

**Anatomy.** — *The digital formula in relation to age, sex and constitutional type.* I. By J. HUIZINGA. (Communicated by Prof. M. W. WOERDEMAN.)

(Communicated at the meeting of March 26, 1949.)

### I. *Introduction.*

If we ask various persons to lay the pronated hand on a flat surface in such a way that the longitudinal axis of the hand is a prolongation of that of the forearm we shall find that:

1. The third finger ends the most distally.
2. The first finger ends the least distally.
3. The fifth finger follows the first in this respect.
4. Sometimes the second finger ends more distally than the fourth, sometimes the converse is true and sometimes these fingers are equal in length.

We may represent a given case as follows:

$$\text{III} > \text{IV} > \text{II} > \text{V} > \text{I}$$

This WOOD JONES (1944) terms the 'digital formula'.

If we confine ourselves to man, we find that the interindividual difference in digital formula consists in the varying relation between the fingers II and IV.

Although it is far from our intention to recommend memoirs such as those of CASANOVA as a source of scientific information, we feel justified in quoting CASANOVA's description of his conversation with the painter RAFAEL MENGES by way of introduction to our problem, the more so as it is our experience that the same dispute about the digital formula can be provoked in any group of people at the present day.

CASANOVA writes as follows (1871):

"Je me souviens qu'un jour je pris la liberté de lui faire observer, en voyant un de ses tableaux, que la main d'une certaine figure me paraissait manquée. En effet, le quatrième doigt était plus court que le second.

— Voilà une plaisante observation, me dit-il, voyez ma main! et il l'étendit.

— Voyez la mienne, répondis je, je suis convaincu qu'elle ne diffère pas de celle des autres enfants d'Adam.

— De qui donc me faites vous descendre? répliqua-t-il.

— Ma foi! lui dis-je après avoir examiné sa dextre, je ne sais à quelle espèce vous rattachez, mais vous n'appartenez pas à la mienne.

— Alors votre espèce n'est pas l'humaine, car la forme manuelle de l'homme et de la femme est bien celle que voilà.

— Je parie 100 pistoles que vous vous trompez, lui dis-je. Furieux de mon défi, il jette palette et pinceaux, sonne ses gens, et leur fait à tous exhiber leurs mains; sa colère fut grandi quand il reconnut que chez tous le doigt annulaire était plus long que l'index. Cependant il voulut bien sentir le ridicule de sa conduite et termina la scène par cette plaisanterie:

— Je suis charmé du moins d'être unique en mon genre sur un certain point."

In 1875 ECKER, was the first anatomist-anthropologist to bring up the problem of the individually-differing prominence of the fingers. Since then numerous publications have appeared; these may be classified as follows on the basis of certain general principles:

1. Prominence and sexual dimorphism
2. Prominence and age
3. Prominence in the light of typology
4. Prominence in the light of racial differences
5. Prominence in the light of problems of evolution
6. Prominence differences between the two hands.
7. Discussion of the causation of differences in prominence.

No single author, however, has dealt with all these aspects at once; this is partly due to the lack of due insight into anthropologo-phenomenological problems. In some cases the contradictory nature of the statements made can be ascribed to the fact that the groups studied were non-comparable. For instance, data furnished by the study of a group of females aged 4 to 71 years, in the absence of any previous investigation of differences according to age, may well lead to premature conclusions about the phenomenon in women.

Although the population of the Netherlands can certainly not be regarded as racially homogenous (in addition to definite Nordic, Alpine and Mediterranean characteristics we also find Baltic and Dinaric features), analysis of our material from this point of view is vitiated by so many uncertainties of race-diagnosis that its results are not worth reporting.

The amount of anthropoid material available was so small that we do not feel justified in including it in our study.

To give some idea of the scope of the problem of prominence, a discussion of the points 1 to 7 mentioned above will precede the description of our own observations.

