THE THIRD INTERDIGITAL PATTERNS ON THE PALMS OF THE GENERAL BRITISH POPULATION, MONGOLOID AND NON-MONGOLOID MENTAL DEFECTIVES.

By T. C. FANG,
Galton Laboratory, University College, London.

[Received 6 May, 1950].

INTRODUCTION.

IN the study of palm prints, a human palm is generally divided into five areas: hypothenar, thenar-first-interdigital, second, third and fourth interdigitals, in each of which various configurations can be observed. These configurations range in form from whorls, loops and vestiges to absence of patterns, i.e. plain structures, called open fields. Whorls are patterns each with two triradii, and loops each with only one triradius. Vestiges, which are local disarrangements of epidermal ridges, vary from resembling a true pattern to approaching an open field.

The area called the third interdigital is located at the distal end of the palm, between the bases of the third and fourth fingers. The configurations in this area have been described by Wilder (1930), who traced the transitions from one type of configuration to another. The bilateral asymmetries and configuration frequencies in European-American and German populations have been studied by Cummins, Leche and McClure (1931), and by Cummins and Midlo (1943), who found that third interdigital patterns occurred more often on the right hands than on left hands, and that the frequency of patterns, including vestiges, was about 40 per cent. for 300 European-Americans, and 54 per cent. for 1,281 German males. The proportion of persons showing bilateral asymmetries in this area has not been analysed.

The genetics of the third interdigital patterns in the general German population have been investigated by Weinand (1937), who concluded that the presence of pattern was controlled by a pair of recessive genes. This is not apparent from his data, for, if the presence of pattern was a fully manifesting recessive character, the matings between two bilaterals (that is, two persons with third interdigital patterns on both hands) should produce nothing but bilaterals among their offspring. This was not so. Among the offspring from this type of mating there were seven unilaterals (persons with third interdigital patterns on one hand only) and one child with an open field, in the third interdigital area, on both hands. In other words, the unitary nature of the character has not been demonstrated. Similar inconsistencies can be found in the study of the genetics of other palmar patterns. This is partly due to the fact that little statistical analysis has been used.

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

The third interdigital configurations have been studied by Cummins (1939), Workman (1939) and Snedeker (1948) in mongoloid imbeciles. The results of Workman's investigation have not been published, but they are said to agree with the findings of Cummins, who found that the frequency of the third interdigital patterns, including vestiges, in mongoloids was 89·3 per cent. for 56 right palms, and 70·2 per cent. for 47 left palms. The difference in frequency of the character between mongoloids and the general population was not regarded as significant. The results of the present investigation on the same character agree, on the whole, with those of Cummins and Snedeker. The frequency of the third interdigital patterns, including vestiges, in the mongoloids was found to be 92·7 per cent. for 410 right palms and 79·5 per cent. for 410 left palms. This was nearly twice as great as that in the control population.

The third interdigital configurations in non-mongoloid defectives have not been previously studied. It was found, in the present investigation, that the non-mongoloid defectives and the control population did not differ significantly from each other in either the morphology or the frequency of the character.

Material and Methods.

The material used in this investigation is the same as that used in the study of the *a-b* ridge count on the palm (Fang, 1949, 1950), and is kept in the Galton Laboratory. It consists of—

1. Control population—926 unrelated British individuals, 462 males and 464 females.
2. Control families—85 British families.
3. Twins—63 pairs of identical twins.
4. Mongoloid imbeciles—205 unrelated mongoloid imbeciles, 98 males and 107 females.
5. Mongoloid families—98 families in which at least one member is a mongoloid imbecile.
6. Non-mongoloid defectives—271 male and 241 female unrelated defectives.

The method used is chiefly concerned with the identification of the various types of configurations described by Cummins and Midlo (1943). Provided that the area has been clearly printed one can usually identify the type of configuration in the third interdigital area under a lens. Occasionally a puzzling situation may be met when a vestige approaches an open field or when it has a slight tendency towards a loop. This is because the variation from an open field to a loop, or some other pattern, is continuous.

Morphology.

The third interdigital area (Fig. 1) is usually bounded by the digital triradii *b* and *c*, and by the palmar main lines *B* and *C*. Since the triradius *b* is nearly always present and the main line *B* very seldom takes part in the formation of any third interdigital pattern, the type of the third interdigital configuration is thus chiefly conditioned by the presence or absence of the triradius *c* and by the course of the main line *C*.

