

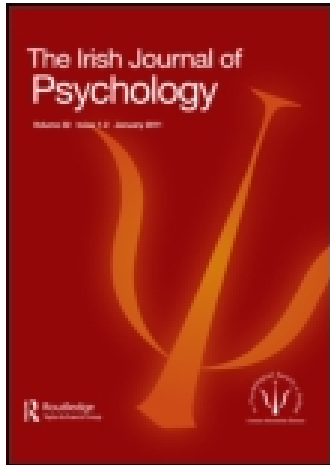
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The heritability of intelligence and social maturity in four to six year olds: A study of Irish twins

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100 Irish 4 to 6 year old twin pairs were tested with the Wechsler Preschool and Primary Scale of Intelligence, the Leiter Performance Scale and the Vineland Social Maturity Scale. The intraclass correlations were higher for Monozygotic than for Dizygotic twins and the heritabilities were estimated in the range of .04 to .52. Within-family and between-family environmental effects were also estimated and showed that the between-family effects were stronger.

Studies using twins have been carried out on the heritability of intelligence since the 1930's. These studies have been of two kinds. The first consists of identical twins separated shortly after birth and reared in different families. Only four such studies have been carried out (Bouchard, Lykken, McGue, Segal & Tellegen, 1990; Juel-Nielsen, 1980; Newman, Freeman & Holzinger, 1937; Shields, 1962), discounting that of Burt which is generally considered to be invalid. The four studies have found that these twin pairs are quite similar for intelligence, suggesting that genetic factors make an important contribution. The mean correlation between the pairs is .72, indicating that 72% of the variability is determined by genetic influences.

The second method compares the degree of similarity, expressed by correlation coefficients, of identical and nonidentical twins reared in the same family. Because these twins are reared in the same family environments, it is considered that differences in the degree to which they are similar must be an index of the effects of heredity. The research literature of the heritability of intelligence estimated by these two methods is considerable and has been reviewed by Bouchard (1993). Different methods of calculating heritabilities and different samples have produced a range of quantitative estimates of heritabilities, the great majority of which

lie in the range of .4 to .8.

The most important recent advance in the understanding of the heritability of intelligence is the realisation that the magnitude of heritability increases during the course of childhood and adolescence. The research reviewed by Bouchard (1993) indicates that heritability is .4 among 4-6 year olds and gradually increases until it reaches .78 among adults.

Some people are surprised by this, imagining that environmental factors would be weak in early childhood but would grow stronger during later childhood and adolescence as environments become more varied and might be expected to have more impact. It seems, however, that this is not the case and that environmental influences which are quite strong in early childhood wear off as children grow older and stabilise at what can be regarded as their genetic level.

The use of twins to estimate the heritability of intelligence has been confined to the United States, Britain, Denmark, Sweden, Norway and Japan. Hitherto no study of this kind has been carried out in Ireland. In this paper we report the results of the first Irish study of this question. The general interest of the study is threefold. Firstly, it is useful to see how far the results obtained in other countries hold for Ireland, thereby adding to the cross cultural consistency of the existing findings. Secondly, the present study has been carried out on 4-6 year olds for whom the existing research literature is quite limited, amounting to only 337 twin pairs (Bouchard, 1993). Thirdly, in addition to intelligence, the study measured "social maturity" for which no heritability studies have as yet been reported.

METHOD

The sample consisted of 100 twin pairs born in University College Hospital in Galway in the Republic of Ireland between 1 January, 1983 and the end of 1986. A total of 134 twin pairs were delivered in the hospital during this period. It proved impossible to test 34 of these. In 10 cases one or both twins died; in 20 cases the families moved from the area, making it impossible to test the twins; in the remaining 4 cases the parents refused to cooperate in the study or for other reasons it was not possible to test the twins.

33 of the twin pairs were diagnosed as monozygotic, 35 as same sex dizygotic and 32 as different sex dizygotic. Zygosity was determined in the first instance by a physical similarity chart which was considered to be reliable for 88 of the pairs. Serum samples were analysed to determine the zygosity of the remaining 12 pairs for whom some doubt existed.