WOLOTZKOI (1924) devised a useful nomenclature and we shall follow him in speaking of hands of the *radial* type (Rd.) when the *index finger extends more distally* than the ring finger, and of hands of the *ulnar* type (Uln.) when the converse holds. The results of our own investigations

lead us to use the term transitional type (T.) for hands in which the index and ring fingers extend equally far distally. This nomenclature will also be used in discussion of the work of other authors.

## II. *Survey of the literature.*

### 1. *Prominence and sexual dimorphism.*

ECKER, who was the first anthropologist to publish an article on this 'oscillating character in the hand of men' (1875), found 24 examples of the ulnar type and one of the T. type in 25 outlines of the hands of American negroes aged 19 to 65 years. In his group of negresses (age 4 to 71 years) he found 15 Uln., 6 Rd. and one T.

With a total absence of criticism as to the age-composition of his groups (note the women) he concludes that there is an unmistakable sex difference: Rd. occurs more in women than in men. From a group of Europeans (composition unknown) he drew the same conclusions, although with some reservations.

The data reported by MANTEGAZZA (1877) (ages not stated) make it possible to calculate 75 % Uln. for 258 Italian women and 92 % Uln. for 336 Italian men. In these groups of individuals examined by him, only Rd. or Uln. is found. Thus the Uln. type predominates in both sexes, as found by ECKER (1875).

PFITZNER (1893) found just the contrary for skeleton hands of adult Alsations: 70 % of 175 male hands were of the Rd. type and 79 % of 90 female hands, while RUGGLES (1930) and BAKER (1888) found in white Americans that more Uln. types on the whole occurred among men and more Rd. types among women.

WEISSENBERG (1895) is more inclined to agree with MANTEGAZZA; he found more Rd. in women than in men but the percentage of Rd. was always below 50 %, so that Uln. predominated in both sexes.

The next publication on sex differences in the digital formula did not appear until 1924 (WOLOTZKOI): in adult Russians Rd. was found in 62 % of 190 men and 77 % of 159 women. For adult Russian Jews the figures are 59 % Rd. in 29 men and 62 % Rd. in 58 women. These figures agree with those of PFITZNER (1893).

WOLOTZKOI then draws the inaccurate conclusion 'that the radial form is a special property of the female hand'.

RUGGLES (1930) concluded from a study of 402 male and 218 female 'white adults' that 'In white adults the ring finger in males is generally longer than the index finger and in females the reverse is found', a conclusion which he (*wrongly*) believes to be identical with those of PFITZNER, ECKER and MANTEGAZZA and contradictory to those of SCHULTZ (1924) and WOOD JONES, neither of whom, however, (the latter at any rate not in his book published in 1944) makes any mention of sexual dimorphism in a comparative sense. As we have not been able to obtain

a copy of the publication of BAKER (1888), we are doubtful as to what RUGGLES describes as BAKER's results (see above).

WECHSLER (1939) found more Uln. types in men than in women.

A number of the older anatomists (e.g. GEGENBAUER (1885), KOLLMANN (1886) believed Rd. to occur more in women than in men, although they did not give quantitative expression to this. The more frequent occurrence of Rd. in women together with the greater beauty of form (in the opinion of many) of the female hand, led various investigators to study the way in which artists depict the hands of their models. ECKER (1875) makes the following pronouncement: ... 'wherever a great artist has endeavoured, whether instinctively or consciously, to depict a hand of perfect beauty ..... he certainly never makes the index finger appreciably shorter than the ring finger as this formation definitely gives the stamp of a lower type'.

WEISSENBERG (1895) did not confirm this in his study of Egyptian and Assyrian art. However, we shall confine ourselves to the mere outline of this aspect of the problem. Summing-up we may remark that the literature fails to provide us with unequivocal information on the sex differences in the digital formula. We shall return to this question in connection with our own investigations.

## 2. Prominence and age.

Much less has been written about the connection between relative length of fingers and age than about the difference between the sexes in this respect. We have already seen how ECKER (1875) put females aged 4 to 71 years in a single group labelled 'women' and then came to the conclusion that there was an unmistakable difference between the sexes.

