

INHERITANCE OF PERSONALITY TRAITS

AN INVESTIGATION INTO THE HEREDITARY DETERMINATION OF NEUROTIC INSTABILITY, EXTRAVERSION, AND OTHER PERSONALITY TRAITS BY MEANS OF A QUESTIONNAIRE ADMINISTERED TO TWINS

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INTRODUCTION

In 1960 a survey of heredity studies of personality characteristics was given by Shields and Slater. In that publication considerable attention has been paid to the investigation of monozygotic (identical) and dizygotic (fraternal) twins by means of personality questionnaires. The inter-correlations of questionnaire measures for neurotic instability generally show to be higher for members of monozygotic twins than for members of dizygotic twins. The authors of these studies are therefore generally inclined to conclude that neurotic instability is at least partly hereditarily determined. The same is true for extraversion. The empirical data in the present study follow the same lines but it will be seen that the conclusion of hereditary determination is not warranted by these data.

SUBJECTS

The opportunity was offered to administer a personality questionnaire to a total of 260 individuals, being the members of 88 monozygotic (MZ) and 42 dizygotic (DZ) twin pairs. They were all voluntary subjects in a genetic investigation of rheumatic disease in the University Hospital at Leiden. By means of advertisements in the local media and by co-operation of the Dutch Association of Twins they were informed of the investigation. The identification of MZ and DZ twins was carried out by several means:

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- | | |
|--------------------------------|------------------------------------|
| (a) hair border | (j) form of hands |
| (b) eye colour | (k) form of nails |
| (c) skin pigmentation | (l) nostrils |
| (d) lanugo | (m) finger prints |
| (e) freckles | (n) tasting of phenylthiocarbomide |
| (f) teleangiectasies on cheeks | (o) blood groups ² |
| (g) tongue wrinkles | (p) haemoglobine |
| (h) form of face | (q) sinking rate of erythrocytes. |
| (i) form of ears | |

The identification of 10 additional twin pairs was uncertain; they were excluded from further investigation.

The sex and age distribution of the $88 + 42 = 130$ pairs is given in table 1. There is no systematic age difference between MZ and DZ pairs.

TABLE 1
Age and sex of the investigated twin pairs

age	MZ		DZ		
	♂♂	♀♀	♂♂	♀♀	♂♀
13-20 years	7	17	2	6	3
21-30 years	4	18	1	7	3
31-40 years	7	12	4	7	3
41-50 years	3	4	1	2	1
51-60 years	5	8	1		
61-69 years		3			1

There is, however, a striking preponderance of women over men, and the proportion between the number of MZ pairs and the number of DZ pairs is about 2 : 1, which is about 1 : 3 in the population. Thus it turns out that the selection procedure has exercised a distinct selective influence.

THE INSTRUMENT

The "Amsterdam Biographical Questionnaire" (ABV) was administered to all subjects. They were all tested individually in the presence of an experimenter, who prevented contacts between subjects during the administration. The ABV is a recent Dutch personality questionnaire containing among others the following scales in 107 items:

² A₁-A₂ BO, MN (two thirds of material MNS), Rhesus (Ccc^w DEe), P₁, K, Fy^a, Jk^a (two thirds of material), Hp.

- N-score Neurotic instability (= neuroticism) as manifested by the presence of psychoneurotic complaints (e.g. "Do you sometimes feel lonesome?")
- NS-score Neurotic instability as manifested by the presence of functional bodily complaints (e.g. headaches, heart palpitations, blurred eyesight)
- E-score Introversion versus extraversion
- T-score Test taking attitude (selfcritical versus self-defensive; "lie score")

This instrument has been standardized over a national sample of 1887 subjects from the Dutch population of men and women between 13 and 78 years of age and a considerable number of validation studies have been carried out to settle the construct validity of the ABV (10). Especially the N-score and the NS-score have shown considerable validity against several external criteria.

By means of the standardization tables it is possible to convert raw ABV-scores directly into percentiles, which have been corrected for age and sex influences.

HYPOTHESES AND PREDICTIONS

In the first place this investigation offers an opportunity to cross-validate the hypothesis of hereditary determination of neuroticism as measured by a questionnaire. The *first and second prediction* will therefore be that the intra-pair correlation of the N- and NS-scores on the ABV will be higher in MZ than in DZ twins.

