A FACTORIAL STUDY OF SOME MORPHOLOGICAL AND PSYCHOLOGICAL ASPECTS OF HUMAN CONSTITUTION.

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1. *Introduction.*—Since Hippocrates and his Roman followers described the *habitus apoplecticus* and the *habitus phthisicus*, linking these antithetical physical types with certain temperamental peculiarities and with susceptibility to specific diseases, much research has been carried out in an attempt (1) to prove the existence of physical types and to discover their nature, and (2) to investigate the relation of these types to temperamental traits. This work has done much to clarify the issues at stake.

Four main schools have contributed to the development of a consistent body of knowledge in this field of the relation of body-build and temperament, each making its specific contribution. Rostan (24) and the French school generally may be credited with the elaboration of the tripartite scheme of body-type (digestive, muscular, and respiratory-cerebral) which has recently been brought back to favour by Kretschmer (18) and Sheldon (25).

The Italian school, founded by Giovanni, introduced the idea of measurement and statistical analysis into the field, and Viola (29) elaborated his morphological index on this basis, dividing the population into microsplanchnic, normosplanchnic and megalosplanchnic types. The German school, beginning with Carus (4) and Beneke (1), added the important theory that body-build is correlated with mental illness.

The Anglo-American school, following the lead of Galton and Pearson, used the concept of correlation to determine more strictly the actual relation between isolated body measurements and single psychological traits (Patterson (22)); they also criticized extensively the very basis of " type " theory, substituting a system of normally-distributed " traits " instead.

In order to determine the nature of the main " traits " in the cognitive, conative and affective fields, the statistical procedure of Factorial Analysis (Burt (2), Thomson (27); Thurstone (28)) has been elaborated, which enables the investigator to isolate the fundamental vectors underlying his measurements in these respective fields. Recently, factorial studies have been made in the field of body measurement (Cohen (5, 6 and 7), Mullen (20), Hammond (15)), and the results suggested to us that this method might be useful in (*a*) determining the main types of body-build, (*b*) making it possible to derive an index of body-type free from the arbitrariness with which many of the indices in the past have been constructed, and (*c*) deriving correlations, not between isolated measurements of morphological and psychological variables, but between morphological and psychological syndromes or trait-constellations.

Although we found previous analyses of great interest and of suggestive value, we considered it necessary to carry out a special analysis of our own, because previous work had certain drawbacks which made the conclusions arrived at inapplicable in detail to our own sample. The number of persons measured had sometimes been rather small; the number of measurements taken had not always been sufficient; and the samples studied (students, psychotics, adolescent boys and girls) bore little resemblance to the material with which we had to deal. The fact that in spite of such wide differences in sampling and procedure our results are in close essential agreement with those of other students encourages us to believe that the factors isolated are truly fundamental in the determination of body-build.

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If it be conceded that the factorial method enables us to establish the main phenotypical (if not the main genotypical) determinants of body-type and body-build, then we are in a position to derive from our data an index of body-type which will have a rather more objective basis than some of those suggested in the past.

The method adopted, which has not to our knowledge been used before, consists in (1) establishing the " types " actually existing in an unselected population by means of a factorial analysis, and (2) measuring these " types " by means of an index containing the most diagnostic measurements as items and their factor saturations (or derivatives of these saturations) as weights. As a last step, it will then be possible (3) to see whether body-types are only the extremes of a normal distribution, or whether there really exist separate " types " giving rise to a bimodal or a multimodal distribution of indices.

Having thus established a valid measure of body-type, we can make an attempt to correlate body-type with various psychological factors. In particular, it will be of interest to see how body-type is related to the main psychological types found previously in a factorial study of 39 personality traits in 700 neurotic soldiers (Eysenck (10)), how it is related to the complex of traits commonly called "schizoid," and how it is related to what might be designated " level of abnormality," as defined by seriousness of present disease, and by hereditary and home factors.

2. *Experimental material.*—Altogether, 389 successive admissions to Mill Hill Emergency Hospital were measured, as well as a sample of 100 non-neurotic soldiers of similar age distribution and military status. Our main interest was in the neurotic group, for whom intelligence test results and temperament and personality ratings by the psychiatrist in charge were available, in addition to the measurements.