The twins were tested for intelligence and social maturity when they were aged between 3 years 10 months and 6 years 7 months. The tests used were the Wechsler Preschool and Performance Scale of Intelligence (WPPSI)

(Wechsler, 1967); the Leiter Performance Scale (Leiter, 1955), a non-verbal intelligence test requiring the analysis of designs; and the Vineland Social Maturity Scale (Doll, 1965), a measure of what is sometimes called social intelligence, consisting of communication and social interaction abilities.

RESULTS

The WPPSI provides measures of full scale IQ, verbal IQ and performance IQ so that there are in all five intelligence measures. The mean IQs were all in the range 97 to 102 and there were no significant differences between the MZ and DZ twins.

Shown in Table 1 are the intraclass correlations for the MZ and DZ twin pairs; the heritability coefficients (h^2) obtained by doubling the difference between the two correlations; and estimates of the within-family environmental variance (ew) and the between-family environmental variance (eb). The figures in brackets are the correlations corrected for test-retest reliabilities of .91 for full scale IQ, .86 for verbal and .88 for performance IQs given in Wechsler (1967). No reliability estimates are available for the other two tests. The figures in brackets in the h^2 column are the heritability coefficients derived from the corrected correlations. The within-family variances were calculated by the formula $1-r_{MZT}$ and between-family variances represent what remains after the heritabilities and the within-family variances have been estimated. The figures in brackets are the variances corrected for test reliability.

Table 1. Intraclass correlations for MZ and DZ twins on 5 tests, heritabilities (h^2) and within-family environmental (ew) and between-family environmental (eb) effects.

Test	MZ	DZ	h^2	ew	eb
WPPSI IQ	.76 (.84)	.58 (.64)	.36 (.40)	.24 (.16)	.40 (.44)
WPPSI Verbal IQ	.61 (.71)	.59 (.69)	.04 (.04)	.39 (.29)	.57 (.67)
WPPSI Perf. IQ	.78 (.89)	.55 (.63)	.46 (.52)	.22 (.11)	.32 (.37)
Vineland SMS	.93	.78	.30	.07	.63
Leiter PS	.77	.44	.66	.23	.11

DISCUSSION

The results contain nine points of interest. Firstly, the heritabilities are appreciable for four of the five tests. The exception is the verbal IQ of the WPPSI. We are not aware of other studies showing such a large difference between the heritability of verbal and performance IQs in the Wechsler tests

as is present in our results. Second, the results for the three tests are in general fairly similar, although the Vineland Social Maturity Scale yields lower coefficients for heritability and within-family environmental effects. Third, the uncorrected correlations and the heritability of the full scale IQ of the WPPSI, the most widely used of the three tests, are closely similar to the existing results reviewed by Bouchard (1993,p.58) who gives the correlations as .78 (MZ) and .58 (DZ) for this age group, giving a heritability of .40. Fourth, our sample of 100 twin pairs constitutes a significant addition to the existing data of 337 pairs and confirms for Ireland the results obtained from other countries.

Fifth, the heritabilities of .36 obtained in this study and of .40 obtained by Bouchard from previous results are much lower than that of about .78 obtained from adults (Bouchard,1993,p.58). Our results therefore confirm existing data showing that the heritability of intelligence is relatively low among 4-6 year olds as compared with adults. Sixth, neither Bouchard nor most others working in behaviour genetics correct their correlations for test reliability. A good case can be made for doing this and, as shown in the Table, this correction raises the heritability by about 10 per cent. Seventh, correction of the correlations for test reliability changes quite substantially the magnitude of the within-family and between-family variances, reducing the within-family variance and increasing the between-family variance. Eighth, we believe this is the first report of heritability and environmental variances for social maturity in young children. It will be noted that the heritability of .30 is not greatly different from that for IQ, but the environmental variance is almost entirely between families. It appears therefore that children learn their social skills from their parents more than their cognitive skills, or alternatively cognitive skills are more affected by experiences unique to one twin such as, possibly, adverse experiences during birth. Finally, our results show that between-family environmental effects are stronger than within-family effects, especially when the correlations are corrected for reliability. This appears to be generally the case among young children although in adolescence and adulthood between-family effects weaken and within-family effects increase (Plomin, DeFries & McClearn, 1990).

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