

## Twin data on hand clasping: a reanalysis<sup>1</sup>

Ademar Freire-Maia

Individuals can be classified into two categories, according to the way of performing hand clasping: R type, when the fingers of the right hand occupies the uppermost position (see fig. in Rothschild, 1930), and L type, when the opposite situation occurs (see fig. in Winchester, 1958). Each person has his peculiar way of clasping his hands, and it is believed that the type persists unchanged throughout the whole life. The reason why some persons clasp the hands with the fingers occupying one position, and not the other, is as yet unknown. This fact cannot be explained by relatively large differences in the shape and proportions of the bones of the hand, since it has been shown that a close over-all similarity between them exists (Greulich, 1960). We suggest, however, that even the small differences detected can explain the situation.

Dahlberg (1926), based on twin and populational data, concluded that "there is hardly reason to presume heredity" in the genesis of the trait. His data can be explained well on the basis of a chance distribution, but this hypothesis can not account for the extensive amount of family data (Lutz, 1908; Yamaura, 1940; Kawabe, 1949; Yoshiwara, 1957; and Freire-Maia, Quelce-Salgado and Freire-Maia, 1958), as well as for the large amount of populational data (see Freire-Maia *et al.*, 1958; Yoshiwara, 1957; Freire-Maia, 1961), and the ethnic, sex, and age differences detected (see Freire-Maia *et al.*, 1958). Although all those authors presented strong evidences of a genetic component on the genesis of the trait, no simple Mendelian mechanism could explain the data, however.

The main purpose of this note is to show that Dahlberg's data (1926) on twins can not be considered as denying the existence of some hereditary influence on the manifestation of the trait. The model to be applied here is quite similar to that previously presented and applied to twin data on handedness (Rife, 1950). It is not our intention to assume that the model would explain all the family and populational data on hand clasping, as well as we do not intend to deny any environmental influence. Our intention is mainly to show that even a relatively simple genetic mechanism can explain at least the twin data, considered until now as disproving the existence of any genetic effect.

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## A genetic hypothesis

Dahlberg's (1926) monozygotic twin data showed that individuals with the same genotype can present difference in the manner of performing hand clasping. Furthermore, intrapair variations in the manner of clasping the hands is practically the same among monozygotic and dizygotic twins, the distribution of the pair-types in both identical and fraternal twins being statistically not different from what would be expected on the basis of a random distribution (Dahlberg, 1926). If, however, based on family and populational data, one makes the assumption that some (perhaps important) hereditary influence exists on the genesis of the trait, then the monozygotic twin data would merely mean that the penetrance of the gene (s) involved is not complete.

Let us consider the simplest hypothesis regarding the assumed genetic component on the genesis of the trait, i.e., that of a single pair of autosomic alleles, one of them (*R*) occurring with the frequency *p* and conditioning the R trait, and the other one (*r*) occurring with the frequency *q* and conditioning the L trait, being  $p + q = 1$ . Homozygous individuals will show the R trait (*RR* individuals) or the L trait (*rr* individuals). Since, according to the twin data, neither one of the two alleles could express itself fully and/or always in the heterozygote, let us make the assumption that half of the heterozygotes show one trait, and half show the other (the general problem, where the penetrance is also incomplete but different from 0.50, will be analysed elsewhere). One could suggest that heterozygous individuals clasp their hands indifferently putting either the right or the left fingers in the uppermost position. In an analysis of the problem, however, Kawabe (1949) found only 7 individuals in 4,022 boys and girls who indifferently clasped their hands with either the right or the left fingers uppermost (the frequency of heterozygotes in such a population, assuming it is in equilibrium, would be much higher than  $7/4,022$ ).

It is clear that intrapair differences among identical twins can occur only when they are heterozygous (*Rr*); when homozygous, they will always show concordance, either with both of them showing the R trait (*RR*) or the L trait (*rr*). Regarding handedness, Rife (1950) admitted that all pairs of heterozygous twins show discordance, and that in dizygotic twin pairs where only one member is heterozygous, half present the R trait and half show the L trait. Let us now hypothesize the same for hand clasping. The expected frequencies for the different genotypes among pairs of identical twins are exactly the same as would be expected for single-born individuals, since the genotype of one twin is identical to that of his co-twin.

