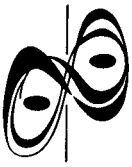

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Self-Awareness in Monozygotic Twins: A Relational Study

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Abstract. This study considers the replies to a 14-item questionnaire, by 27 monozytogic (MZ) and 38 dizygotic (DZ) pairs. Another sample consisting of 48 sets of parents of twins (24 of whom were MZ and 24 DZ, not necessarily corresponding to the couples of twins actually studied) was used, to answer a questionnaire directly related the one put to the twin pairs. The results of statistical tests performed (canonical correlation and Fisher's discriminant) indicate that only in MZ twins does self-awareness outweigh pair-awareness. This does not seem to be related to any difference between MZ and DZ twins in the education/upbringing received from their parents.

Key words: Canonical correlation, Identity, Self

INTRODUCTION

According to a study at the end of the 1970s [19, 20], there are three factors impinging upon MZ twins' acquisition of an awareness of separate identity: heredity, environment, and interaction between the twins themselves. This last factor was first considered by an author in the late 1940s, and more recently by another researcher, but from a different standpoint [21]. According to the latter author, role division (for instance leadership/submission) is the main cause of what he calls *le paradoxe des jumeaux*: ie. the existence of psychological differences between two individuals who are quite identical from a biological standpoint, and share identical environments.

Of course, it is quite plausible to consider psychological differences to be the causes, rather than the effects, of the role divisions between the twins of an MZ pair. This way of thinking, which attributes an overall importance to the interaction between identical individuals, stresses the role of the cognitive assessment that the MZ twins very likely help to build, taking part in the dialectic between their respective personal identities and the shared identity of the couple.

Recently, several authors [2-7] have addressed the task of elucidating cognitively

meaningful areas that for MZ twins can be representative of the more individual component of self-awareness, as well as of the interactive one. In doing so, these authors have found it useful to pay particular attention to such elements as twins' first names and the social activities shared with the other twin. Whenever the first name of one of the twins is examined with particular reference to feelings, behaviours, etc. which are connected to the other twin's first name and the social activities shared with him/her, it is evident that the joint identity of the twin pair exerts an influence. This is true, even considering the extent to which one's first name is a principal symbol of personal identity [9].

Choosing the semantic areas to study is a task which is obviously not devoid of difficulties and pitfalls. Even more formidable, however, are the methodological problems that arise whenever the researcher attempts to study MZ twins' self-awareness by means of a relational approach.

The well-known 'twin of control' method [11], the only one able to adequately model the internal dynamics of a pair of MZ twins, may be considered the most obvious tool for studying MZ self-awareness. Given the psychological differences that exist between MZ twins, despite their genetic identity and shared environment, any study of them requires a valid control group. In the opinion of the authors, this is best provided by pairs of DZ twins, who share the same environment, but not, by definition, identical genes. The real problem encountered when comparing MZ and DZ twins is the need to follow the contrasting group method introduced by Galton in 1875. By its very nature, this method is not compatible with the 'twin of control' method, which in turn is crucial in any relational approach to the study of a group of MZ twins.

For this reason, in the present study the authors were compelled to find a statistical procedure able to contrast groups of subjects, detecting cognitive features (in our case self-awareness) peculiar to one group (the MZ twins for instance) and not to the other (the DZ twins). We chose a canonical correlation analysis test to compare the most statistically significant linear combinations computable from the responses obtained from each twin in MZ or DZ pairs. The (statistical) approach to the study of twins' behaviours tested here departs from that of most previous studies, in which the classical methodology of Gesell and Galton has predominated, and seeks to overcome the methodological problem arising from the previously described incompatibility between these classical methods. In synthesis, the aim of the present study is to find plausible answers to the following questions:

(1) Are there differences between MZ and DZ twins regarding the cognitive assessment of their self-awareness?

(2) Are any such differences bound up with the physical similarity typical of MZ twins?

