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Multivariate Analysis in Twins

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We present the results of a noncentral χ^2 test applied to 63 like-sexed twin pairs.

We have separated the pairs into two groups: 30 serologically identical and 33 serologically nonidentical pairs for nine sera of the blood groups ABO, MN, and Rh.

The probabilities of monozygosity of the serologically identical pairs, calculated by the method of Maynard-Smith and Penrose, range from 0.83 to 0.92 — rather small values. With the help of Belgian frequencies of DZ and MZ twins, we could prove that there are about 50% chances of having less than two DZ pairs amongst the 30 serologically identicals.

Consequently, our first group with 30 pairs is *mostly* MZ (less than 7 DZ pairs in 96% of the cases); while our second group, with 33 pairs, is *completely* DZ.

We did not try to extract out of the 30 serologically identicals, such pairs that might " seem " DZ. For instance, we have kept in our first group two twins — one with blue and one with brown eyes — because the genetics of eye colour is not yet enough well-known to be safely used in twin-diagnosis; and also in memory of Madame de Sévigné, who had one brown and one blue eye. Imperfect as the composition of our sample is, we have avoided at least one mistake: adding, to surely DZ pairs, twins who are " seemingly " DZ, but not proven to be so.

Fig. 1 shows the results for two and four head measurements (frontal diameter, head length, breadth and height). The abscissa gives the probability, P, that a random member of a population of same age and sex of two given twins, A and B, would be closer to A than his cotwin B. The generalized distances take into account the correlations and variances of the measurements in the population. Thus, small values of P correspond to very similar twins. The ordinate gives the proportion of cases having a given P value. We used P, instead of generalized distances, because it takes into account the generalized distances between the center of the population and each of the twins; thus, P is the more accurate measurement.

The contrast between the two types of twins is unmistakable and is further enhanced when more measurements are used; the serologically identicals have, on the whole, smaller P values than the nonidenticals, proving the importance of heredity in head measurements.

For the body, seven measurements were taken, including standing height, arm length, breadth of shoulders and pelvis, etc. (Fig. 2). We compare the results for three and seven variables. These body measurements also demonstrate the existence of

Acta Genet. Med. Gemellol. (1970), 19: 150-154

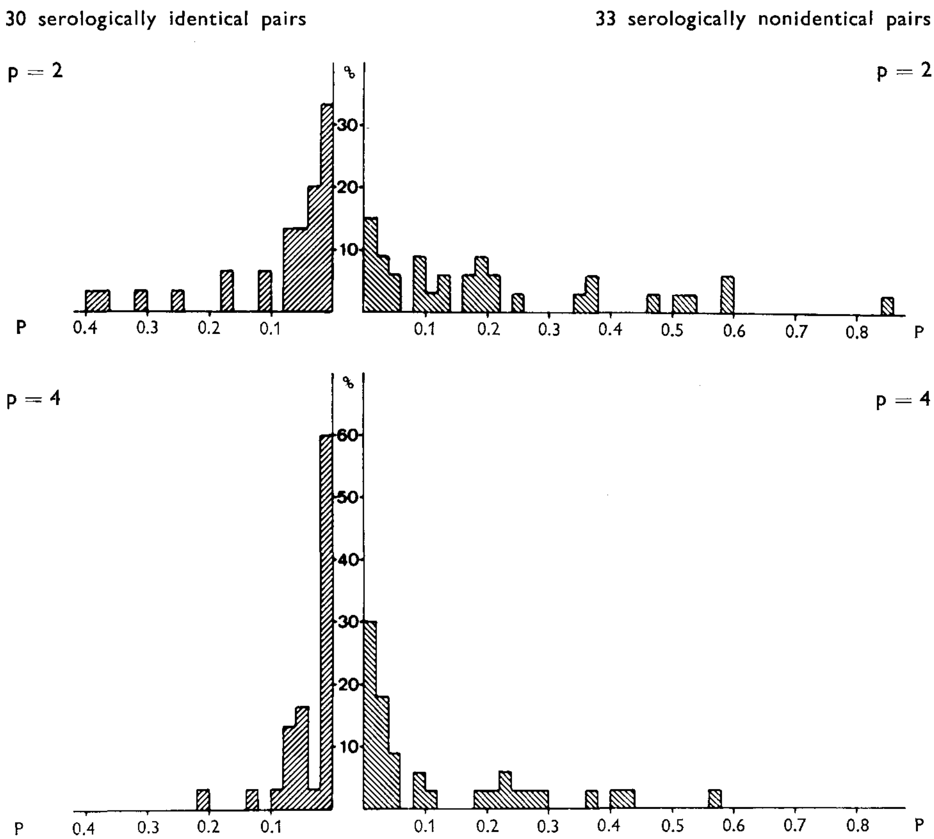

Fig. 1

hereditary factors, because the identicals have smaller P values. When more variables are added, the contrast between the two groups becomes greater.

