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Inheritance of Dermatoglyphic Formulae

I. Ulnar loops in complete or partial symmetrical formulae

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In a previous work (Lázaro *et al.*, 1963) we have found that the observed frequency of the ten most common formulae for the population of Montevideo departs significantly from the calculated one, based on the independent incidence of the four main patterns four fingers (ulnar and radial loops, whorl and arch) (Kolski, Scazzocchio, 1961). So we concluded that complete formulae or certain combinations of patterns (partial formulae) should be considered as unities of inheritance.

In this paper we seek an explanation to the way in which some partial formulae seem to be inherited.

Material and methods

For that purpose we studied 200 families taken at random from the population of Montevideo, with a total number of 323 children.

We decided to study the incidence of all the possible combinations of ulnar loops in symmetrical forms. Other pattern combinations will be studied in further stages of our work.

The families were recorded on punched cards, and worked out by means of a 075 IBM sorter machine. The observed frequencies were compared with those found in a randomized sample taken from our population, made up of 2122 individuals, and with a theoretical frequency based on the combined chances of patterns. We then studied the incidence of formulae and single patterns per finger in the offspring of the families that were arranged according to the presence of the formula or pattern in none, one or both parents. The χ^2 method was used for all our comparisons.

Results and discussion

Tab. 1 shows the results of a first comparison of all possible symmetrical formulae with the frequency of the same found in our population sample.

According to these results, the frequency of some formulae in the offspring, when

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Tab. 1. Observed frequencies of all possible symmetrical formulae in the offspring of arranged families, compared with their frequency in the population

Formulae	Parents with formula	Total no. of children	Children with formula	Popul. freq. (%)	χ^2 (*)	P
U....	both	63	41		16.27	$P<0.01$
U....	one	146	60		0.03	$0.99<P<0.98$
	none	114	31	40.29	8.19	$P<0.01$
.U...	both	10	1		0.52	$0.30<P<0.50$
.U...	one	89	20		0.55	$0.30<P<0.50$
	none	224	31	19.41	4.39	$0.02<P<0.05$
..U..	both	103	73		8.87	$P<0.01$
..U..	one	179	88		3.71	$0.10<P<0.05$
	none	41	16	56.31	4.85	$0.05<P<0.02$
...U.	both	36	25		15.35	$P<0.01$
...U.	one	158	67		1.12	$0.30<P<0.20$
	none	129	33	37.94	8.42	$P<0.01$
....U	both	159	129		4.65	$0.05<P<0.02$
....U	one	137	89		5.33	$0.05<P<0.02$
	none	27	8	73.66	26.36	$P<0.01$
UU...	both	5				
UU...	one	48	4		0.07	$0.80<P<0.70$
	none	270	26	10.69	0.30	$0.70<P<0.50$
U.U..	both	25	13		8.08	$P<0.01$
U.U..	one	140	38		0.008	$0.95<P<0.90$
	none	158	32	26.82	3.41	$0.10<P<0.05$
U..U.	both	12	6		6.08	$0.02<P<0.01$
U..U.	one	103	29		3.39	$0.10<P<0.05$
	none	208	34	20.78	2.66	$0.20<P<0.10$
U...U	both	39	22		10.09	$P<0.01$
U...U	one	135	46		0.10	$0.80<P<0.70$
	none	149	39	32.79	2.91	$0.10<P<0.05$
.UU..	both	6				
.UU..	one	78	17		2.12	$0.20<P<0.10$
	none	239	30	15.78	1.86	$0.20<P<0.10$
.U.U.	both	1				
.U.U.	one	57	8		1.38	$0.30<P<0.20$
	none	265	20	9.75	1.22	$0.30<P<0.20$
.U..U	both	5				
.U..U	one	77	12		0.01	$0.95<P<0.90$
	none	241	29	16.21	3.05	$0.10<P<0.05$
..UU.	both	23	13		11.04	$P<0.01$
..UU.	one	130	37		0.26	$0.70<P<0.50$
	none	170	39	26.48	1.08	$0.30<P<0.20$
..U.U	both	60	35		3.28	$0.10<P<0.05$
..U.U	one	176	77		0.70	$0.50<P<0.30$
	none	87	28	46.94	7.55	$P<0.01$
...UU	both	32	20		10.34	$P<0.01$
...UU	one	157	68		4.27	$0.05<P<0.02$
	none	134	134	35.44	5.53	$0.02<P<0.01$

* When the number of the observed individuals in any class was five or less, the Yates' correction was applied.