MATERIAL AND METHODS

In this study, the authors consider the answers given to a 14-item questionnaire (see Appendix) by 14 male and 13 female MZ twin pairs (27 MZ pairs in total), and by 7 male, 11 female and 20 mixed-sex DZ twin pairs (38 DZ pairs in total). The ages of twins in the sample ranged from 4 to 19 years (mean age: 11.12 yrs; standard deviation (SD): 4.11; median age: 12 yrs). The authors recorded which twin in each MZ and DZ pair

was born first. A questionnaire directly related to the one put to the twin pairs was put to an sample containing 48 sets of parents of twins (24 MZ and 24 DZ, not necessarily corresponding to the pairs of twins actually studied). In order to analyse the answers given by the twin pairs to the questionnaire (see Appendix), the scores relating to the 14 questions were reworked into three groups, each one homogeneous with respect to its component items. Scores to items 1 through 5, all concerning the respondent's first name, were recodified so that the highest possible score (=6) corresponded to the most positive attitude expressed by respondents concerning their first name. For instance, an affirmative and enthusiastic answer to the question: "Do you like your first name? Why so?" (see Appendix item no. 1) corresponded to a 6 score, and so on. Items 3 and 4, exploring twins' awareness of how their first name was chosen, seemed to lend themselves better to a binary score (1 for a satisfying degree of information, otherwise 0). The scores pertaining to the first 5 items were combined by means of an unweighted sum, and a new interval variable "One's first name evaluation" defined. Items 6 through 9 and items 10 through 14 were similarly treated, and two new interval variables, respectively "Other twin's first name evaluation" and "Shared activities evaluation" defined. Items 13 and 14 were scored by the rough number of activities furnished by the subject, discarding any information about the nature of the activities themselves.

All of the statistical analyses were performed on the standardised scores of the variables defined above, ie., after having reduced them to a null mean and a unitary variance, treating MZ and DZ twins' scores independently. The canonical correlation test better indicates the presence of any statistically significant relation existing between the members of the twin pairs in the sample. The test computes the linear combinations of two groups of variables (the so-called 'canonical function'), which the correlation between the two groups will be maximised for. The very number of the canonical functions obtainable is cogently limited by the rank of the matrices, while their statistical significance decreases with their order of extraction. Two earlier authors give differently flavoured but entirely classical accounts of this subject [15, 18].

The task of the authors of the present study, however, was a rather peculiar one, owing to the fact that the two groups of variables were of the same rank (usually one attempts to find a relation between a large set of variables and a few categories). For this reason, it was found more satisfactory to resort to a variant of the canonical correlation test, which although originally introduced in order to analyse contingency tables [14], was perfectly fitted to our situation. According to this method, the coefficients of the canonical functions were obtained first, through the 'Singular values decomposition' [14, 16, 17] of a matrix Z_i defined thus:

$$Z_i = S_{1,1}^{-\frac{1}{2}} S_{1,2} S_{2,2}^{-\frac{1}{2}} = W D_\varrho X^T$$

$$i \epsilon \{1,2\}$$

$$W^T W = X^T X = I$$

here, $S_{1,1}$, $S_{1,2}$, and $S_{2,2}$ are the covariance matrices for Z_1 (MZ) and Z_2 (DZ), made up of the scores along the three composed variables (see above). I is the identity matrix and T indicates the usual transposition operator.

The canonical coefficients were computed through the following formulae:

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$$A = S_{1,1}^{-\frac{1}{2}} W$$

$$B = S_{2,2}^{\frac{1}{2}} X$$

while the singular values along the diagonal of $D\varrho$ in (1) are the canonical correlations. The test was performed upon the matrices of scores for the 27 MZ and the 38 DZ twins, respectively, comparing the scores of the pairs. The statistical significance level was determined by Bartlett's V statistic [18], which it was necessary to compare to the χ_2 distribution having the same number of degrees of freedom as the product of the numbers of variables for the two groups (here, $3 \times 3 = 9$ d.f.).