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

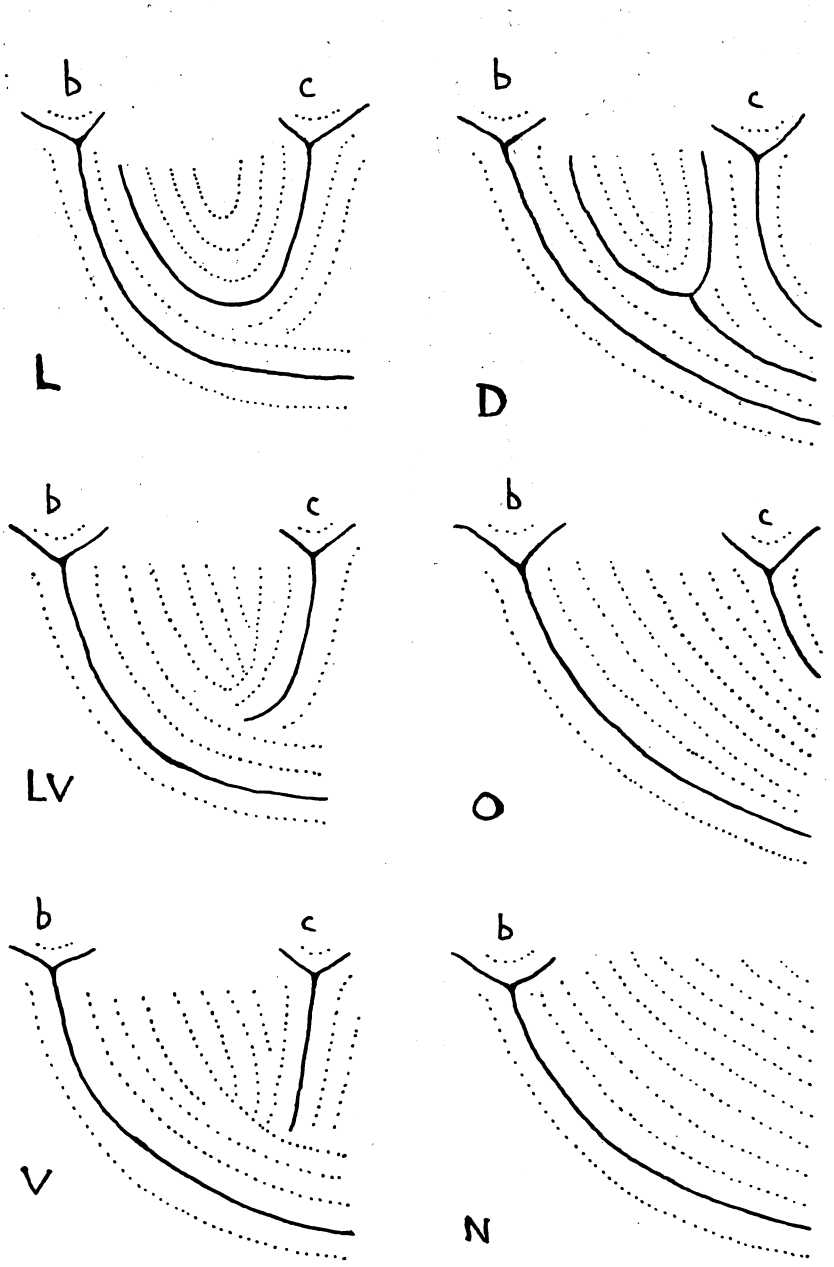


FIG. 1.—Diagram showing the types of configuration between the digital triradii *a* and *b*: heavy lines are the radiants of the triradii.

L = loop without an accessory triradius.
LV = vestige with a distinct tendency towards a loop.
V = vestige without a distinct tendency towards a loop.
O = open field.
N = absence of the triradius *c*.
D = loop with an accessary triradius.

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

When the triradius *c* is absent, the third interdigital configuration usually looks like an open field or a vestige. The frequency of absence of the triradius *c* on either hand was about 4 per cent. in the males and 7 per cent. in the females.