WEISSENBERG (1895) classified his 574 male Jews according to age as well as sex. For the right hand he gives:

	5-10 yr.		11-20 yr.		21-30 yr.		31 yr. and older	
Rd.	30	45.5%	57	18.9%	29	23.6%	21	25.0%
Uln.	34	51.5%	222	73.8%	86	69.9%	59	70.2%
T.	2	3.0%	22	7.3%	8	6.5%	4	4.8%

From this it follows that boys from 5 to 10 years of age show the Rd type more frequently (45 %) than older boys (25 % for age about 20 yr.). Although the proportion of Rd types is higher between the ages of 5 and 10, WEISSENBERG's data show it to remain still below 50 %. He also remarks 'both types of hand may be found even in new-born infants'.

WOLOTZKOI (1924) arranged his Russian and Jewish men and women in age-groups as proposed by STRATZ (1903). In the periods from 1 to 4 and 8 to 10 years growth in breadth is regarded as predominating over that in height (first and second filling-out periods; turgor primus et turgor secundus), while those of 5 to 7 and 11 to 14 years correspond to relatively

greater increase in height (first and second periods of extension; proceritas prima et secunda). Then follows the maturation period from 15 to 20 years.

In order to facilitate comparison with our own findings we give WOLOTZKOI's figures in full:

Russians.

age-groups	Males				Females			
	number	%/0Rd.	%/0Uln.	%/0T	number	%/0Rd.	%/0Uln.	%/0T
1—5	13	77	21	2	18	60	28	12
5—7	59	81	15	4	67	76	21	3
8—10	53	64	30	6	53	77	21	2
11—14	78	50	42	8	184	63	29	8
15—20	61	53	44	3	52	67	33	—
21—older	190	62	34	4	159	77	21	2

Jews (Moscow).

age-groups	Males				Females			
	number	%/0Rd.	%/0Uln.	%/0T	number	%/0Rd.	%/0Uln.	%/0T
5—7	9	99	10	—	9	100	—	—
8—10	10	70	30	—	13	46	38	16
11—14	10	20	80	—	25	64	28	8
15—20	13	54	38	8	20	80	20	—
21—older	29	59	27	14	58	62	31	7

WOLOTZKOI concludes that the hands of children show a predominance of the Rd. type, but that with increasing age the number of Uln. forms increases. He also remarks that after the 20th year the converse phenomenon appears and the number of Uln. decreases in favour of Rd. forms. (This is not the case with the Jewesses, J. H.).

Although both WEISSENBURG and WOLOTZKOI examined Russian Jews, there is an enormous difference between their percentages for the different hand-types. WEISSENBURG finds 70 % of Uln. forms in adult males, whereas WOLOTZKOI gives 27 %. To what extent the cause of these discrepancies is to be sought in the number of subjects examined, we need not discuss here. It seems justifiable to conclude from both these investigations that the *Rd. type* is more frequent in *youth* than at a more advanced age, although the actual percentage reported by these two authors differ widely.

We shall discuss this conclusion further in connection with our own work.

As far as we know the only publication in which mention is made of the hands during intrauterine life is that of MIERZECKI (1946). Without specifying the number of subjects examined or their sex, he gives the following percentages for negroes (N) and whites (W)

	3th. month		4th. month		9th. month		10th. month	
	W	N	W	N	W	N	W	N
Uln.	33.3	57.1	14.7	50.0	33.5	63.2	31.8	54.6
T.	64.7	42.9	69.0	50.0	53.4	36.8	54.6	45.4
Rd.	2.0	—	16.3	—	13.1	—	13.6	—

In whites, thus, it appears that the index finger is longer than the ring finger in the third month in only 2 % of cases, whereas at birth the occurrence of this relation is 14 %. According to MIERZECKI, in negroes the hand during intrauterine life is invariably *non-Rd.* 'In the development of the hand of the negro, as in that of apes, no tendency whatever is seen for the length relation between the fingers to change in favour of the index finger.'

The high percentage of T. in the above table is remarkable. The number of cases in which the investigator is unable to make a decision is largely dependent on the method of examination used. What looks like a T form on simple inspection may be shown by accurate measurements to be Rd. or Uln., or vice versa. We may also agree to use the terms Rd. or Uln. only in cases where the difference in prominence exceeds a given number of millimetres. MIERZECKI is silent on this point.