The technique used in taking the anthropomorphic measurements was that described by Hrdlicka (16), some additional measurements being taken according to the methods described by Martin (19) and Wilder (30). All the measurements were taken by one of us (W.L.R.), always at the same time of the day, thus eliminating two possible sources of error in measurement. In Table I, below, are set out the actual measurements taken, as well as the means and S.D.'s of the measures for the normal group and for a sample of 200 neurotics, representing successive admissions.

In addition to the measurements, somatoscopic gradings were carried out on Kretschmer's leptosomatic-pyknic scale for each of the 100 normal soldiers, one of us (W.L.R.) dividing the subjects into seven groups as defined below:

TABLE I.

	100 normal soldiers.		200 successive admissions to neurosis centre.	
	Mean.	S.D.	Mean.	S.D.
Age	29·27	6·06	28·8	5·89
Stature	171·01	5·32	170·9	6·77
Suprasternal height	139·47	4·67	139·4	5·78
Symphysis height	86·39	4·55	86·5	4·81
Trunk length	53·41	2·05	52·9	2·58
Breadth of skull	15·28	0·52	14·9	0·58
Length of skull	19·60	0·65	19·2	0·66
Biacromial diameter	39·61	2·10	38·8	1·68
Transverse chest diameter	28·77	2·12	27·9	1·85
Sagittal chest diameter	20·60	1·63	20·4	1·58
Bicristal diameter	29·08	1·59	26·7	1·61
Sternal length	21·89	2·23	21·2	1·78
Arm length to radial styloid	55·77	2·35	55·7	2·78
Arm length to tip of medius	76·45	3·23	75·3	3·57
Chest circumference at inspiration	95·79	4·87	92·2	3·57
Chest circumference at expiration	87·96	5·30	86·5	4·50
Hip circumference	79·93	6·64	80·2	5·27
Weight	65·00	6·88	64·6	7·22

1. Extreme leptosome	} *Leptosome* = 23 per cent.
2. Average leptosome	
3. Leptosome intermediate	} *Intermediate* = 53 per cent.
4. Average intermediate	
5. Pyknic intermediate	
6. Average pyknic	} *Pyknic* = 24 per cent.
7. Extreme pyknic	

This grading was carried out before the factorial analysis described in the next section was undertaken, and before our Index of Body-Type was developed quite independently. It is necessary to stress the fact that the intuitive rating, based largely on reading and experience with judgments of body-type, and the perfectly objective, mathematico-inductive method used in developing our Index, were carried out without reference to each other, because otherwise the extremely high correlation between the results of the two methods ($r = +0{\cdot}962$) might be thought to be due to a lack of independence of the two methods.

TABLE

	1.	2.	3.	4.	5.	6.	7.	8.
1. Age	..	−·071	−·050	−·069	+·048	+·029	−·150	+·039
2. Stature	..	..	+·915	+·875	+·089	+·179	+·454	+·210
3. Suprasternal height	..	..	..	+·851	+·109	+·188	+·488	+·237
4. Symphysis height	..	..	..	..	+·106	+·178	+·460	+·167
5. Skull breadth	..	..	..	..	..	+·149	+·222	+·255
6. Skull length	..	..	..	..	..	..	+·146	+·168
7. Biacromial diameter	..	..	..	..	..	..	..	+·663
8. Transverse chest diameter	..	..	..	..	..	..	..	..
9. Sagittal chest diameter	..	..	..	..	..	..	..	..
10. Bicristal diameter	..	..	..	..	..	..	..	..
11. Trunk length	..	..	..	..	..	..	..	..
12. Sternal length	..	..	..	..	..	..	..	..
13. Arm length to radial styloid	..	..	..	..	..	..	..	..
14. Arm length to tip of medius	..	..	..	..	..	..	..	..
15. Chest circumference at inspiration	..	..	..	..	..	..	..	..
16. Chest circumference at expiration	..	..	..	..	..	..	..	..
17. Hip circumference	..	..	..	..	..	..	..	..
18. Weight	..	..	..	..	..	..	..	..

3. *Factorial analysis.*—Intercorrelations of the 18 variables (age and 17 body measurements) were calculated for 200 neurotics, representing successive admissions to the hospital, and are given in full in Table II. As will be seen, all the coefficients are positive excepting some of those with age. In Table III are given the results of a factorial analysis of Table II, carried out by means of Burt's Summation Method (2). Two significant factors were extracted. The first factor, which has positive saturations throughout, contributes 34 per cent. to the variance, while the second factor, which is bipolar, contributes 12 per cent. to the variance. The communality of each item is also given ($= h^2$) ; it will be seen that the communality is ·46, while the uniqueness ($= u^2$) is ·54.

