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Diversity and asymmetry of finger ridge-counts in a sample of the Belgian population

by

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1. Introduction

As the study of finger ridge-counts is progressing, it becomes more and more obvious that the total ridge-count gives a very rough idea of the digital ridge-count variability. So that the values on separate fingers were used in an attempt to express some general aspects like the degree of diversity between fingers and the asymmetry between both hands.

Various indices have been devised to study diversity (HOLT, 1958) and asymmetry (HOLT, 1954 ; PARSONS, 1964 ; SINGH, 1968). We chose :

a) for diversity, the expression formulated by JANTZ (1976, p. 216) :

$$S \,/\, \sqrt{5} = \sqrt{\left(\sum_{i=1}^{5} q_i^2 - \frac{Q^2}{5}\right) / 5} \quad \text{where}$$

Q is the total ridge-count
q_i is the sum of the ridge-counts on homologous digits, the summing being supposed to eliminate the effects of asymmetry.

b) for asymmetry, the modification (JANTZ, 1975) of the relation established by Singh :

$$\sqrt{A^2} = \sqrt{\sum_{i=1}^{5} (R_i - L_i)^2}$$

which is said to be more symmetrically distributed.

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2. Indices values for the Belgian samples

From samples of Belgians (202 ♂ and 158 ♀) already used for a first analysis of the interdigital variability of ridge-counts (VRYDAGH and LEGUEBE, 1976 and 1977), we obtained the values indicated in table 1 (the differences with the values published previously are due to giving up some decimals in the first calculations).

2.1. *Sexual differences*

Diversity and asymmetry are higher in males than in females of our sample, as it is in the two White populations studied by Jantz, but none of the sexual differences is significant (t between .2 and 1.8). The standard deviations of all three variables for our samples are near equal to those tabulated by Jantz.

2.2. *Relation between diversity and asymmetry indices*

Considering now the relation between diversity and asymmetry indices of the different subjects, we obtain correlation coefficients amounting to:

r = .256** (.127 to .386 at .05 level) for males
r = .211* (.072 to .370 at .05 level) for females.

The sexual differences are significant ($t = 3.46$; $P < .01$) and those correlations are nearly the same as those quoted by JANTZ (1975, p. 218). Thus introducing the sum of the values of homologous digits of each subject in the calculation of the diversity index does not render it independant from the asymmetry index (JANTZ, 1975, p. 218).

2.3. *Relations of indices with total ridge-count*

The relations between each index and the total ridge-count should likewise be investigated. For our samples, correlation coefficients amount to:

	males	females
TRC / diversity	- .247 (- .117 to - .377)	- .264 (- .118 to - .410)
TRC / asymmetry	- .116 (+ .018 to - .251)	- .111 (+ .043 to - .265)

Sexual differences are non-significant (t = 1.72 and .45).

The correlation between total ridge-count and diversity is negative, the same as Holt observed for S^2 (1958) and JANTZ (1975) for $S / \sqrt{5}$ in 11 out of 14 samples: for male Eastern Islanders and male and female Pygmies the correlations are positive. The values obtained for Belgians are very similar to those of American Whites and of English males. Sexual differences are non-significant, as well in Jantz's samples as in ours but, contrary to our results, all of Jantz's female samples except Pygmies present higher correlations than males.

Considering now the coefficients of correlation between total ridge-count and asymmetry of the subjects of our samples, they are negative and smaller than those for the diversity index, the same as for the majority of the populations studied by Jantz. Using as a measure of asymmetry the difference between the sums of ridge-counts on right and left hand, HOLT (1954) found no correlation with total ridge-count (r = -.02).

Sexual differences are non-significant as those of other samples except Eastern Islanders and Pygmies. Our values are approaching those for the English and somewhat less than these for American Whites.