The figure of 27 subjects along 3 variables is a rather unfavourable one, giving a ratio of $27/3 = 9$ subjects for each variable, less than the figure of 12-15 usually considered for most multivariate tests. Moreover, a low subjects/variables ratio may negatively affect the interpretative validity of the canonical functions obtained after the first one. For this reason, the authors resorted to the so-called the minumum 'bootstrapping' technique [8], attributing the role of Twin 1 randomly for every pair. The procedure was repeated 10 times, making use of a different random distribution of roles each time, although preserving the identity of the pairs as an obvious requisite.

Parents' replies to a questionnaire directly related to that presented in Appendix A, previously recodified in quite a similar way to that set out above in this section, were analysed by the statistical test originally designed by R.A. Fisher to determine a linear composition of variables proportional to a discriminant function [10]. In order to perform such a test, it is necessary to construct a pseudo-variable, by assigning to every subject an arbitrarily defined score that will qualify him/her as belonging to one of the groups considered [16]. Here the two groups were, of course, parents of MZ and DZ

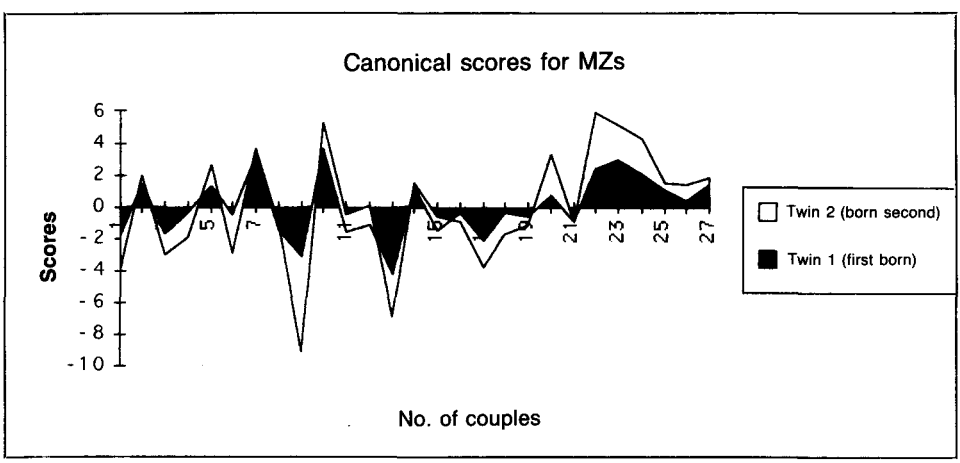

Figure. Comparison of canonical scores obtained for MZ canonical correlation analysis. The patterns presented by Twin 1 and Twin 2 are strikingly similar overall.

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twins. Owing to the fact that the pseudo-variable is not normally distributed, it is necessary to evaluate the statistical significance of the test by a 'pseudo-analysis of variance', through an F-distributed statistic obtained from the multivariate standard distance between the (two) groups [10]. The result of the test is in all respects analogous to that obtained by a multiple regression test, with the added advantage of allowing determination of which of the variables considered best explains the amount of variance present.

RESULTS

In the present sample, the V statistic obtained for the canonical test was 18.4433 ($p = 0.0304$) for MZ, and 4.2222 ($p = 0.8962$) for DZ Twins when Twin 1 was the first born. For MZ twins, the canonical function first extracted was the only statistically significant one, giving a correlation coefficient of 0.7040 between cotwins. For the sake of completeness, the correlation coefficient given by the (not significant) first canonical function obtained for DZ twins may be considered to be 0.3153. The existence of one statistically significant canonical function for MZs, while none was obtainable for DZs, clearly points to some kind of relation that, while existing between MZ twins, is not apparent for DZs in the present sample.