The different genotypes and phenotypes of the pairs of identical twins will occur with the following frequencies:

$$\begin{array}{ll}
 \text{R-R pairs:} & p^2 \quad (RR) \\
 \text{R-L pairs:} & 2pq \quad (Rr) \\
 \text{L-L pairs:} & q^2 \quad (rr)
 \end{array}
 \qquad
 \begin{array}{l}
 R = p^2 + pq = p \\
 L = q^2 + pq = q
 \end{array}$$

In the case of fraternal twins, it was necessary to develop special formulas (Rife, 1950), which are as follows (as a matter of fact, in the original there is a small press error):

$$\begin{aligned} \text{R-R pairs: } & p^2 - p^2q^2/4 \\ \text{R-L pairs: } & 2pq + p^2q^2/2 \\ \text{L-L pairs: } & q^2 - p^2q^2/4 \end{aligned}$$

Dahlberg's (1926) twin data on hand clasping have been analysed according to the above mentioned hypothesis, and the results (Tables 1 and 2) are in close agreement with the assumed model. The main conclusion to be drawn, however, is that, contrary to what has been considered until now, Dahlberg's twin data do not disprove the existence of some hereditary influence on the genesis of hand clasping.

An alternative hypothesis has been proposed by Rife (1950), namely that, in cases of heterozygous pairs of twins (whether identical or fraternal) the probability that one or the other co-twin presents one or the other phenotype will be just a matter of pure chance. Under this assumption, the frequency of concordant heterozygous twins would be equal to that of discordant heterozygous ones. Although the discrepancy between the hypothesis and Dahlberg's dizygotic twin data is statistically

Tab. 1 - Hand clasping in pairs of monozygotic twins

Pair Types	Absolute and relative frequencies	
	observed *	expected **
R-L	18 (0.2609)	17.76 (0.2573)
R-L	34 (0.4927)	34.49 (0.4999)
L-L	17 (0.2464)	16.75 (0.2428)

$X^2 = 0.01, P > 0.05$

\* Data obtained by Dahlberg (1926). \*\* See text.

Tab. 2 - Hand clasping in pairs of dizygotic twins

Pair types	Absolute and relative frequencies	
	observed *	expected **
R-L	34 (0.2764)	29.33 (0.2385)
R-L	56 (0.4553)	65.34 (0.5312)
L-L	33 (0.2683)	28.33 (0.2303)

$X^2 = 2.85, P > 0.05$

\* Data obtained by Dahlberg (1926). \*\* See text.

not significant at the 0.05 level, this hypothesis can not be fitted to the data on monozygous twins.

Assuming the same hypothesis (one pair of alleles with the heterozygotes labile enough to show one and/or the other trait), Merrell (1957) presented formulas for calculating the expected frequencies of R and L single-born children from matings R x R, R x L, and L x L. Merrell's formulas give the frequency of R and L individuals in the population who are the offspring of each one of the mating types. As we are mainly interested in knowing those frequencies, not as a fraction of the whole population, but as a fraction of the total number of children from each one of the mating type, the formulas can be simplified as in Table 3.

Tab. 3

Mating type	Frequency of R and L children	
1. R × R	$R_1 = \frac{p^2(p+1)/2}{[p^2(p+1)/2] + p^2q/2} = \frac{p^3+p^2}{2p^2}$	$R_1 = \frac{p+1}{2} \quad (1)$
	$L_1 = \frac{p^2q/2}{[p^2(p+1)/2] + p^2q/2} = \frac{p^2q}{2p^2}$	$L_1 = \frac{q}{2} \quad (2)$
2. R × L	$R_2 = \frac{pq(2p+1)/2}{[pq(2p+1)/2] + pq(2q+1)/2} = \frac{2p^2q+pq}{4pq}$	$R_2 = \frac{p+0.5}{2} \quad (3)$
	$L_2 = \frac{pq(2q+1)/2}{[pq(2p+1)/2] + pq(2q+1)/2} = \frac{2pq^2+pq}{4pq}$	$L_2 = \frac{q+0.5}{4} \quad (4)$
3. L × L	$R_3 = \frac{pq^2/2}{(pq^2/2) + q^2(q+1)/2} = \frac{pq^2}{2q^2}$	$R_3 = \frac{p}{2} \quad (5)$
	$L_3 = \frac{q^2(q+1)/2}{(pq^2/2) + q^2(q+1)/2} = \frac{q^3+q^2}{2q^2}$	$L_3 = \frac{q+1}{2} \quad (6)$

$$R_1 + L_3 = R_2 + L_2 = R_3 + L_3 = 1$$

We applied those formulas (Table 3) to family data from the literature and found that the fit is reasonably good, although not exact (*unpubl.*); a non-exact fit has also been obtained by Merrell (1957) when he applied the formulas to Rife's (1950) data on handedness. The result on hand clasping is not surprising, however, if one recall that factors such as age, sex, and ethnic group, at least, are influent on the manifestation of the trait, and that the proposed formulas do not take in account these variables. The good fit obtained between hypothesis and twin data would be explained by the fact that the differential effect of those factors among pairs of twins, specially identical twins, is trivial.

Although it is as yet unknown the exact mechanism conditioning the types of hand clasping, and although more (familial, populational, and, specially, twin) data are needed, it is our impression that heredity plays some (perhaps an important) role in the genesis of the trait, which can be useful in anthropological and human population genetic studies.

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