3. Between-populations analysis of diversity and asymmetry

3.1. *Comparison of the mean individual values of indices $S / \sqrt{5}$ and $\sqrt{A^2}$ in different populations.*

By comparison with the results given by JANTZ (1975, table 1):

a) total ridge-count: for the men, our value is in agreement with those of other White populations but for the women, it is rather small.

b) diversity: our samples provided high values of the index, males being second among 8 populations and females first among 8 populations.

c) asymmetry: our values rank amid the highest, males first and females third among 8 populations.

TABLE 1

Total ridge-count, diversity and asymmetry of Belgian samples

	N	Total ridge-count		Diversity		Asymmetry	
		mean	st.dev.	mean	st.dev.	mean	st.dev.
Males	202	138.51	47.67	7.54	3.34	9.30	3.93
Females	158	119.27	50.53	7.20	3.21	8.74	3.65

It is noteworthy however that TYAGI and MASALDAN (1975) obtained 3 values higher than ours for two samples of men and one of females of Khattri from Uttar Pradesh: respectively 11.15 and 10.24 for men and 9.56 for females (computed from the values of Singh's asymmetry index, 1968).

JANTZ (1975, fig. 1) points out that, on populations comparison level, the means of the diversity and asymmetry indices are tightly related. It is also the case for our samples which are situated on that diagram just between the English and the American Whites. So that, according to the scheme we follow, the populations which present the highest diversity are also those having the most pronounced asymmetry, even though, among individuals belonging to the same populations, the two indices are by far not so much correlated. In actual fact, the same ranking of the populations results thus from the use of each index and it is highly questionable that those indices define precisely and independently the range of diversity and of asymmetry.

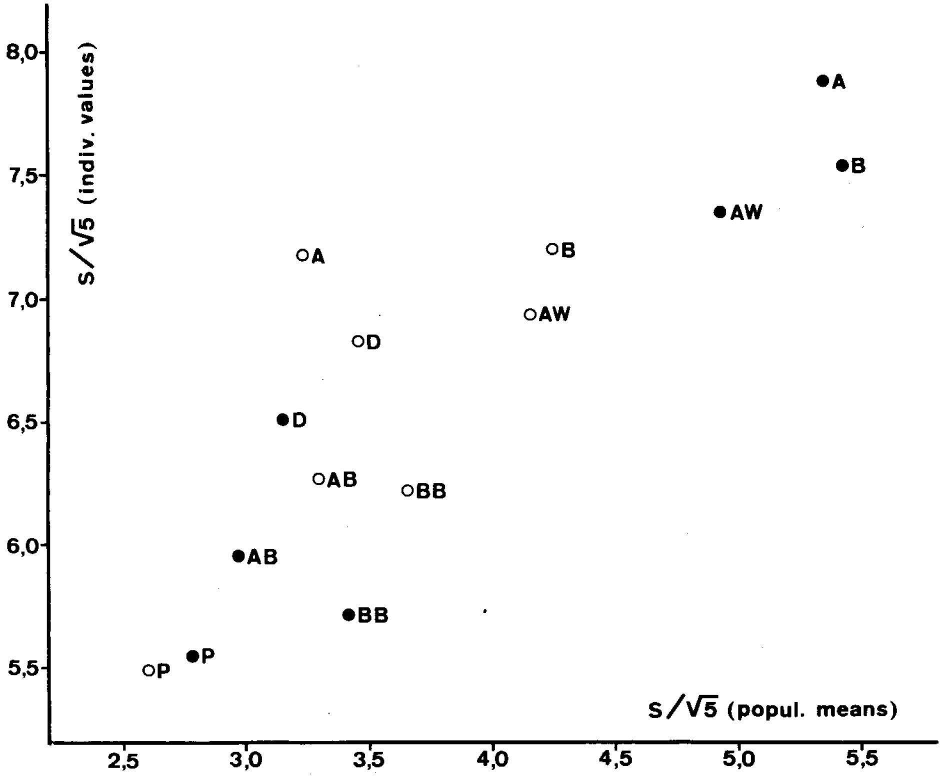

FIGURE 1. — Bivariate plot showing the relationship between index of diversity calculated from individual values and from population means.