Table III gives, in addition to the saturations and the communalities, the correlations of each item with the Morphological Index, the Pignet Index, the Stromgren Index, the Brugsch Index,* and an intelligence test score. (The test used was the Progressive Matrices Test (Raven (23)), which has been studied extensively in connection with neurotic patients (Eysenck (11, 12)). It will be seen that, roughly speaking, the correlations of the indices with the various items correspond in size and sign with the second factor saturations ; the Brugsch index, which measures the same factor as the other indices in reverse, as it were, has of course opposite sign in most cases to the saturations and the other indices.

* These indices are defined in the Appendix, where references will also be found.

The interpretation of these two factors is perhaps too obvious to require formal statement. The first factor measures general bodily growth in all directions; the second factor measures specific growth in length as opposed to growth in breadth. The first factor is a factor of *body-size*, while the second factor is one of *body-type*, dividing the *homo crassus* from the *homo macer*. That this type-factor is essentially identical with the classical body-types is shown by a comparison of the saturations in Table III with the correlations of the various measurements with the indices given there.

This interpretation is in good agreement with the interpretation put upon the results of their respective analyses by Cohen, Hammond, and Mullen, whose work, carried out on human material differing widely from our own, gives in general results very similar to those reported above. Three studies by Cohen on 64 males and 62 female psychotics and 50 university students (5, 6, 7), a study by Hammond on 100 Irish males (15), and a study by Mullen on 305 girls, 15 years of age (20), all resulted in finding two factors substantially identical with those isolated in the present study. Below are given the percentage contributions of the two factors in

I.

9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
+·177	−·103	+·004	+·162	−·085	−·027	+·087	+·129	+·103	−·008
+·296	+·494	+·457	+·252	+·727	+·710	+·252	+·184	+·292	+·471
+·351	+·503	+·504	+·331	+·797	+·780	+·324	+·255	+·378	+·553
+·301	+·484	+·163	+·194	+·803	+·751	+·230	+·199	+·323	+·442
+·148	+·279	+·076	+·103	+·061	+·087	+·309	+·298	+·331	+·309
+0·97	+·113	+·136	−·046	+·195	+·215	+·171	+·152	+·095	+·266
+·302	+·451	+·218	+·232	+·504	+·504	+·500	+·503	+·487	+·613
+·361	+·452	+·202	+·248	+·259	+·246	+·731	+·711	+·572	+·686
..	+·403	+·225	+·296	+·381	+·329	+·616	+·594	+·562	+·601
..	..	+·305	+·401	+·504	+·488	+·466	+·492	+·743	+·634
..	..	..	+·306	+·271	+·251	+·200	+·181	+·046	+·341
..	..	..	..	+·300	+·322	+·248	+·209	+·170	+·156
..	..	..	..	..	+·266	+·077	+·140	+·139	+·101
..	..	..	..	..	..	+·085	+·116	+·144	+·113
..	..	..	..	..	..	..	+·315	+ 223	+·819
..	..	..	..	..	..	..	..	+·291	+·296
..	..	..	..	..	..	..	..	..	+·222
..	..	..	..	..	..	..	..	..	..

each of these studies to the variance, their communalities, the number of subjects used (n), and the number of measurements taken (N). Also included in this Table are the results of a factorial analysis we ventured to undertake of some correlations reported by Dearborn and Rothney (8). These authors deny the existence of morphological types, but our analysis confirms Burt's criticism of their view (3), and shows that their conclusions are not in line with their results.

The differences, both absolute and relative, between the saturations and the communalities of these various studies are probably mainly due to (1) the different selection of characteristics measured, and (2) the differences in homogeneity in the various samples measured.

In Fig. 1 is given a geometrical representation of the factor pattern. Two groups of measurements are seen to stand out as defining clearly the two aspects of the bipolar factor; on the one hand, stature, suprasternal height, symphysis height, and arm length; on the other, transverse chest diameter, hip circumference, and chest circumference. When the two best-fitting lines are drawn through these two clusters, their angle of separation (alpha) is 71′ 30″, which corresponds to a correlation of + 0·32 between the two clusters. The fact that even extreme measures of the two body types correlate together weakens the argument that we should have used some method of axis-rotation in order to reach " simple structure "

TABLE III.

