allport, G., Vernon, P.E., & Lindzey, G. (1960). *Manual for the study of values* (3rd ed.). Boston: Houghton Mifflin.

Bouchard, T.J., Jr. (1984). Twins reared together and apart: What they tell us about human diversity. In S.W. Fox (Ed.), *The chemical and biological bases of individuality* (pp. 147–178). New York: Plenum.

Bouchard, T.J., Jr. (1987). Diversity, development and determinism: A report on identical twins reared apart. In M. Amelang (Ed.), *Proceedings of the meetings of the German Psychological Association–1986*. Heidelberg: Germany.

Bouchard, T.J., Jr., & McGue, M. (in press). Genetic and rearing environmental influences on adult personality: An analysis of adopted twins reared apart. *Journal of Personality* [Special Issue on Behavior Genetics].

Cavalli-Sforza, L.L., Feldman, M.W., Chen, K.H., & Dornbusch, S.M. (1982). Theory and observation in cultural transmission. *Science, 218,* 19–27.

DeFries, J.C., & Fulker, D.W. (1986). Multivariate behavioral genetics and development: An overview. *Behavior Genetics, 16,* 1–10.

Eaves, L.J., Eysenck, H.J., & Martin, N.G. (1989). Genes, culture and personality: An empirical approach. New York: Academic Press.

Falconer, D.S. (1981). *Introduction to quantitative genetics* (2nd ed.). London: Longman.

Goldsmith, H.H. (1983). Genetic influences on personality from infancy to adulthood. *Child Development, 54,* 331–355.

Goldsmith, H.H., & Gottesman, I.I. (1977). An extension of construct validity for personality scales using twin based criteria. *Journal of Research in Personality, 11,* 381–397.

Hathaway, S.R., & McKinley, J.C. (1951). *The Minnesota Multiphasic Personality Inventory manual.* New York: Psychological Corporation.

Hansen, J.C., & Campbell, D.P. (1985). *Manual for the SVIB-SCII.* Stanford; CA: Stanford University Press.

Jinks, J.L., & Fulker, D.W. (1970). Comparison of the biometrical genetical, MAVA, and classical approaches to the analysis of human behavior. *Psychological Bulletin, 73,* 311–349.

Li, C.C. (1987). A genetic model for emergenesis: In memory of Lawrence H. Snyder, 1901–86. *American Journal of Human Genetics, 41,* 517–523.

Loehlin, J.C., & Nichols, R.C. (1976). *Heredity, environment and personality: A study of 850 sets of twins*. Austin: University of Texas Press.

Lykken, D.T. (1978). The diagnosis of zygosity in twins. *Behavior Genetics, 8;* 437–473.

Lykken, D.T. (1982). Research with twins: The concept of emergenesis. *Psychophysiology, 19,* 361–373.

Lykken, D.T., Bouchard, T.J., Jr., McGue, M., & Tellegen, A. (1989). *The Minnesota Twin Registry*. Paper delivered at the Sixth International Twin Congress, Rome, Italy.

Martin, N.G., Eaves, L.J., Heath, A.C., Jardine, R., Feingold, L.M., & Eysenck, H.J. (1986). Transmission of social attitudes. *Proceedings of the National Academy of Sciences, USA, 83,* 4364–4368.

McGue, M., & Bouchard, T.J., Jr. (1984). Adjustment of twin data for the effects of age and sex. *Behavior Genetics, 14,* 325–343.

Moos, R.H., & Moos, B.S. (1986). *Manual: Family Environment Scale*. Palo Alto: Consulting Psychologists Press.

Plomin, R. (1986). *Development, genetics, and psychology*. Hillsdale, NJ: Lawrence Erlbaum.

Plomin, R. (1989). Environment and genes: Determinants of behavior. *American Psychologist, 44*(2), 105–111.

Plomin, R., & Daniels, D. (1987). Why are children in the same family so different from one another? *Behavioral and Brain Sciences, 10,* 1–59.

Pogue-Geile, M.F., & Rose, R.J. (1985). Developmental genetic studies of adult personality. *Developmental Psychology, 21,* 547–557.

Scarr, S., & Weinberg, R.A. (1981). In S. Scarr (Ed.), *Race, social class and individual differences in I.Q.* Hillsdale, NJ: Lawrence Erlbaum.

Tellegen, A., Lykken, D.T., Bouchard, T.J. Jr., Wilcox, K.J., Segal, N.L., & Rich, S. (1988). Personality similarity in twins reared apart and together. *Journal of Personality and Social Psychology, 54,* 1031–1039.

Waller, N.G., Lykken, D.T., & Tellegen, A. (in press). Occupational interests, leisure time interests and personality: Three domains or one? Findings from the Minnesota Twin Registry. In R.V. Dawis & D. Lubinski (Eds.), *Assessing individual differences in human behavior: New methods, concepts and findings*. Minneapolis: University of Minnesota Press.

Wiggins, J.S. (1966). Substantive dimensions of self-report in the MMPI item pool. *Psychological Monographs, 80.*

(RECEIVED 8/7/89; ACCEPTED 9/11/89)