● = Males O = Females

A = English AB = American Black AW = American White

B = Belgian BB = Bedik-Bassari D = Dogon P = Pygmy

3.2. *Population means indices*

TALBOT and MULHALL (1951, appendix II) demonstrated in the case of the cephalic index, that the more simple procedure using the ratio of the two means gives a "slightly better estimate of the true value" than the computation and averaging of the individual indices preferred by many anthropologists.

That conclusion is not necessarily valid for every ratio or for every index (WEBER, 1951). However when we calculate the indices of diversity and asymmetry from the population means, the obtained results are different by their values but they are highly correlated with the means obtained from individual indices (fig. 1 and 2). There is no reason to think that one index is a better measure of diversity or asymmetry than the other.

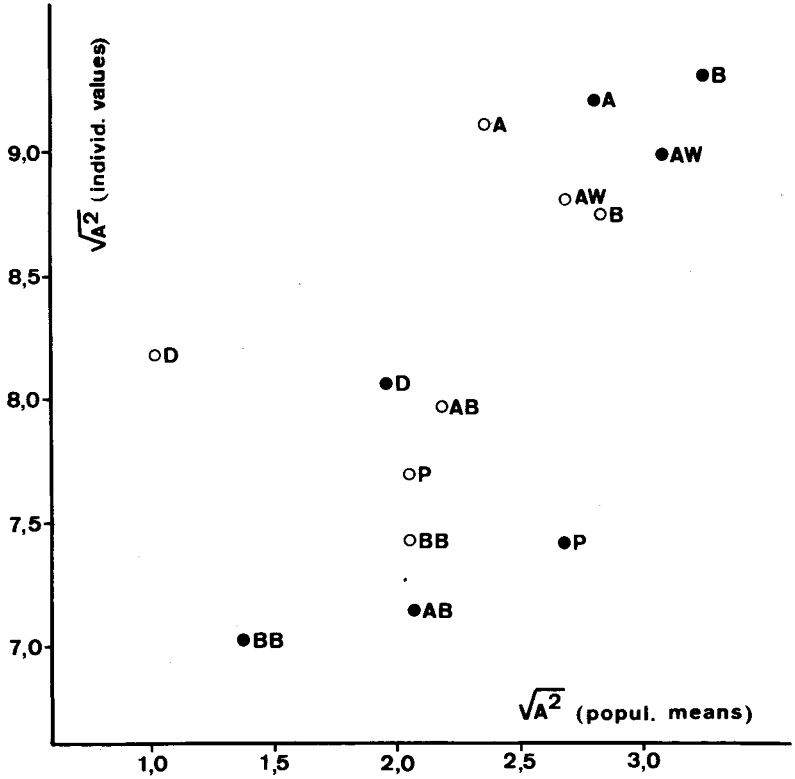

FIGURE 2. — Bivariate plot showing the relationship between index of asymmetry calculated from individual values and from population means.

3.3. *Difference of ridge-counts of the thumbs*

Many authors used as a measure of asymmetry the difference between the ridge-count of right and left hands (ROSTRON and MITTWOCH, 1977). We showed recently (VRYDAGH and LEGUEBE, 1977) that the ridge-counts of the thumb have the most important weight in the description of some aspects of diversity. So we used, as a measure of asymmetry, the difference between the ridge-counts of the right thumb and the left thumb. As is evident from figure 3, that difference is highly correlated with the asymmetry index $\sqrt{A^2}$.