However, the contrast between the two groups is smaller for the body than for the head; so, we can deduce that the body is more influenced by environmental factors than is the head, which is heavily dependant on genetic factors.

For the face, we have taken 11 measurements, and P values are even smaller than those for the head and body (Fig. 3).

All twins have very similar face measurements, but the contrast between the two types of twins is smaller than for the head, because many DZ pairs have strikingly similar faces.

The DZ twins shown in Fig. 4 look very similar and their P is very small. Let us now consider the population of boys of their age; P is then the proportion of boys who are closer to the first twin than his cotwin. In this case, P is very small.

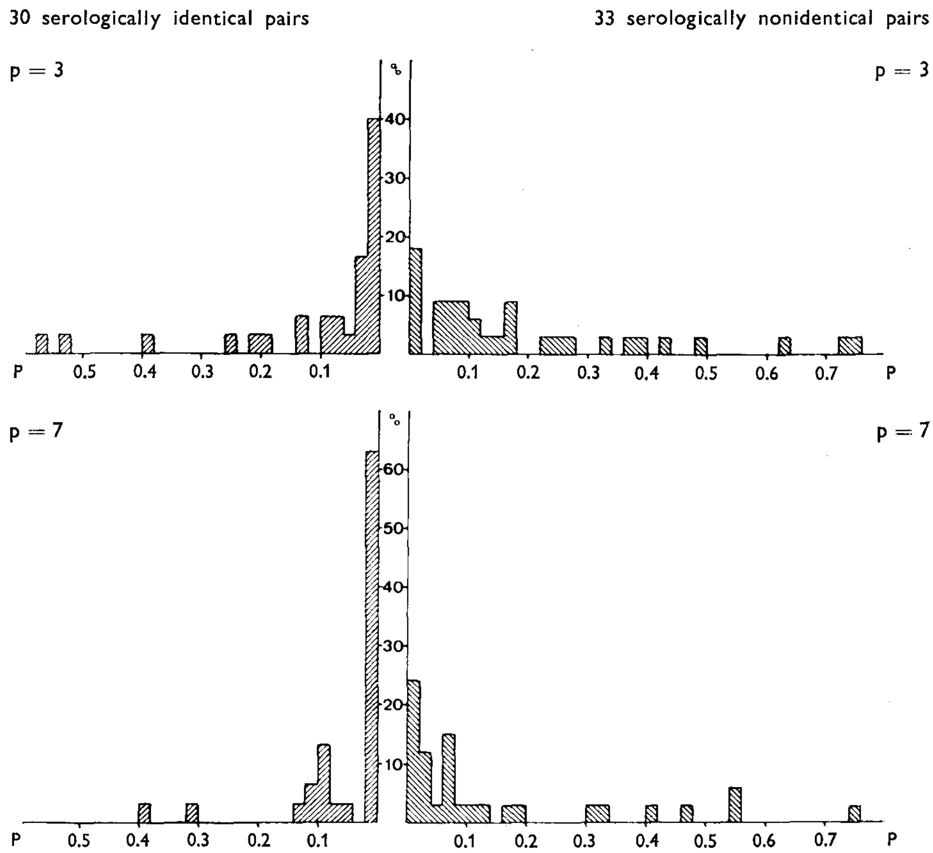

Fig. 2

Fig. 5 also shows very similar DZ twins, with a small, yet somewhat larger, P value. Fig. 6 shows an identical pair with small P value and with a probability of monozygosity of 0.83. Another identical pair, with a higher P value than the first DZ pair, is shown in Fig. 7.

The contrast between the two types of twins is smaller for the face than for the head. This might lead us to suppose that the face is less genetically controlled than the head, though this is difficult to believe. However, assortative mating in a group of Belgian parents was found to be greater for face than for head measurements; so, this may explain in part the great similarity of the faces of many DZ pairs, and the corresponding lack of great contrast in the P values of the two types of twins.

The following conclusions may be drawn:

1. Multivariate analysis, especially the use of P values, improves the contrast between serologically identical and nonidentical twin pairs.

https://doi.org/10.1017/S1120962300025300 Published online by Cambridge University Press