In the second place a cross-validation can be carried out of the hypothesis that there is a hereditary factor in the extraversion of individuals. Our *third prediction* will therefore be that the intra-pair correlations of the E-score will be higher in MZ than in DZ pairs. With regard to test taking attitude no specific hypothesis concerning its hereditary determination seems to have formulated as yet. In an investigation by Eysenck and Prell (2), however, an intra-pair correlation of .481 in 20 MZ pairs and of .109 in 24 DZ pairs was found for a questionnaire "lie score". Other findings by Furneaux and Gibson (4) and by Barendregt (1) show correlations between "lie scores" and other behaviour (hypnotizability and susceptibility to LSD-25). It seems plausible, therefore, to consider the T-variable as a reflection of a personality variable and not as a more or less accidental questionnaire variable alone. Taking these findings into account we had the *fourth prediction*

say that the intra-pair correlations of the T-score will be higher in MZ pairs than in DZ pairs. Eysenck and Prell (2) conclude from their findings that heredity plays a more important role in the development of the degree of neurotic instability of their subjects than environmental influences. In order to test this hypothesis on the present subjects we deduced the *fifth prediction*: The intra-pair correlations of N- and NS-scores in separately living MZ pairs will be higher than the corresponding correlation of DZ pairs living together in the same home. All twin pairs were therefore divided into two subgroups:

- a) twins living separately for five years or more
- b) twins living in the same home and twins who have been separated for less than five years.

This subdivision seems justified, as a period of at least five years should be long enough to produce observable personality changes due to changes in the environment. Furthermore this cutting point renders two subgroups which are not too small for statistical treatment of the data.

RESULTS

Table 2 gives product-moment correlation coefficients of the four variables in the four groups, plus the subgroups combined. The coefficients in the N- and NS-columns are in accordance with predictions 1 and 2. The coefficients in the E- and T-columns hardly follow the predictions concerned. The correlations in column N and column NS are in accordance with the *fifth prediction*. But it does not seem reasonable to consider this finding as support for the hypothesis that heredity explains more neuroticism variance than environment does. This is a consequence of the fact that the reasoning, which is fundamental for the deduction of the fifth prediction, is clearly contradicted by the present findings. For this reasoning says that living together, that is a similar environment will have a converging influence on questionnaire scores of a twin pair. A comparison, however, between the coefficients in the fourth and fifth row of the table, shows that cohabiting rather has an diverging than a converging influence on questionnaire scores of DZ twins. The MZ pairs show an irregular picture in this respect. When separated their NS-scores seem to converge and their E scores seem to diverge, while there is no clear difference with respect to the N- and T-scores.

This is only one interpretive difficulty. But even a statistical evalua-

TABLE 2
Intrapaircorrelations of 88 MZ and 42 DZ twin pairs *

		N	NS	E	T	MF **
1	MZ-cohab. <i>n</i> = 50	<u>0.55</u>	<u>0.45</u>	<u>0.58</u>	<u>0.48</u>	<u>0.45</u>
2	MZ-separ. <i>n</i> = 38	<u>0.52</u>	<u>0.75</u>	0.19	<u>0.46</u>	<u>0.44</u>
3	MZ-all <i>n</i> = 88	<u>0.53</u>	<u>0.67</u>	<u>0.37</u>	<u>0.46</u>	<u>0.44</u>
4	DZ-cohab. <i>n</i> = 21	-0.14	-0.05	0.19	0.33	-0.34
5	DZ-separ. <i>n</i> = 21	0.28	<u>0.64</u>	0.36	<u>0.49</u>	0.30
6	DZ-all <i>n</i> = 42	0.11	<u>0.34</u>	<u>0.35</u>	<u>0.54</u>	0.02

* Double underlining refers to a significance of .01; single underlining refers to a significance of .05; assuming normality of distributions.

** This table also lists the results of the MF (masculinity-femininity) scale of the ABV, which was derived empirically by means of contrasting groups of 200 men and 200 women from the national sample. All twin pairs of different sex have been excluded. The *n*'s in row 4, 5, and 6 are 14, 17, and 31. How suggestive a comparison of the MF correlations may be, they will not be described in detail in this publication.

tion of the first and second prediction cannot be carried out easily. This is due to the fact that strictly speaking the testing formula (6, p. 148)

$$t = \frac{Z_1 - Z_2}{\sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}}}$$

cannot be applied as it assumes normality of distributions. With percentiles, as we used, this is clearly not the case. Furthermore the power-efficiency of this testing model is low, which makes it more probable that the null-hypothesis will not be rejected, even if it is false. For these reasons we have looked for a different statistical test procedure.