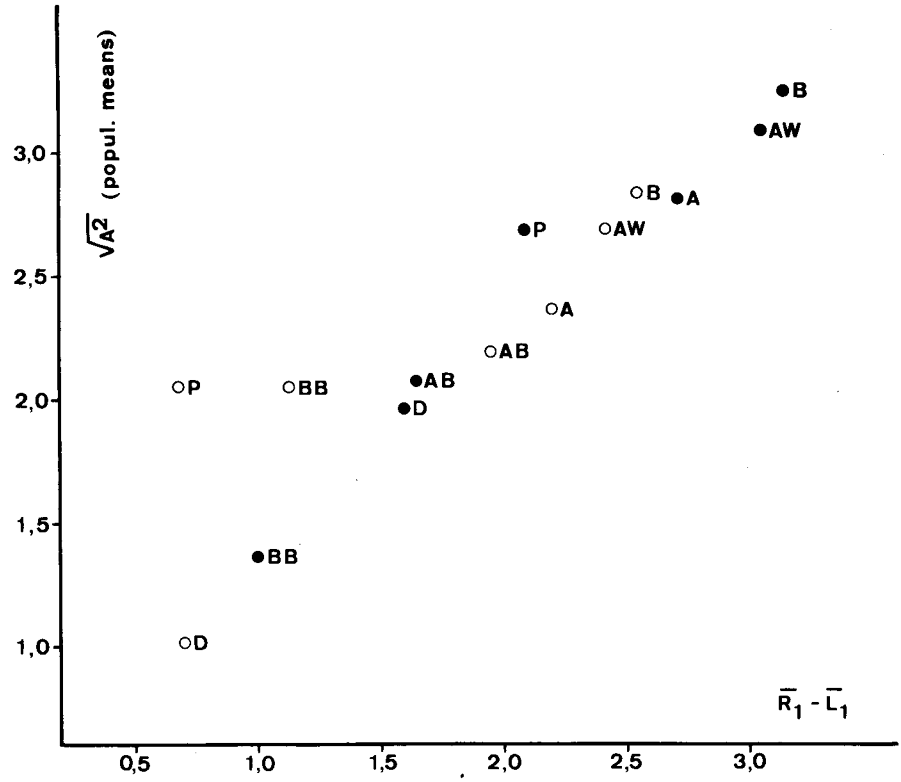

FIGURE 3. — Bivariate plot showing the relationship between index of asymmetry computed from population means and the difference between the means of the left and right thumbs ridge-counts.

4. Conclusion

The calculation of indices combining variables without taking their correlations into account is open to criticism. In the case of ridge-counts, one knows that the correlations between different fingers are peculiarly high. Eventually, the nature of the scale established cannot be stated precisely. Two individuals could have exactly the same index calculated from quite different individual values.

With regard to statistics, the digital ridge-counts present the drawback of not being normally distributed as is shown by the histograms previously published (HOLT, 1949, 1958 ; DA CUNHA and ABREU, 1954) and as is confirmed by the values of skewness and kurtosis of our distributions (table 2, VRYDAGH and LEGUEBE, 1976). Many are reaching the levels of significance drawn out of PEARSON and HARTLEY (1956) and reported in table 3.

However, despite their transformations, diversity and asymmetry indices maintain very high deviations from normality (table 4 and JANTZ, 1975). So that the results

TABLE 2

Skewness and kurtosis of the distributions of finger ridge-counts

202 males				
Finger	Right hand		Left hand	
	Skewness	Kurtosis	Skewness	Kurtosis
I	-0.488^{xx}	-0.001	-0.724^{xx}	0.724^{x}
II	0.073	-1.117^{xx}	0.238	-0.389
III	-0.309^{x}	-0.655^{xx}	-0.295^{x}	-0.255
IV	-0.537^{xx}	-0.373	-0.522^{xx}	0.237
V	-0.457^{xx}	-0.572^{x}	-0.361^{x}	-0.304
I - V	-0.324^{x}	-0.349	-0.233	-0.007
Total	Skewness: -0.307^{x}		Kurtosis: -0.205	
158 females				
Finger	Right hand		Left hand	
	Skewness	Kurtosis	Skewness	Kurtosis
I	-0.625^{xx}	0.080	-0.582^{xx}	-0.296
II	0.105	-0.948^{xx}	0.308^{x}	-0.896^{xx}
III	-0.042	-0.613^{x}	-0.153	-1.011^{xx}
IV	-0.365^{x}	-0.450	-0.357^{x}	-0.745^{xx}
V	-0.040	-0.898^{xx}	-0.073	-0.806^{xx}
I - V	-0.028	-0.579^{x}	0.165	-0.422
Total	Skewness: 0.008		Kurtosis: -0.776^{xx}	

of tests valid for normal distributions lead to highly doubtful interpretations when applied to those indices.