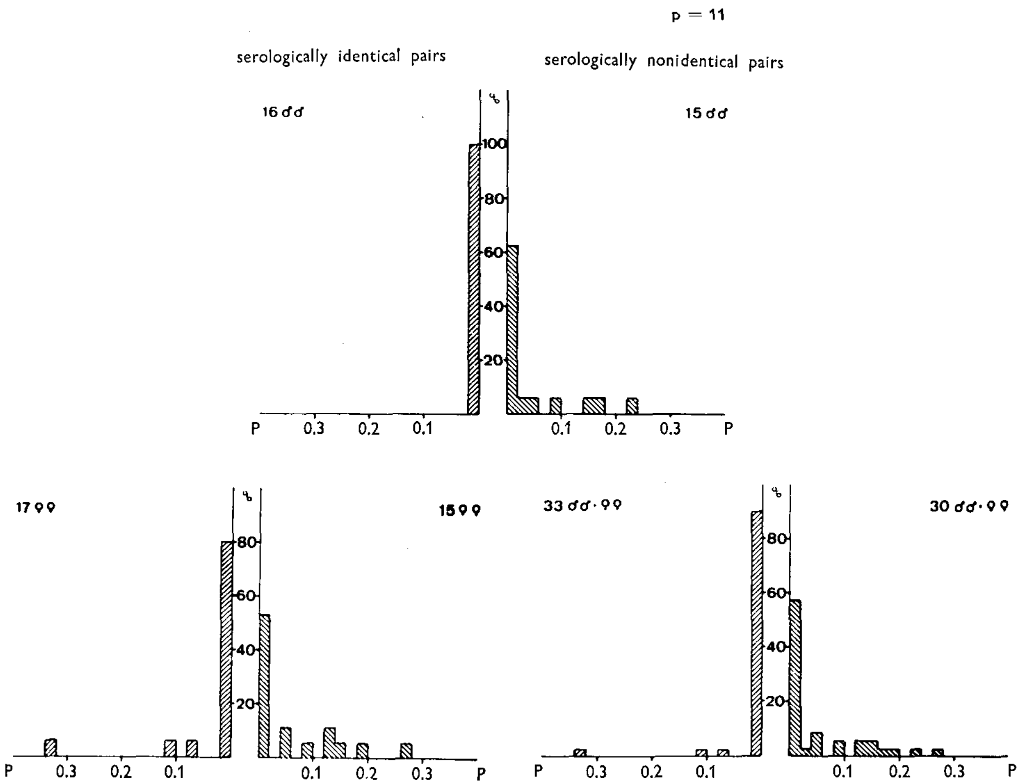

Fig. 3

2. According to our results, the head seems to be the most genetically conditioned part of the body, with measurements not much influenced by assortative mating. Body measurements on the other hand, seem to be more dependent on environmental factors, assortative mating being greater than for the head and about the same as for the face. Face measurements are similar in both twin groups, giving very small P values; this cannot be completely explained by similarity of environmental factors, although the contrast between the two twin types is small; the relative importance of assortative mating in face measurements probably explains (at least partly) why many DZ twins are so strikingly similar in facial appearance.

3. No zygosity diagnosis can as yet be based on biometrical characters, because the initial separation into MZ and DZ twins cannot yet be achieved without mistake on the basis of known discriminating factors. Zygosity diagnosis of individual twin pairs should, for the time being, be only based on well-known and fully penetrant genetic traits. Even striking similarity of features does not prove monozygosity, and we still do not really know how far dissimilarity of features proves dizygosity.

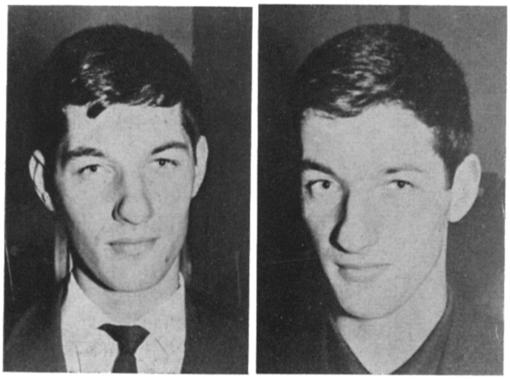

Fig. 4. DZ pair. Face: P = 0.00003.

Fig. 5. DZ pair. Face: P = 0.00782.

Fig. 6. Serologically identical pair.
Face: P = 0.00006; probability of MZ = 0.83.

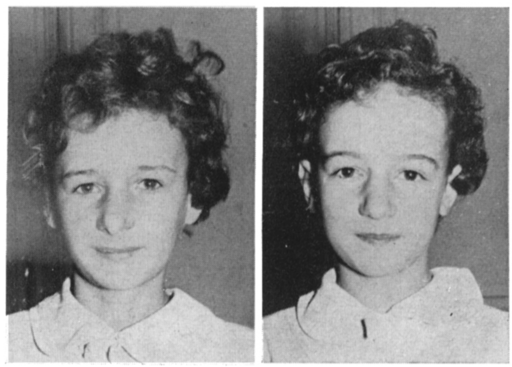

Fig. 7. Serologically identical pair.
Face: P = 0.00064; probability of MZ = 0.85.

4. However, if the probability of monozygosity had been very high, at least 0.99 for each serologically identical pair, and if we had worked on a much larger number of twins in order to control many exceptional cases, then our results might be used in retrospect and specifically in Belgium, for diagnosis of a given twin pair.

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https://doi.org/10.1017/S1120962300025300 Published online by Cambridge University Press