Tab. 1

Formulae	Parents with formula	Total no. of children	Children with formula	Popul. freq. (%)	χ^2	P
UUU..	both	1				
UUU..	one	52	6		0.46	0.50<P<0.30
	none	269	19	8.90	1.14	0.30<P<0.20
UU.U.	both	1				
UU.U.	one	39	2		0.000	P<0.99
	none	283	15	6.50	0.66	0.50 P 0.30
UU..U	both	3				
UU..U	one	51	3		0.66	0.70<P<0.50
	none	269	18	9.66	2.72	0.10<P<0.05
U.UU.	both	8				
U.UU.	one	88	18		1.68	0.20<P<0.10
	none	227	31	15.46	0.54	0.50<P<0.30
U.U.U.	both	22	7		0.71	0.50<P<0.30
U.U.U.	one	114	30		0.37	0.70<P<0.50
	none	187	36	24.41	6.00	0.02<P<0.01
U..UU	both	12	6		6.09	0.02<P<0.01
U..UU	one	102	28		4.45	0.05<P<0.02
	none	209	33	19.27	1.58	0.30<P<0.20
.UUU.	both	1				
.UUU.	one	50	7		2.23	0.20<P<0.10
	none	272	22	8.25	0.007	0.95<P<0.90
.UU.U	both	4				
.UU.U	one	59	8		0.005	0.95<P<0.90
	none	260	31	13.33	0.29	0.70<P<0.50
.U.UU	both	1				
.U.UU	one	52	7		1.10	0.30<P<0.20
	none	270	20	9.28	1.10	0.30<P<0.20
..UUU	both	19	11		10.70	P<0.01
..UUU	one	130	34		0.04	0.90<P<0.80
	none	174	43	25.30	0.02	0.90<P<0.80
UUUU.	both	1				
UUUU.	one	36	2		0.000	P<0.99
	none	286	14	5.27	0.06	0.95<P<0.90
UUU.U	both	2				
UUU.U	one	46	3		0.01	0.95<P<0.90
	none	275	18	8.15	0.93	0.50<P<0.30
UU.UU	both	1				
UU.UU	one	34	1		0.17	0.70<P<0.50
	none	288	15	6.31	0.56	0.50<P<0.30
U.UUU	both	8				
U.UUU	one	86	18		2.70	0.20<P<0.10
	none	229	29	14.75	0.76	0.50<P<0.30
.UUUU	both	1				
.UUUU	one	45	6		1.74	0.20<P<0.10
	none	277	22	8.15	0.01	0.95<P<0.90
UUUUU	both	1				
UUUUU	one	34	2		0.000	P<0.99
	none	288	14	5.27	0.08	0.80<P<0.70

both parents or none have it, departs significantly from the expected values. These formulae are:

...U. and U....
...U. U....

Very similar results were obtained with the formulae:

....U ..U.. and ...UU
....U ..U.. ...UU

Using the same methodology, we tried to find out to what extent ulnar loop seems to be inherited independently as a pattern. We can see that in most cases the incidence of the pattern is significantly higher in the offspring when both parents have it, and significantly smaller when none have it (Tab. 2).

Tab. 2. Observed frequencies of single patterns in the offspring of arranged families compared with their frequency in the population

Finger	Parents with formula	Total no. of children	Children with formula	Popul. freq. (%)	χ^2	P
Right thumb	both	95	63	50.14	9.48	P<0.01
	one	150	75		0.001	0.98<P<0.95
	none	78	23		13.29	P<0.01
Left thumb	both	98	70	52.46	14.15	P<0.01
	one	157	85		0.17	0.70<P<0.50
	none	68	32		0.68	P<0.01
Right index	both	31	13	36.11	0.44	0.70<P<0.50
	one	152	44		3.58	0.10<P<0.05
	none	140	37		5.63	0.02<P<0.01
Left index	both	56	31	34.43	10.81	P<0.01
	one	138	49		0.07	0.80<P<0.70
	none	129	22		17.23	P<0.01
Right medium	both	166	130	70.84	4.47	0.05<P<0.02
	one	139	85		6.35	0.02<P<0.01
	none	18	7		8.68	P<0.01
Left medium	both	157	111	66.02	1.55	0.30<P<0.20
	one	145	83		4.95	0.02<P<0.01
	none	21	10		3.23	0.10<P<0.05
Right ring-finger	both	54	33	45.85	5.13	0.02<P<0.01
	one	164	83		1.49	0.30<P<0.20
	none	105	32		9.93	P<0.01
Left ring-finger	both	94	73	55.53	18.64	P<0.01
	one	171	87		1.47	0.30<P<0.20
	none	58	19		12.35	P<0.01
Right little finger	both	200	169	80.23	2.32	0.20<P<0.10
	one	104	73		6.54	0.02<P<0.01
	none	19	6		27.83	0.02<P<0.01
Left little finger	both	195	167	83.30	0.78	0.50<P<0.30
	one	110	78		12.06	P<0.01
	none	18	11		5.92	0.02<P<0.01

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Finally a calculated frequency for each of the five formulae, based on the incidence of the pattern per finger, was established. We compared them with their frequency observed in our population sample (Tab. 3). Here again the findings of our previous paper (Lázaro *et al.*, 1963) are repeated: the incidence of the partial formulae is always larger than the estimate.