Other statistical methods are more suitable to the study of the diversity and asymmetry of finger ridge-counts ; their investigation will be the subject of another paper.

TABLE 3

Percentage points of the distribution of $\sqrt{b_1}$ and of b_2

Skewness			Kurtosis		
>0 : left clustered <0 : right clustered			>0 : peaked <0 : flat		
Prob.	202 ♂	158 ♀	Prob.	202 ♂	158 ♀
0.01	0.403	0.464	0.01	0.98	1.13
0.05	0.280	0.321	0.05	0.57	0.65
			0.05	-0.51	-0.55
st.dev.	0.171	0.196	0.01	-0.63	-0.71

TABLE 4

Skewness and kurtosis of the diversity and asymmetry indices

	Diversity index		Asymmetry index	
	Skewness	Kurtosis	Skewness	Kurtosis
males	0.480^{xx}	-0.447	0.835^{xx}	1.020^{xx}
females	0.323^{x}	-0.521^{x}	0.791^{xx}	0.944^{xx}

BIBLIOGRAPHY

DA CUNHA, A. X. and M. D. A. ABREU.
1954 Impressoes digitais de Portugueses.
Contr. Est. Antrop. portug., **5**: 315-347.

HOLT, S. B.
1949 A quantitative survey of the finger-prints of a small sample of the British population.
Ann. Eugen., **14** (4): 329-338.
1954 Genetics of dermal ridges: bilateral asymmetry in finger ridge-counts.
Ann. Eugen., **18** (3): 211-231.
1958 Genetics of dermal ridges: the relation between total ridge-count and the variability of counts from finger to finger.
Ann. hum. Genet., London, **22** (4): 323-339.

JANTZ, R. L.
1974 Finger ridge-counts and inter-finger variability in Negroes and Whites.
Hum. Biol., **46** (4): 663-675.
1975 Population variation in asymmetry and diversity from finger to finger for digital ridge-counts.
Am. J. phys. Anthrop., **42** (2): 215-224.
1976a The relation between total finger ridge-count and variability of counts from finger to finger: genetic implications of racial variation.
Ann. hum. Genet., London, **40** (2): 221-224.
1976b Multivariate analysis of dermatoglyphic variation in man.
Yearb. phys. Anthrop., **18**: 121-139.

PARSONS, P. A.
1964 Finger-print pattern variability.
Acta genet., Basel, **14** (3/4): 201-211.

PEARSON, E. S. and H. O. HARTLEY (Edit.).
1966 *Biometrika tables for statisticians.*
Cambridge Univ. Press, 1, 238 p.

ROSTRON, J. and U. MITTWOCH.
1977 Sex and lateral asymmetry of the finger ridge-count.
Ann. hum. Biol., **4** (4): 375-377.

SINGH, S.
1968 A measure of asymmetry of finger ridge counts.
Acta genet., Basel, **18** (6): 599-605.

TALBOT, P. A. and H. MULHALL.
1962 *The physical anthropology of southern Nigeria.*
Cambridge Univ. Press, 127 p.

TYAGI, D. and K. MASALDAN.
1975 Asymmetry in finger ridge counts.
Archeol. phys. Anthrop. in Oceania, **10** (1): 73-76.

VRYDAGH, S. and A. LEGUEBE.
1976 Variabilité des nombres de crêtes par doigt chez des sujets belges.
Bull. Mém. Soc. Anthrop. Paris, 13ᵉ sér., **3** (2): 91-104.

1977 Analyse multivariée d'empreintes digitales de sujets belges.
Mitt. anthrop. Ges. Wien, **107** : 254-258.

WEBER, A. A.
1951 Efficacité de l'indice crânien et de l'indice nasal comparée à l'analyse discriminante.
Acta genet. Stat. med., **2** (4) : 351-363.

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