FURTHER CALCULATIONS

The percentiles were first transformed into deciles, in order to make handling of the data easier. Now, suppose we express the similarity between two members of each twin pair in the difference between the

two decile values. The smaller the difference the greater the similarity then is. By means of a comparison of the decile differences between MZ pairs with the decile differences between DZ pairs the prediction can be checked that MZ twins are more alike one another than DZ pairs. The significance test of the difference between the two distributions of decile differences becomes more complicated, however, if the two distributions of deciles of the subjects from the two groups *considered as individuals* (not as pairs), are not identical. In the case, for example, in which one group has systematically higher N-scores than another group, the result will be an *accumulation* of the N-scores in some deciles. As a consequence of this accumulation the decile differences will be automatically relatively low in the group concerned, which makes an adequate test impossible of the prediction in question.³ A correction for deviant distributions of deciles in the subsamples can easily be carried out by a preceding calculation of the *chance distribution of decile differences*. This chance distribution of decile differences is the distribution of decile differences which would arise from a random comparison of the individual members from all twin pairs with the individual members from all other twin pairs; thus if every twin member was combined with every other twin member except with his/her own twin brother or sister. Now, if we replace the factual decile differences within the pairs by the relative probability that such a difference (or a smaller) will happen in the group concerned, then the scores of this group can adequately be compared to the scores of any other group of twin pairs, which have undergone the same treatment. The two resulting distributions, which consist of the numbers of factual decile differences and the relative probabilities as "scores", can be tested then for statistical significance of difference by means of the Mann-Whitney U test (9, p. 116) for example. The Kolmogorov-Smirnov one sample test (9, p. 47) can be used as a means of testing the significance of discrepancy between the distribution of factual decile differences and the distribution of the chance decile differences in the same group of subjects.

SPECIFIC CHARACTERISTICS OF THE SUBSAMPLES

The calculation of chance distributions of decile differences necessitates a decile tabulation of the scores of all the subdivisions of subjects

³ This effect is comparable to the consequence of restriction of range in the case of correlation coefficients.

TABLE 3

Cumulative percentual distribution of questionnaire scores (expressed in deciles) of 176 MZ and 84 DZ twins, considered as individuals. Two-tailed probabilities.

		N		NS		E		T	
		MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ
a. Decile	1.	10	5	14	11	9	10	13	14
	2.	19	11			15	26	25	25
	3.	34	20	19	13	23	38	34	35
	4.	43	30	29	23	35	45	41	42
	5.	53	37	41	32	49	50	52	49
	6.	61	46	52	45	62	64	65	55
	7.	73	60	66	52	74	70	73	75
	8.	84	74	81	70	82	83	82	76
	9.	93	87	90	87	91	93	90	86
	10.	100	100	100	100	100	100	100	100
b. NZ vs. DZ, D max.		0.16		0.14		0.15		0.10	
c. Critical D max. at $P = 0.05$		0.181		0.181		0.181		0.181	
d. Probability D max.		$P < 0.10$		$P > 0.10$		$P > 0.10$		$P > 0.10$	
e. Direction of b		MZ < DZ		MZ < DZ		MZ > DZ		MZ < DZ	
f. N and NS combined		D max. = 0.21							
g. Probability of f		$P < 0.03$							

as individuals. These tables (tables 3 and 4) offer a parenthetical opportunity to investigate if the differences between MZ and DZ twins as individuals, which have been observed by Eysenck and Prell, are repeated in our material. These authors found that MZ individuals scored lower on their N-scale and higher on their "lie scale" than DZ individuals. Furthermore they observed a greater variance of MZ individuals in the factor scores for neuroticism. From table 3 can be seen that the present MZ individuals also score lower in N and in NS than the present DZ individuals. But the two-tailed P -values are both in the vicinity of .10. If the N- and NS-score are combined per subject by simple summation, and if the two groups are again compared (not visible from the table) then the two-tailed P value reads $P < .03$ (Kolmogorov-Smirnov). With regard to the T-score, however, we find a difference in an opposite direction to the findings of Eysenck and Prell, but it is not significant. Table 4 gives a survey of the scatter of the

ABV-scores in the two groups of twins. The N-scores and NS-scores of MZ individuals show a (insignificantly) smaller variability than those of DZ individuals, which is opposite to the observations of Eysenck and Prell. We found an impressive difference in scatter of the E-score ($\chi^2 = 8.40$, $df = 1$, $P < .005$) as can be seen from table 4. It is evident from this study of differences in height and scatter in scores of MZ and DZ individuals, that accumulation effects as mentioned are serious enough to justify special attention. The raw findings obviously need a correction by means of the distribution of chance decile differences.