When the triradius *b* and *c* are very near together, as in the case of syndactyly, the third interdigital configuration is often a loop. In some cases of syndactyly where the triradii *b* and *c* fuse, the third interdigital area can be regarded as absent.

Though the main line *C* is the proximal radiant of the triradius *c*, the presence of this triradius does not necessarily imply the presence of a main line *C*. Not rarely the main line *C* is very poorly developed or abortive, in which case the third interdigital configuration usually looks like a vestige; in about half of the cases this has a tendency towards a loop.

When the main line *C* is well developed it usually terminates in one of the following regions: (i) the third interdigital area, (ii) the fourth interdigital area, or (iii) the hypothenar margin. In the first case the third interdigital configuration is a loop; in the second and third cases it is an open field, except when there is an accessory triradius.

Accessory triradii in this area occurred in less than 1 per cent. of the control population. When they are present they are accompanied by loops or small whorls. Whorls and loops with accessory triradii differ qualitatively from ordinary loops formed by the main line *B*.

To sum up, the types of configurations found in the third interdigital area, on either hand in all samples studied, are these:

Configuration.	*Symbol.*
1. Whorls	*W*
2. Loops with accessory triradii	*D*
3. Loops without accessory triradii	*L*
4. Vestiges with distinct tendency towards loops	*LV*
5. Vestiges without distinct tendency towards loops	*V*
6. Open field	*O*

The types of configurations on the right and left hands together are these:

Configuration.	*Symbol.*
1. Third interdigital patterns, *W*, *D*, *L* or *LV*, present on both hands	*Bil. or bilateral.*
2. Third interdigital pattern, *W*, *D*, *L* or *LV*, present on one hand only	*Uni. or unilateral.*
3. No pattern present on either hand, but vestiges present at least on one hand	*VO*
4. Neither pattern nor vestige in the investigated area on either hand	*OO*

Asymmetries.

The third interdigital configuration on the right hand can be the same as, or different from, that on the left hand of an individual. In other words, there are bilateral symmetries and asymmetries with respect to the character in question (Table I). Among the control population 44·4 per cent. of males and 42·2 per cent. of females showed bilateral asymmetries. Similar observations were recorded in mongoloid and non-mongoloid defectives (Table II).

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

TABLE I.—*Bimanual Distribution of the Third Interdigital Configuration in the General British Population.*

Males shown thus: 1. Females shown thus: (1).

Right hand.	Left hand. *W.*	*D.*	*L.*	*LV.*	*V.*	*O.*	Sum.
W	1	..	..	..	..	..	1
						(1)	(1)
D	..	1	2	..	1	3	7
		(1)	(1)			(2)	(4)
L	..	1	92	32	35	62	222
		(1)	(86)	(27)	(27)	(70)	(211)
LV	..	..	1	5	3	13	22
				(1)	(7)	(13)	(21)
V	..	..	1	1	8	19	29
			(3)	(1)	(6)	(18)	(28)
O	..	..	16	7	8	150	181
			(8)	(9)	(8)	(174)	(199)
Sum	1	2	112	45	55	247	462
		(2)	(98)	(38)	(48)	(278)	(464)

TABLE II.—*Percentage Frequencies of Asymmetries with regard to Third Interdigital Configurations in the Control Population, Non-mongoloid Defectives and Mongoloid Defectives.*

	Control population.	Non-mongoloid defectives.	Mongoloid defectives.
Male	44·4	47·2	48·0
Female	42·2	41·1	35·5

Assymmetries on all samples studied were characterized by the fact that complicated configurations were observed more often on right hands than on left hands. For instance, if an individual had only one third interdigital pattern, this was more often than not on the right hand. With open fields it was almost the other way round. Furthermore, third interdigital loops were generally bigger and more fully developed on right hands than on left.

FREQUENCIES.