The standard canonical coefficients obtained for the MZ pairs and the correlation coefficients between cotwins' canonical scores and the compound variables described in the previous section (see Tables 1 and 2) provide clear evidence for a high positive corre-

Table 1 - Standard canonical coefficients for MZ twin pairs

Twin 1	Twin 2
0.3017	0.2043
0.1843	-0.0144
-0.6205	-0.5529

Note: "Twin 1" denotes the firstborn and "Twin 2" the second-born twin.

Table 2 - Correlation coefficients between canonical scores for MZ twin pairs and compound variables

Variable	Twin 1	Twin 2
"One's first name evaluation"	0.1451	0.3534
"Other twin's first name evaluation"	-0.2462	-0.1079
"Shared activities evaluation"	-0.8598	-0.9259

Note: "Twin 1" denotes the twin born first and "Twin 2" the twin born second.

lation between the canonical function and each twins' evaluation of their first name, while twins' evaluation of shared activities with their cotwin shows a high negative correlation. Subjects' evaluations of their cotwin's first name are between the values resulting for the "One's first name" and "Other twin's first name evaluation" interval variables, although the correlation is negative. The scores obtained from the canonical function for MZ subjects (Table 3 and Figure) show a higher degree of similarity between "Twin 1" and "Twin 2". The absence of any canonical function significant for DZs clearly makes it impossible to show any analogously significant figure.

The 'bootstrapping' tests (see the preceding section) gave remarkably similar results to the ones just presented. For several of the 10 tests performed, the V statistic was even more significant ($V = 20.5831$), $p = 0.0146$, with a correlation coefficient between cotwins of 0.7282 was the highest figure obtained). An additional advantage obtained by

Table 3 - Canonical scores for MZ twin pairs

No. of couple	Twin 1	Twin 2
1	-1.84225475063167e-01	-2.0726121688389
2	1.39834491666212e-01	5.5607639625888
3	-1.71840366784288e-01	-1.2760372991392
4	-3.41764946484620e-02	-1.5751472301264
5	1.31094465587900e-01	1.2724854380408
6	-5.19540806495006e-02	-2.4472859773923
7	3.21960121520831e-01	4.1463536804318
8	-1.50013593253786e-01	3.4544906523360
9	-3.16100898388449e-01	-5.9164675126232
10	3.61960452140757e-01	1.6291557476336
11	-1.56206147393226e-01	1.0438546080549
12	-1.10013262633860e-01	1.2072546864871
13	-4.21284015755464e-01	-2.6655836813659
14	1.30286254930109e-01	2.0400803701789
15	-1.43012828456556e-01	8.6616585235444
16	-4.19936043439930e-02	-4.6912930342690
17	-2.15196380000876e-01	-1.6293984565718
18	-3.41764946484620e-02	-1.3742066260176
19	-5.97630561045216e-02	-4.9504390489930
20	6.84591507796818e-02	2.5781511706574
21	-9.47912828122035e-02	-1.8891617307404
22	2.44094692650447e-01	3.4948544174523
23	2.91912132965903e-01	2.2803340378618
24	2.06931233573298e-01	2.1995218108481
25	1.02671032589063e-01	4.5855346847624
26	4.00357177808450e-02	1.0109160327301
27	1.45508234751766e-01	3.7838764055840

Note: "Twin 1" denotes the firstborn and "Twin 2" the second-born twin.

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this procedure was that of being able to give a negative answer to any question regarding the existence of different roles for MZ twins, discernable from the present data. The authors looked also for any influence exercised by the more common covariates, such as gender, age, and education level. No statistically significant result was obtained from covariance analysis tests for the above-mentioned covariates, with respect to canonical scores for MZ and DZ twins.