RESULTS OF THE FURTHER CALCULATIONS

We now can proceed with the verification of the predictions by means of the testing model introduced. The predictions only have to be restated in terms of decile differences. The *first prediction* now reads that the decile differences of the N-score, when corrected for chance, will be smaller in the 88 MZ pairs than in the 42 DZ pairs. As can be seen

TABLE 4

Scatter of questionnaire scores expressed in extreme deciles of 176 MZ and 84 DZ twins considered as individuals. Two-tailed probabilities.

	N		NS		E		T		Chance distribution	
	MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ
a. Deciles 1, 2, 3, 8, 9, 10 deciles 4, 5 and 6	106 70	51 33	93 83	51 33	86 90	57 27	107 69	54 30	106 70	50 34
b. Deviation from expected distribution, MZ; χ^2	0.00		4.02		9.49		0.02			
c. Deviation from expected distribution, DZ; χ^2	0.05		0.05		2.42		0.79			
d. Two-tailed probability of b	$P = 1.00$		$P < 0.05$		$P < 0.01$		$P < 0.90$			
e. Two-tailed probability of c	$P > 0.80$		$P > 0.80$		$0.20 > P > 0.10$		$B > 0.30$			
f. Scatter greater or smaller than chance scatter MZ	equal		smaller		smaller		greater			
g. Like f, DZ	greater		greater		greater		greater			
h. Difference of scatter MZ vs. DZ; χ^2			1.425		8.40					
i. Two-tailed probability of h			$0.30 > P > 0.20$		$P < 0.005$					

TABLE 5
Cumulative percentual distribution of decile differences in N-scores; 88 MZ and 42 DZ twin pairs.

Decile difference	MZ-all			DZ-all			DZ-cohab.			DZ-separ.		
	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.
0.	19	10		10	10		04	12		14	10	
1.	51	28		43	34		48	34	14	38	27	
2.	72	43	29	60	46	14	62	51		57	42	15
3.	81	57		71	61		71	68		71	56	
4.	91	68		75	75		71	78		76	66	
5.	93	81		81	82		81	89		81	77	
6.	96	90		91	91		90	96		90	85	
7.	99	96		100	96		100	99		100	91	
8.	99	98		100	99		100	100		100	97	
9.	100	100		100	100		100	100		100	100	
a. MZ-Obs. vs. Exp.	$P < 0.01 *$											
b. DZ-Obs. vs. Exp.	$P > 0.20 *$											
c. MZ vs. DZ	$d (MZ) < d (DZ)$ $P < 0.002 **$											
d. DZ-c Obs. vs. Exp.	$P > 0.20 *$											
e. DZ-s Obs. vs. Exp.	$P > 0.20 *$											
f. DZ-c vs. DZ-s	$d (DZ-c) > d (DZ-s) P < 0.26 **$ $P > 0.20 *$											

* Kolmogorov-Smirnov
** Mann-Whitney

TABLE 6
Cumulative distribution of decile differences in IQ-scores, 88 MZ and 42 DZ twin pairs

Decile difference	MZ-all			MZ-cohab.			MZ-separ.			DZ-all			DZ-cohab.			DZ-separ.		
	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.
0.	25	11		26	13		26	11		29	12		29	15	14	33	13	
1.	49	31		48	34		53	30		45	32		48	40		48	27	
2.	76	50	26	76	53	23	76	48	28	71	50	21	67	55		76	49	
3.	85	66		88	71		82	60		81	65		67	72		95	63	32
4.	92	77		98	82		84	72		83	78		71	84		95	72	
5.	96	86		98	91		92	81		93	85		86	89		100	82	
6.	97	93		98	97		95	90		95	93		90	93		100	93	
7.	100	97		100	99		100	95		98	97		95	98		100	96	
8.	100	100		100	100		100	99		100	100		100	100		100	100	
9.	100	100		100	100		100	100		100	100		100	100		100	100	
a. MZ Obs. vs. Exp.	$P < 0.01^*$																	
b. DZ Obs. vs. Exp.	$P = 0.05^*$																	
c. MZ vs. DZ	$P < 0.056^{**}$																	
d. MZ-c Obs. vs. Exp.	$P = 0.01^*$																	
e. MZ-s Obs. vs. Exp.	$P < 0.01^*$																	
f. DZ-c Obs. vs. Exp.	$P > 0.20^*$																	
g. DZ-s Obs. vs. Exp.	$P < 0.05^*$																	
h. MZ-s vs. MZ-c	$P = 0.085^{**}$																	
i. DZ-s vs. DZ-c	$P = 0.069^{**}$																	