Significant differences were observed in the frequencies of the third interdigital configurations between the control population and mongoloid defectives. This can be represented in two ways: (i) on right and left hands separately (Table III). The difference in the frequencies of loops (L) on the right hands in these two samples was + 35·6 per cent., with a standard error, 3·2 per cent.; of loops on the left hand was + 29 per cent., with a standard error, 4·3 per cent.; of open fields on the right hands was — 33·7 per cent., with a standard error, 2 per cent.; and of open fields on the left hands was — 30·2 per cent., with a standard error, 3·3 per cent. (ii) On right and left hands together

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

TABLE III.—*Comparison of Percentage Frequencies of Third Interdigital Configuration in the Control Population, Non-mongoloid and Mongoloid Defectives.*

Configuration.	Right hand. Control (926).	Right hand. Non-mongoloid (512).	Right hand. Mongoloid (205).	Left hand. Control (926).	Left hand. Non-monoloid (512).	Left hand. Mongoloid (205).
W	0·2	0·2	..	0·1	..	..
D	1·2	2	1·5	0·4	0·2	0·5
L	46·8	44·3	82·4	22·7	21·3	51·7
LV	4·6	5·1	4·4	9	6·5	10·2
V	6·2	7·8	4·4	11·1	15	16·1
O	41	40·6	7·3	51·7	57	21·5

The frequency of patterns, including vestiges, on right hands is 92·7 per cent. in mongoloids, and 59 per cent. in controls; that on left hands is 79·5 per cent. in mongoloids, and 48·3 per cent. in controls.

(Table IV). The difference in the frequencies of bilaterals between these two samples was + 34·3 per cent., with a standard error, 3·6 per cent., and of *OO*'s was — 29·2 per cent., with a standard error, 2·4 per cent.

TABLE IV.—*Comparison of Percentage Frequencies of the Bimanual Third Interdigital Configuration among Control Population, Non-mongoloid and Mongoloid Defectives.*

Bil. = Third interdigital patterns on both hands.
Uni. = ,, ,, ,, on one hand only.
VO = No third interdigital pattern on either hand, vestiges on at least one hand.
OO = Neither pattern nor vestige in third interdigital area on either hand.
LV treated as *L*.

Bimanual configuration.	Control population. Male (462).	Control population. Female (464).	Control population. Average.	Non-mongoloid defectives. Male (271).	Non-mongoloid defectives. Female (241).	Non-mongoloid defectives. Average.	Mongoloid defectives. Male (98).	Mongoloid defectives. Female (107).	Mongoloid defectives. Average.
Bil.	29·2	25·2	27·2	25·1	23·2	24·2	56·1	66·4	61·5
Uni.	30·7	30·4	30·6	35·4	26·1	31	31·6	24·3	27·8
VO	7·6	6·9	7·2	6·6	12·5	9·4	7·2	2·8	4·9
OO	32·5	37·5	35	32·9	38·2	35·4	5·1	6·5	5·8

No significant differences were observed in the configuration frequencies in the control population and non-mongoloid defectives.

INHERITANCE.

The heritability of the third interdigital configurations was shown by the estimated correlation coefficients between relatives. The father–child correlation coefficient was 0·32, mother–child 0·26, total parent–child 0·43, sib–sib 0·27, and identical twins 0·78 (Table V).

The regression line of the character in offspring on that in total parents was calculated. Deviation from linearity was found to have a probability not far from 0·2. This indicates that there is probably no recessivity in the character.

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

TABLE V.—*Correlations of the Third Interdigital Configurations between Relatives in the Control Families.*

(The correlations were calculated by assigning numerical values to various phenotypes.)

Type of pair.	Number of pairs.	r ± s.e.
Father–child	182	0·32 ± 0·07
Mother–child	182	0·26 ± 0·07
Total parent–child	182	0·43 ± 0·06
Sib–sib	361	0·27 ± 0·05
Identical twins	63	0·78

Attempts were made to analyse the mode of inheritance. It was found that the present collection of pedigrees, in the control and mongoloid families, was not sufficient for this study. Any further genetic studies on this character have to take the following two points into consideration: First, since the character is susceptible to environmental changes (as the correlation coefficient in identical twins has shown), phenocopies are probably present. Secondly, since the variation from an open field to a pattern is continuous, the classification of some types of configuration is frequently arbitrary.

MONGOLISM AND THIRD INTERDIGITAL PATTERNS.

The frequency of persons with at least a third interdigital pattern (*W*, *D*, *L* or *LV*) on one hand was about 89 per cent. in the mongoloid defectives, and 52 per cent. in the control population. A test for homogeneity, by a $2 \times n$ table, among members of mongoloid families, revealed the following facts (Table VI).