Tab. 3. Partial formulae calculated on the basis of the frequency of the patterns per finger, and the observed incidence of such in our formulae population sample

Formulae	Calculated frequency	Observed frequency
...U ...U	67%	74%
..U.. ..U..	47%	56%
U.... U....	26%	40%
...U. ...U.	25%	38%
...UU ...UU	17%	35%

Several authors have studied the inheritance of patterns per fingers in different ways (Becker, 1954, 1960; Elderton, 1920; Grüneberg, 1928; Müller, 1930; Walker, 1941). We have seen that patterns, particularly ulnar loops and whorls, are inherited possibly as a polygenic system, since the greater the number of patterns in the parents, the greater their number in the offspring (Lázaro *et al.*, 1961). A similar hypothesis was suggested by several authors (Kramp, 1954; Lamy *et al.*, 1957; Rife, 1953). That conclusion is strengthened by the results that appear in Tab. 2.

Now we see that some partial formulae seem to be dependent on a genetic mechanism. They also appear to be inherited in a higher degree than the theoretical expectancy of the combined chances of the patterns they are made up of.

Therefore we conclude that, to a basic influence of factors determining the inheritance of independent patterns, a second force or influence resulting from the meeting of some patterns, is added, to give a more remarkable genetic effect, perhaps a polygenic one.

On the other hand, we have seen recently that a similar hypothesis has been suggested to explain ethnic differences between two populations of Jews and Ethiopians (Bat-Miriam, 1961).

Summary

The results are presented of a study of ulnar loops in complete or partial symmetrical formulae, in all possible combinations, in a sample of 200 families taken at random in the population of Montevideo.

Some partial formulae not only appear in a significantly higher proportion when both parents have them, and in a smaller amount when they lack them, but also seem to be inherited in a higher degree than the theoretical expectancy of the combined chances of the patterns they are made up of.

The authors' conclusions is that there seems to be a basic influence of factors determining the inheritance of independent patterns, plus a second one, resulting from the meeting of some patterns to give a more remarkable genetic effect for the inheritance of partial formulae.

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RIASSUNTO

Vengono presentati i risultati di uno studio di anse ulnari in formule simmetriche parziali o totali, in tutte le combinazioni possibili, effettuato su un campione di 200 famiglie prese a caso nella popolazione di Montevideo. Alcune delle formule parziali non solo si trovano in una proporzione significativamente più alta quando sono presenti e più bassa quando sono assenti in ambedue i genitori, ma sembrano ereditate in misura maggiore di quanto ci si attenderebbe dalla combinazione delle probabilità delle figure di cui esse si compongono. Secondo gli Autori, vi sarebbero un'influenza primaria di fattori che determinano la trasmissione delle figure indipendenti, ed una seconda influenza, risultante dall'incontro di più figure, e comportante un maggiore effetto genetico per la trasmissione di formule parziali.

RÉSUMÉ

Les Auteurs présentent les résultats d'une étude de boucles ulnaires en formules symétriques partielles ou totales, dans toutes les combinaisons possibles, effectuée chez un échantillon de 200 familles choisies au hasard dans la population de Montevideo. Quelques formules partielles non seulement se trouvent dans une proportion significativement plus élevée quand elles sont présentes et moins élevée quand elles sont absentes chez les deux parents, mais aussi bien semblent elles être héritées à un degré plus élevé de ce qu'on pourrait attendre par la combinaison des probabilités des figures dont elles se composent. D'après les Auteurs, il existerait une influence primaire de facteurs déterminant la transmission des figures indépendantes, ainsi qu'une deuxième influence, résultant de la combinaison de plusieurs figures, qui produit un effet génétique plus remarquable pour la transmission de certaines formules partielles.

ZUSAMMENFASSUNG

Bei einer auslesefreien Serie von 200 Familien in Montevideo wurden die Ellenschleifen in allen möglichen Kombinierungen, in teilweise oder völlig symmetrischen Formeln untersucht. Es ergab sich daraus, dass einige der partiellen Formeln nicht nur wesentlich häufiger vorkamen, wenn auch beide Eltern sie haben und weniger häufig, wenn keiner der Eltern sie hat, sondern auch, dass sie scheinbar in höherem Masse vererbt werden als auf Grund der Kombinierungsmöglichkeiten der Figuren, aus denen sie gebildet werden, zu erwarten wäre. Den Schlussfolgerungen der Verf. gemäss scheint es, dass dabei zwei Faktoren mitspielen: primär der Einfluss von Faktoren, die die Übertragung der unabhängigen Figuren auslösen; sekundär der Einfluss, den das Treffen mehrerer Figuren ausübt und welcher für die Übertragung der partiellen Formeln von höherer genetischer Wirkung ist.