When submitted to the Fisher's discriminant test (see the preceding section), the parents' data produced a $F_{9,38} = 3.7441$ ($p = 0.001$; see [10] for the method used to determine degrees of freedom). As might easily have been predicted, the only dependent variable that was found to be stable was the number of physical features listed by parents as making their twins alike. A greater number of such physical features were enumerated by parents of MZ twins. The univariate ANOVA between the MZ and DZ parents, for this score, produced an N F1,46 = 40.3010 ($p = 0.0000008$); the mean for MZ parents was 2.8461 (standard error = 0.1753); the corresponding figure for DZs 1.5429 (standard error = 0.1068). Some caution is in order, when one attempts to interpret the figures produced in the last paragraph, however; the R^2 for the Fisher's discriminant test was as low as 0.2321, while that for the ANOVA was 0.4700. The amount of variance explained, therefore, is indeed smaller. Moreover, the obviously greater physical resemblance between MZ twins is of uncertain practical use when seeking to identify the parental influences determining the development of MZ self-consciousness.

CONCLUSIONS

The most interesting aspect of the results obtained may be the directions for future research which they indicate. The reworking of the data obtained from twins' questionnaire replies (see Appendix) into three new variables, "One's first name evalutation", "Other twin's first-name evaluation", and "Shared activities evaluation" is only the first step that needs to be taken in order to be able to analyse MZ and DZ pairs separately. The canonical correlation test shows that: a) statistically significant differences exist between MZ and DZ twins, and b) MZ cotwins adopt a fully congruent position when asked to evaluate their first name (both giving highly positive evaluations) and the activities shared with the other twin (both giving a negative evaluation).

The conclusion most readily drawn from such results is the high likelihood that one's first name plays a significant role in the development and assertion of self-identity in MZ twins. Their attempt to denigrate or undervalue their shared activities would seem to reveal a paradox in MZ twins, whereby the pair's joint identity is subjugated to each cotwin's individual identity, the latter being powerfully symbolised by his or her first name. Analysis of data from replies to the questionnaire given to parents of MZ twins does not provide evidence for attributing, the forementioned features of MZ self awareness to any differences in parenting, even if MZ twins' parents appear to be fully aware of the physical resemblance of their twins. The authors hope that, in addition to the possible value of the results obtained here, the present study may be of some use in establishing methodological guidelines for those working in the undoubtedly complex field of twin research.

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Appendix - Twins' Questionnaire (Original Version)

1. Do you like your name? Why?
2. Would you like to be called something else? What?
3. Do you know who chose your name?
4. Do you know why you were given your name?
5. Is your name important to you? Why is that?
6. Do you like your twin's name?
7. Have you ever called yourself by your twin's name? Did you enjoy it? Why?
8. Would you like to have your twin's name? Why?
9. Have you ever been called by your twin's name? Did you like that? Why?
10. Do you like dressing like your twin?
11. Do you have the same friends?
12. Do you go out together?
13. Which are the things you enjoy doing most with your twin?
14. What are the things you enjoy doing most on your own?

For each item in the questionnaire, twins were asked to choose a value on a 6-point scale, worded according to the question. For example the scale for item no. 1 was as follows: 1 = very much, 2 = a lot, 3 = quite a lot, 4 = little, 5 = very little, 6 = not at all (say why). To keep the format of the questionnaire as uniform as possible, high-rating answers always correspond to lower figures (1, 2, etc.). This obviously makes some recoding necessary: assigning the value 1 to item no. 5 denotes a high evaluation of one's first name (or self-identity), so the true value ought to be 6,

This was accomplished for item no. 1, 5, 6-9, 10 and 11 by recoding the scores according to the following formula: $N = -O + 7$. That is to say that the adjusted value was obtained by adding a 7 (the highest permissible score plus 1) to the reciprocal of the original value. Answers to item nos. 3 and 4 have been recoded into a binary format (1/0 = I know/I don't know). In this way, the scores to the 14 items exhibit a consistent grading, ranging from 1 to 6 for the valuation of the subject's personal identity (item nos. 1-5), of the other twin's personal identity (item nos. 6-9), and of the pair's identity (item nos. 10-14) respectively.