In addition to this, the uncritical fashion in which he makes use of ECKER's data makes it impossible for us to have very great faith in his percentages.

### 3. *Prominence in the light of typology.*

In 1875 (long before the time of Kretschmer) ECKER remarked in his publication that, where the Rd type occurs in European men, this 'is found more frequently in tall, thin individuals than in those of short, stocky build'. We understand him to mean that this does not hold for women.

The Viennese investigator ROMICH (1932) describes the distribution of the two hand forms among the constitutional types distinguished by him.

The *progressive* constitutional type (P. T.) 'includes the sum of all progressive characteristics that are necessary for the static functions and that find expression in the transformations of the entire locomotor apparatus which are brought about by and adapted to these functions'. This part of his definition will, we believe, suffice to show the direction in which the characteristics are oriented.

The *conservative* constitutional type (C. T.) 'adapts itself, with respect to the locomotor apparatus, for the dynamic function and shows a pronounced accentuation of the rudimentary formation'.

Among 300 adults of both sexes (proportions not stated, J. H.) consisting of 150 P. T. and 150 C. T. individuals, 40 % showed Uln.,

51 % Rd. and 9 % T. forms. Classifying these according to C. T. and P. T. types, however, ROMICH found:

	P.T.	C.T.
Uln.	60%	20%
T.	8%	10%
Rd.	32%	70%

The percentage of Rd. forms for the whole group (51 %) appears thus to result from the occurrence of Rd. in 70 % of the conservative and 32 % of the progressive groups (these groups being numerically equal). ROMICH further states that in his progressive type (i.e. that in which the static function is to the fore) a narrow, gracile hand with long fingers is usually found, while the hand of the conservative type is short and broad with short fingers.

This would mean that the progressive hand corresponds to that of the leptosome type, in which, therefore, the Uln. form must predominate (60 %). If we are really justified in using the term leptosome here, it seems that this conclusion conflicts with the findings of ECKER already mentioned.

We are, further, inclined to believe that ROMICH's typology is no great acquisition.

#### 4. *Prominence and racial differences.*

We have already mentioned the distribution of the two hand forms found by ECKER (1875) in American negroes. Although ECKER makes no definite statement, SCHAAFFHAUSEN (1884) after comparing the 'so-called savages with civilized human beings' considers himself justified in remarking that it is 'as ECKER was the first to show, a characteristic of culture versus savagery that the index finger increases in length relative to the fourth or ring finger'. Although we ourselves have not investigated racial differences, we do not wish to cast doubt on the possibility that differences may exist, even to a very large extent. But we see in the fact that judgements on this problem, pronounced at the end of the 19th century, were frequently based on the examination of 2, 3, 4 or 5, individuals of little-known races — and often without any attention to age or sex — a reason for not attaching undue value to such statements.

VIRCHOW (as stated by WECHSLER in 1939) asserted in 1898 that cultured peoples have the Rd. type while primitive peoples show the less elegantly proportioned hand of the Uln. type. VIRCHOW also remarked (in our opinion humorously): 'the tendency to a longer index finger happened to be greatest in the chief of the negro tribe studied: in him there was no difference between these two fingers'.

We have already mentioned the results of PFITZNER (1893) with Alsatians and those of WOLOTZKOI (1924) with Russians and Jews, as

well as those of WEISSENBERG (1895) with Jews. According to SCHULTZ (1924) the rule that primates (see below) have the Uln. type holds for negroes.

RUGGLES (1930) states in connection with his American whites: 'There is no indication of any relationship between the finger type and (either handedness or) eye color'.

Comparison of the results of racial investigations gives a confused picture.

##### 5. *Prominence and problems of evolution.*

Here again we must mention ECKER who was the first to include anthropoids in his investigations. He remarks that in all the apes examined — but least in the Gorilla — the Uln. type occurs. The number of apes examined was very small.