* Kolmogorov-Sminov

** Mann-Whitney

TABLE 7
Cumulative percentual distribution of decile differences in E-scores; 88 MZ and 42 DZ twin pairs.

Decile difference	MZ-all			MZ-cohab.			MZ-separ.			DZ-all		
	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.	Obs.	Chance	Dmax.
0.	15	10		18	10		11	10		17	10	
1.	47	30		44	30		50	27	23	40	18	22
2.	61	48		62	48		61	44		55	43	
3.	83	63	20	84	64	20	82	59		74	55	
4.	90	76		92	77		87	72		81	68	
5.	93	85		98	87		87	82		90	78	
6.	95	92		100	93		90	90		95	87	
7.	95	96		100	97		97	95		100	95	
8.	99	98		100	99		100	98		100	99	
9.	100	100		100	100		100	100		100	100	
a. MZ-Obs. vs. Exp.	$P < 0.01^*$											
b. DZ-Obs. vs. Exp.	$P < 0.05^*$											
c. MZ vs. DZ	$P < 0.25^{**}$											
d. MZ-c Obs. vs. Exp.	$P < 0.05^*$											
e. MZ-s Obs. vs. Exp.	$P < 0.05^*$											
f. MZ-c vs. MZ-s	$P < 0.21^{**}$											

* Kolmogorov-Smirnov
** Mann-Whitney

TABLE 8

Cumulative percentual distribution of decile differences in T-scores; 88 MZ and 42 DZ twin pairs.

		MZ-all			DZ-all		
		Obs.	chance	Dmax.	Obs.	change	Dmax.
Decile difference	0.	23	10		10	10	
	1.	48	27		26	25	
	2.	67	42	25	57	38	
	3.	76	56		79	51	28
	4.	84	69		86	62	
	5.	92	80		93	73	
	6.	95	87		98	83	
	7.	99	93		98	90	
	8.	100	97		100	96	
	9.	100	100		100	100	
a. MZ-Obs. vs. Exp.		<u>$P < 0.01$ *</u>			<u>$P < 0.01$ *</u>		
b. DZ-Obs. vs. Exp.							
c. MZ vs. DZ		$P < 0.55$ **					

* Kolmogorov-Smirnov

** Mann-Whitney

from table 5 (row c), this prediction is clearly borne out. The critical testing value U (Mann-Whitney U test) being large enough to reject the null-hypothesis at a .01 level (two-tailed). The *second prediction* (with regard to NS) is also borne out (see table 6, row c) but its significance is dubious ($P < .056$ two-tailed). *Prediction 3 and 4* (see row c in tables 7 and 8) both keep at a considerable distance from the significance level (the two-tailed P values being resp. $P < .25$ and $P < .55$). The tables 5, 6, 7, and 8 have been prepared in such a way that a significance test can be made to evaluate differences between subgroups, that seem to deviate from one another according to table 2:

E-score,	MZ living together	versus	MZ separated
N-score,	DZ „ „	„	DZ „
NS-score,	MZ „ „	„	MZ „
NS-score,	DZ „ „	„	DZ „

The calculated two-tailed probabilities of the observed differences are resp. $P < .21$, $P < .26$, $P < .085$, and $P < .069$ (calculated with the Mann-Whitney U test over the relative probabilities of the observed

decile differences). None of these is significant, although some of them approximately reach the significance level. The differences between "DZ-together" and "DZ-separated", however, all point into the same direction.

DISCUSSION

When calculating the chance distributions of decile differences we simultaneously investigated if there were any systematic differences between the first born (A) and the second born (B) member—so registered by their own report—in each twin pair. The result is represented in table 9. Significance was investigated by means of the sign test (9, p. 68). Table 9, which is meant to be self-explanatory, gives the impression that personality differences between the younger and the elder partner cannot merely be excluded. The separate tabulation of cohabiting and separated twins and of first born and second born twins gives rise to several remarks which may be of some importance. The unexpected differences between cohabiting and separated, first born and second born twins necessitate an additional hypothesis. This hypothesis could be that the persons in the direct environment of a twin pair have differential expectancies with regard to the behaviour of the twin members and as such

TABLE 9

Comparison of first born (A) and second born (B) members of 88 MZ and 42 DZ twin pairs.

