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Genetic and environmental contributions to pro-social attitudes: a twin study of social responsibility

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Although 51 twin and adoption studies have been performed on the genetic architecture of antisocial behaviour, only four previous studies have examined a genetic contribution to pro-social behaviour. Earlier work by the author with the University of London Institute of Psychiatry Adult Twin Register found that genes contributed approximately half of the variance to measures of self-report altruism, empathy, nurturance and aggression, including acts of violence. The present study extends those results by using a 22-item Social Responsibility Questionnaire with 174 pairs of monozygotic twins and 148 pairs of dizygotic twins. Forty-two per cent of the reliable variance was due to the twins' genes, 23% to the twins' common environment and the remainder to the twins' non-shared environment.

Keywords: altruism; social attitudes; twins; genes; cultural transmission

1. INTRODUCTION

Ever since Darwin (1871), human beings have been viewed as a highly intelligent species that evolved ideologies of social responsibility and trust to make communal living more effective. Although people interpret 'the general good' in different ways, most feel some degree of social responsibility, despite wide-ranging individual differences. Twin, adoption and neurohormonal studies have shown genetic variation in both pro-social and antisocial behaviour.

Monozygotic (MZ) twin pairs share 100% of their genes whereas dizygotic (DZ) twin pairs share 50%, thus doubling the difference between their correlations provides one simple estimate of heritability (the proportion of total variance accounted for by genetic factors; Plomin *et al.* 2001). In an analysis of self-ratings from 850 pairs of high school MZ and DZ twins of both sexes, Loehlin & Nichols (1976) found 40% heritabilities for both males and females for clusters labelled *argumentative*, *family quarrel* and *kind*. Matthews *et al.* (1981) found 72% heritability for a self-report adjective checklist measure of empathy of 114 MZ and 116 DZ middle-aged male twins. A study of 563 pairs of MZ and DZ twins by Rushton *et al.* (1986) found that 50% of the variance in altruism, empathy, nurturance and aggression was due to the genes with 50% due to environmental factors. An Altruism Scale asked respondents about the frequency with which they had engaged in specific acts such as 'I have given directions to a stranger' and 'I have donated blood'. An Emotional Empathy Scale asked people to endorse positively keyed items such as 'I like to watch people open presents' and negatively keyed ones such as 'I find it silly for people to cry out of happiness'. A Nurturance Scale asked for agreement with items such as 'I like to take young people under my wing', and an Aggressiveness Scale with items such as 'some people think I have a violent temper'.

Not only was 50% of the variance in altruism and in aggression attributable to additive genetic influence in the study of Rushton *et al.* (1986), but very little, if any, of the variance was due to the twins' common environment. Rather, the non-genetic variance was attributable to each twin's non-shared environment. Interestingly, parents, peers and teachers see altruism and aggression as traits that should be socialized heavily. However, *ca.* 50% of the variance was associated with genetic influence and most of the 50% environmental variance appeared to be idiosyncratic to the particular twin. The pro-social and antisocial measures were negatively correlated ($r = -0.29$).

Consequently, Rushton (1996) asked the twins to report on acts of delinquency, including those of criminal violence. Had they ever stolen goods from a store? Had they skipped school, drunk under age, or taken a bicycle or motorcar that did not belong to them? In addition, had they engaged in acts of violence, such as breaking or smashing things in a public place? Had they ever used a weapon—such as a knife or a razor or a broken bottle? Had they ever fought to get away from a police officer? Although the endorsement rate for acts of violence was lower than for the other acts, genetic factors contributed 50% to scores in males, although not at all in females. In males, the non-genetic variance was again of the non-shared rather than the shared variety. In the females, a substantial common family environmental effect was found.

One advantage of a genetic hypothesis is the focus that it brings to underlying physiology. Harris *et al.* (1996) related levels of salivary testosterone in 306 university students to the same measures of altruism and aggression used in the twin study of Rushton *et al.* (1986). In men and women, testosterone levels related positively ($r = 0.32$) to scores on the aggression questionnaire and negatively ($r = -0.39$) to the ones on empathy and nurturance.