SCHAAFFHAUSEN (1884), the student of 'savages' already mentioned, states in connection with the occurrence of the Rd. type 'this is seen in none of the anthropoid animals; in these the ring finger is invariably the longer and the index finger the shorter'.

HARTMANN (1883) whom WEISSENBERG calls one of the greatest experts on the anthropoids, states, however, that Rd. prominence does occur in apes.

SCHULTZ (1924) remarks: 'Among all primates, except in a large percentage of white men and perhaps of some other human races, the fourth finger surpasses the second in length'. WOOD JONES (1944) also describes the Uln. form as typical of all 'monkeys and apes'. The Rd. type is 'definitely non-simian and constitutes a characteristic human specialisation'. He also remarks that, although the Rd. type is found only in man 'this formula is found only in a certain number of cases, that it may be present in one hand and not in the other and that it depends upon the greater development of the index finger'.

It is precisely this 'elongated index' that we may regard as a 'distinctly human specialisation'. In this connection WOOD JONES points to the differentiation of a separate deep index flexor muscle from the musculus flexor digitorum profundus vel perforans. 'The factor underlying the differentiation of this portion is undoubtedly the human specialisation of the index.'

From the literature it seems justifiable to conclude that, while the Rd. type may perhaps occur sometimes in anthropoids, the Uln. type is the rule in apes and anthropoids.

##### 6. *Difference in prominence between the two hands.*

Little attention seems on the whole to have been paid to a possible difference in prominence between the right and the left hand. According to WEISSENBERG (1895) the Rd. type is commoner in the left hand. We quote the figures for his 574 Jewish boys and men.



RUGGLES (1930) comes to exactly the opposite conclusion, stating that the Rd. type predominates in the right hand in both men and women.

Rd. type (WEISSENBERG 1895).

	5—10 yr.		11—20 yr.		21—30 yr.		31 yr. and older	
Right	$n = 30$	45.50%	$n = 57$	18.90%	$n = 29$	23.60%	$n = 21$	25.00%
Left	$n = 29$	43.90%	$n = 75$	24.90%	$n = 39$	31.70%	$n = 27$	32.10%

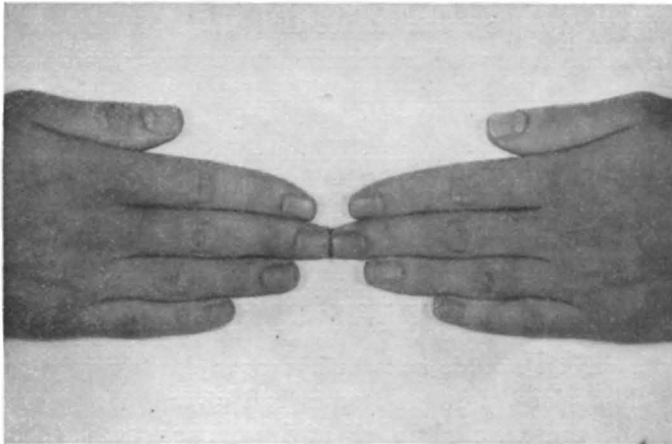
We have already seen that WOOD JONES (1944) says of the Rd. type 'that it may be present in one hand and not in the other'.

According to RUGGLES (1930) there is no relation between hand type and 'handedness'.

Rd. type (RUGGLES 1930).

	<i>Men</i>		<i>Women</i>	
Right	$n = 56$	280/0	$n = 57$	520/0
Left	$n = 40$	200/0	$n = 51$	470/0

As is the case with practically all the aspects of the prominence problem which we have discussed here, a study of the literature once again presents us with contradictory opinions.



WOLOTZKOI (1924) determines the 'mean' prominence of the two hands of an individual by placing the hands, each with its longitudinal axis along the prolongation of that of the forearm, in the same plane, with the middle fingers tip to tip. If the distance between the tips of the index fingers is smaller than that between the tips of the ring fingers we have a (mean) Rd. type. As this method doubles the difference in prominence between II and IV and thus shows it more clearly, we also used it for our investigations (see photo).