		N		NS		E		T		both in N and in NS	
		MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ
a.	A > B	34	26	45	18	37	15	46	16	21	15
b.	A < B	51	16	36	23	48	26	34	26	23	13
c.	A = B	3	0	7	1	3	1	8	0		
d.	Sign test MZ A vs. B	$P = 0.10$		$P > 0.25$		$P > 0.25$		$P = 0.25$		$P > 0.25$	
e.	Sign test DZ A vs. B	$P = 0.25$		$P > 0.25$		$0.25 > P > 0.10$		$P = 0.25$		$P > 0.25$	
f.	Direction of d and e	different		different		same		different		different	
g.	χ^2 A vs. B (df = 1)	5.40		1.74				4.16		0.23	
h.	Probability of g	<u>$P = 0.02$</u>		$P > 0.20$				<u>$P < 0.05$</u>		$P > 0.50$	
i.	Summation of d and e					$\chi^2 = 3.86$					
j.	Probability of i					<u>$P < 0.05$</u>					

these persons exert a differential influence on the behaviour of the distinct partners of a twin pair. As soon as the partners leave the parents' home and go to live separately, then the systematic differential influence also comes to an end and their "true personality" can emerge. In a recent investigation Shields (7) has observed a greater similarity between MZ pairs who were brought up separately almost from the very beginning of their life than in MZ pairs brought up together. DZ pairs were not investigated in this respect. It should be noted, however, that in our material the DZ twins do much more converge after separation than MZ twins do. This might imply that the persons in the environment of cohabiting MZ twins rather exert a non-differential or even a homologizing influence on these twins. If one accepts this reasoning, it is evidently inadequate to say that "*the environment is identical*" or "*the environment is different*", but it should be stated clearly which environmental variable is identical and which one is not. From the view-point of *systematic* differential influence on behaviour, the environment of cohabiting twins might be more unlike than the environment of separated twins.

From here it seems to be only one step to ascribe the greater similarity of personality of MZ twins, when compared with DZ twins, also to environmental variables. The greater resemblance between MZ and DZ twins in some respects might in the last resort be reduced to the perception of the parents "these children are identical" or "these children are different". It seems reasonable to expect a considerable correlation between the parents' perception of zygosity and factual zygosity, and this perception might be considered as the starting point of homologizing or differential influencing. The investigators, who deny the conclusive force of twin research with regard to heredity hypotheses on account of all sorts of postnatal influences, might be reproached that they have never demonstrated precisely how postnatal influences are responsible for differences between MZ and DZ pairs. Their explanations are always of a posteriori kind. Unfortunately it cannot be said of the present investigation that it is an exception in this respect. In a psychological heredity investigation one should try to subject all possible environmental influences to objective measurement, so that their influences on the dependent variables (difference and similarity of twin pairs) can be evaluated by empirical standards. The present material also illustrates how specific sample characteristics can have an influence on the evaluation of hereditary determination on personality traits. Suppose this investigation had been carried out on cohabiting twins alone, one would

have been inclined to conclude a hereditary determination of extraversion as well (see rows 1 and 4 in table 2). The other coefficients in this column make this conclusion improbable. McLeod (5) and Eysenck (3) do conclude a hereditary determination of extraversion. Their subjects, however, were school-children, that is to say, subjects who seldom live separately.

SUMMARY

A questionnaire investigation into the hereditary determination of several personality traits is reported. The subjects are 88 monozygotic and 42 dizygotic twin pairs. A questionnaire was administered to assess the following personality traits: Neuroticism as manifested by the presence of psychoneurotic complaints, Neuroticism as manifested by the presence of functional bodily complaints, Introversion-extraversion, and Test taking attitude. A special calculation model was designed to test differences between similarity measures. The most striking is the observation of generally greater similarity of scores among dizygotic pairs who live separately than among dizygotic pairs living in the same home. This finding contradicts one of the principal working hypotheses in heredity research by means of twins. This unexpected result gives reason to doubt the conclusions which otherwise would have been drawn from a comparison of the similarity measures.

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