A striking result from the twin studies is that the 50% non-genetic variance came from non-shared environmental sources, not from shared ones. Behaviour genetic designs typically distinguish between these two different types of environmental effect. The *shared environment* (also called *common* or *between-family environment*) includes all those variables that children reared in the same family have in common (e.g. father's occupation, family cultural practice, parents' child-rearing style); they make people growing up

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in the same family similar to one another. The *non-shared environment* (also called *within-family* or *specific environment*) includes all those variables that are unique to each child (e.g. an accident, illness, or chance friendship that happens to one sibling and not to the other); they make people growing up in the same family different from one another. The finding that between-family variance accounts for only a tiny percentage of individual difference variance in pro-social and antisocial behaviour provides a challenge for understanding how parents contribute to the development of their offspring's personality—other than through their genes (Harris 1998, 2000; Plomin *et al.* 2001).

Adoption studies have corroborated the strong genetic and the weak common family effect on adult antisocial behaviour. One Danish study, for example, followed some 14 000 adoptees and found that boys with no criminal parents, either adoptive or biological, had a baseline rate of criminal conviction of 14%. If the adoptive but not the biological parents were criminals, boys still had a conviction rate of only 15%. If the biological but not adoptive parents were criminal, the rate increased to 20%. If both biological and adoptive parents were criminal, the rate increased to 25% (Mednick *et al.* 1984).

A meta-analysis of 51 twin and adoption studies was conducted by Rhee & Waldman (2002) to estimate the magnitude of genetic and environmental influence on antisocial behaviour. The best fitting model included proportions of variance due to genetic influences (41%), shared environmental influences (16%) and non-shared environmental influence (43%). There were no significant differences in the magnitude of genetic and environmental influences for males and females. With age, during adolescence, the importance of genetic factors grew stronger and common environment grew weaker.

Not all twin studies have concluded that altruism and aggression are opposite ends of a continuum or share the same etiologies. Krueger *et al.* (2001) reported a male-only study that included 170 pairs of MZ twins and 106 pairs of DZ twins. Although they found in favour of the 50% genes plus 50% non-shared environment for antisocial behaviour, they found 0% genetic effects for altruism. Instead, all the variance was divided between shared and non-shared environment. They also found a zero correlation between altruism and antisocial behaviour, which loaded on independent dimensions of positive and negative emotionality. Krueger *et al.*'s results were particularly at odds with those of Rushton *et al.* (1986) because the former's measure of altruism was an extended version of the Self-Report Altruism Scale of Rushton *et al.* (1981) on which Rushton *et al.* (1986) found a 50% heritability and an anchor for a pro-social/antisocial continuum.

The present study aims to reduce the uncertainty over the heritability of pro-social behaviour, examining further genetic and environmental contributions. Previous studies have tended to tap the polar ends of what may turn out to be discrete traits (Krueger *et al.* 2001). In the current twin study, a moderate range of attitude items are measured with a standardized test of social responsibility.

2. MATERIAL AND METHODS

Members of the University of London Institute of Psychiatry Twin Register were mailed a 22-item standardized Social Responsibility Questionnaire (Berkowitz & Daniels 1964; Rushton 1980) in 1982, with a follow-up in 1983. (The data are only now being published; see also Rushton 1996.) The questionnaire asked for agreement on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) with positively keyed items such as 'I am the kind of person people can count on' and 'It is always important to finish anything you have started', and negatively keyed ones such as 'why bother to vote when you can do so little with just your vote' and 'letting your friends down is not so bad because you can't do good all the time for everybody'. The validity of the scale has been shown by its predicting aspects of civic responsibility such as voting in elections, joining voluntary organizations and helping others (Berkowitz & Daniels 1964; Rushton 1980). Subjects were instructed to complete the questionnaires under conditions of anonymity in their homes and mail them back in a prepaid envelope.

A total of 322 pairs of twins (644 individuals) responded. The twins ranged in age from 18 to 75 years, with a mean of 32 years. There were 101 MZ female pairs, 73 MZ male pairs, 82 MZ female pairs, 28 DZ male pairs and 38 opposite-sex pairs. The return rate, excess of women over men, and MZs over DZs, is comparable to that from previous studies with this register and other volunteer twin samples (Lykken *et al.* 1978; Rushton *et al.* 1986; Rushton 1996).