TABLE VI.—*Comparison of the Frequencies of the Bimanual Third Interdigital Configurations in the Control Population and Members of Mongoloid Families.*

Configuration.	Control population.		Mongoloid families.							
			Parents.		Offspring.					
					Mongoloid.		Non-mongoloid.		Total.	
	No.	%.	No.	%.	No.	%.	No.	%.	No.	%.
Bil.	252	27·2	63	32·1	55	55	48	34·8	103	43·3
Uni.	283	30·6	57	29·1	29	29	36	26·1	65	27·3
VO	67	7·2	22	11·2	9	9	10	7·3	19	8
OO	324	35	54	27·6	7	7	44	31·9	51	21·4
Total	926	100	196	100	100	100	138	100	238	100

Test of homogeneity by a $2 \times n$ table, number of degrees of freedom = 3.

1. Between parents of mongoloids and control population: $\chi^2 = 4·59$.
2. " " " and total offspring: $\chi^2 = 6·46$.
3. " " " and mongoloid offspring: $\chi^2 = 22·34$.
4. " " " and non-mongoloid offspring: $\chi^2 = 2·29$.

1. The mongoloid offspring deviated significantly from their parents, but the non-mongoloid offspring did not do so.

2. The parents and non-mongoloid offspring did not differ significantly from the control population.

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press

3. A consistent decrease in the frequency of *OO*'s from the control population to parents of mongoloids and to mongoloids was observed.

4. As matings between two *OO*'s in the mongoloid families have produced four bilateral offspring, all of whom are mongoloids, this indicates that the conditions favouring the formation of mongolism also favour the development of third interdigital patterns.

Summary.

1. The variation of the third interdigital configuration was found to be continuous, though the intermediates were few.

2. Bilateral asymmetries were conspicuous in the area investigated, and more pronounced in males than in females.

3. Heritability of the third interdigital patterns was shown, but no recessivity in the character was demonstrated. The variation of the character could not be explained by any simple genetic hypothesis.

4. The mongoloid defectives did not differ significantly from the control population in the morphology of the patterns, but did so in the frequency of the character.

5. The parents of mongoloids did not differ significantly from the control population in the frequencies of the character, though they tended to have fewer *OO*'s and more bilaterals than the controls. This tendency was accentuated in mongoloid offspring.

6. The total offspring, including mongoloids, did not deviate significantly from their parents, though the mongoloid offspring did so from their sibs and parents.

7. No significant differences were found in the control population and non-mongoloid defectives with regard to the morphology, asymmetries and frequency of the character in question.

Acknowledgments.

The writer is gratefully indebted to Professor L. S. Penrose for suggestions and criticism.

References.

Cummins, H. (1939), "Dermatoglyphic Stigmata in Mongoloid Imbeciles," *Anat. Rec.*, **73**, 407.

Idem, Leche, S., and McClure, K. (1931), "Bimanual Variation in Palmar Dermatoglyphics," *Am. J. Anat.*, **48**, 199.

Idem and Midlo, C. (1943), *Finger Prints, Palms and Soles.* Philadelphia: Blackiston & Co.

Fang, T. C. (1949), "A Comparative Study of the *a-b* Ridge count on the Palms of Mental Defectives and the General Population," *J. Ment. Sci.*, **95**, 945.

Idem (1950), "The Inheritance of the *a-b* Ridge Count on the Human Palm, with a Note on its Relation to Mongolism (unpublished—Ph.D. thesis).

Snedeker, D. M. (1948), "A Study of the Palmar Dermatoglyphies of Mongoloid Imbeciles," *Human Biology*, **20**, 146.

Workman, G. (1939), "A Study of the Palmar Dermatoglyphies of Mongoloid Idiots." (Thesis, University of Toronto).

Weinand, H. (1937), "Familienuntersuchungen über den Hautleistenverlauf der Handfläche," *Zts. Morphol. Anthropol.*, **36**, 418.

Wilder, I. W. (1930), "The Morphology of the Palmar Digital Triradii and Main Lines," *J. Morphol.*, **49**, 153.

https://doi.org/10.1192/bjp.96.404.780 Published online by Cambridge University Press