3. RESULTS

The 22-item Social Responsibility Questionnaire was internally consistent (i.e. the items correlated with each other implying they were all measuring the same construct) with a Cronbach's alpha of 0.71 both for males and for females, as well as the combined sample. Age and sex effects were found. Women had higher scores than men (means $= 87, 84$; s.d. $= 8,9$; $F_{1,634} = 5.24$; $p < 0.05$). Older people had higher scores than younger people ($r = 0.16$, $n = 644$, $p < 0.05$). Scores are corrected for age and sex in all analyses. The twin correlations for the total sample were significantly higher for the 174 MZ pairs ($r = 0.45$) than for the 148 DZ pairs ($r = 0.32$) and these differences were greater in men ($r = 0.50$ and 0.21) than in women ($r = 0.44$ and 0.34) suggesting genetic influence in both sexes. Doubling the difference between the MZ and DZ correlations gives simple heritabilities of 26% for the whole sample, 58% for men and 20% for women.

Model fitting can give a more accurate estimate of genetic and environmental influences than correlations because they take more of the variance into account (Plomin *et al.* 2001). Here, the raw data are the between- and within-twin-pairs variances and covariances. The between-pair mean squares reflect both pair resemblances and pair differences, and the within-pair mean squares, reflect pair differences. Models were fit to the age- and sex-corrected variance–covariance matrices using the computer program AMOS 4.01 (Arbuckle 1999).

The total phenotypic variance was partitioned into three sources: A (additive genetic effects); C (common environment); and E (unique, non-shared environment). For the total sample, the ACE model gave a good fit to $A = 30\%$, $C = 16\%$ and $E = 54\%$ ($\Delta\chi^2 = 1.44$, CFI $= 1.00$; RMSEA $= 0.00$). Correcting for unreliability by dividing the A and C components by Cronbach's alpha gave for the total sample: $A = 42\%$, $C = 23\%$ and $E = 35\%$ ($\Delta\chi^2 = 1.44$, CFI $= 1.00$; RMSEA $= 0.00$). There was a hint of sex differences in the best-fit models. For males the AE model gave the very best fit ($A = 50\%, C = 0\%$ and $E = 50\%$; $\chi^2 = 2.52$, $CFI = 1.00$, $RMSEA = 0.00$) while for females the CE model gave the best fit ($C = 40\%$ and $E = 60\%$), although the AE model also worked for females ($A = 42\%, E = 58\%$; $\chi^2 = 8.82$, $p < 0.07$; $CFI = 0.86, RMSEA = 0.08$) and was not statistically significantly different from the CE model in goodness-of-fit.

4. DISCUSSION

The results show a genetic contribution of 42% of the reliable variance to pro-social behaviour for men and women combined. The results also support the contention of Krueger *et al.* (2001) that pro-social behavior may have a significant proportion of the variance due to common family environment (23% of the reliable variance). There was a suggestion that the genetic contribution was lower for women than for men (40% versus 50%) and the common upbringing environment was higher (40% versus 0%), a finding in accord with a previous study by Rushton (1996) of antisocial behaviour in which a lower heritability was found for females. This possible sex difference in heritability suggests that parents may monitor female behaviour more carefully than they do male behaviour. This speculation should be treated with caution, however, because the earlier study of Rushton *et al.* (1986) of altruism and aggression found equal magnitudes for genetic and environmental influence for males and females, as did Rhee & Waldman (2002) in their meta-analysis of 51 studies of antisocial behaviour, which included both of Rushton's earlier studies. Rhee & Waldman found genetic influences accounted for 41% of the variance; shared environmental influences, 16%; and non-shared environmental influences, 43%.

It is unclear why variations occur in the 'genetic architecture' estimated from the four previous twin studies of prosocial behaviour. These reported heritabilities ranged from 0% to 72%, with a mean of 40%, very close to the present one of 42%. It is a truism in science that replication and parameter extension are essential. Meta-analytic techniques have solidified many behavioural genetic results in the field of personality (Bouchard & Loehlin 2001) and in antisocial behaviour (Rhee & Waldman 2002). It will be of interest to know from further research, whether broad-based pro-social attitudes, which are highly valued by parents and likely to be well socialized, have a different genetic architecture from other traits.

It must be concluded that heritable individual differences in social responsibility and other traits have been established by behavioural genetic research to the point that evolutionary psychologists can make important contributions by unravelling their origins.

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