	First factor.	Second factor.	Communality.	Morphological index.	Pignet index.	Stromgren index.	Brugsch's index.	Intelligence grade.
1. Age	+·02	−·09	+·01	−·25	−·10	−·10	+·14	+·17
2. Stature	+·73	+·57	+·85	−·03	+·18	+·39	−·50	+·11
3. Suprasternal height	+·82	+·56	+·98	+·15	+·08	+·29	−·70	+·08
4. Symphysis height	+·69	+·47	+·70	+·09	+·14	+·33	−·38	+·06
5. Breadth of skull	+·31	−·27	+·17	−·24	−·31	−·18	+·16	−·06
6. Length of skull	+·25	+·00	+·06	−·11	−·02	−·03	−·07	−·04
7. Biacromial diameter	+·71	−·11	+·51	−·35	−·32	−·13	+·22	+·01
8. Transverse chest diameter	+·67	−·54	+·74	−·63	−·64	−·69	+·57	−·06
9. Sagittal chest diameter	+·65	−·23	+·47	−·66	−·54	−·61	+·43	+·06
10. Bicristal diameter	+·77	−·05	+·59	−·34	−·33	−·20	+·16	+·11
11. Trunk length	+·41	+·15	+·19	−·40	−·07	+·01	−·09	+·10
12. Sternal length	+·41	+·06	+·17	−·17	−·10	−·12	+·02	+·12
13. Arm length to radial styloid	+·58	+·46	+·55	+·00	−·02	+·02	+·00	+·06
14. Arm length to tip of medius	+·57	+·39	+·47	−·09	−·03	−·03	−·01	+·07
15. Chest circumference at inspiration	+·54	−·35	+·41	−·16	−·24	−·23	+·22	+·05
16. Chest circumference at expiration	+·54	−·41	+·46	−·26	−·28	−·35	+·33	+·10
17. Hip circumference at expiration	+·54	−·33	+·40	−·17	−·12	−·22	+·13	+·18
18. Weight	+·64	−·23	+·46	−·19	+·02	−·24	+·13	+·17

TABLE IV.

Investigator.	Factor I. %	Factor II. %	h^2. %	n.	N.
Cohen, 1	44	24	68	50	14
,, 2	46	19	65	64	14
,, 3	35	25	60	62	12
Hammond	31	9	40	100	12
Dearborn and Rothney	59	8	67	533	8
Mullen	56	19	75	305	8
Rees and Eysenck	34	12	46	200	18
Average	43	17	60	188	12

(Thurstone (28)); with figures of this kind the non-rotated factors appear more meaningful than rotated orthogonal or oblique factors (Holzinger (15*a*)).

We conclude accordingly that there are two main factors in body-build: (1) a general factor of over-all growth, bulk, or *body-size*, and (2) a factor determining *body-type*, according to whether growth has taken place mainly in *length* or in *breadth*. Whether these factors are merely *phenotypes*, of descriptive convenience only, or *genotypes*, of some more fundamental importance, cannot be decided on the basis of a factorial analysis. Such outside evidence as is available, however, suggests that our factors are connected with some fundamental physiological processes.

Hall (14), in a study of growth in 2,000 school-children, found that when the vertical dimension of the body undergoes an acceleration, the horizontal dimension undergoes a retardation in its rate of growth. More recently, Duckworth (9) quotes the work of Godin, who found that growth in length alternates with growth in breadth. Friend (13) found in growing schoolboys that the maximum increase in height occurred during spring, while that for weight occurred in autumn. Finally, the postulation of two factors of growth is consistent with the distinction drawn by Huxley (17) between *isogonic* and *heterogonic* growth in lowlier animals. These researches seem to lend strong support to the results of our statistical analysis.

4. *Index of body-type.*—The main scientific requirements of an index of body-type have been mentioned in the introduction: (1) That the types to be measured

should be defined inductively, not arbitrarily, and (2) that the index must be derived mathematically from the correlations of the various measurements with the "type" factor isolated. To these scientific requirements we may add the practically desirable points (3) that the index should be simple, consisting of few, easily made measurements, and not embody any complex statistical method of calculation, in order that interested workers from other fields should be able to use it without difficulty; and (4) that the index should have a mean of 100 (by analogy with the I.Q.) and a coefficient of variation of at least 5, and preferably higher than that.

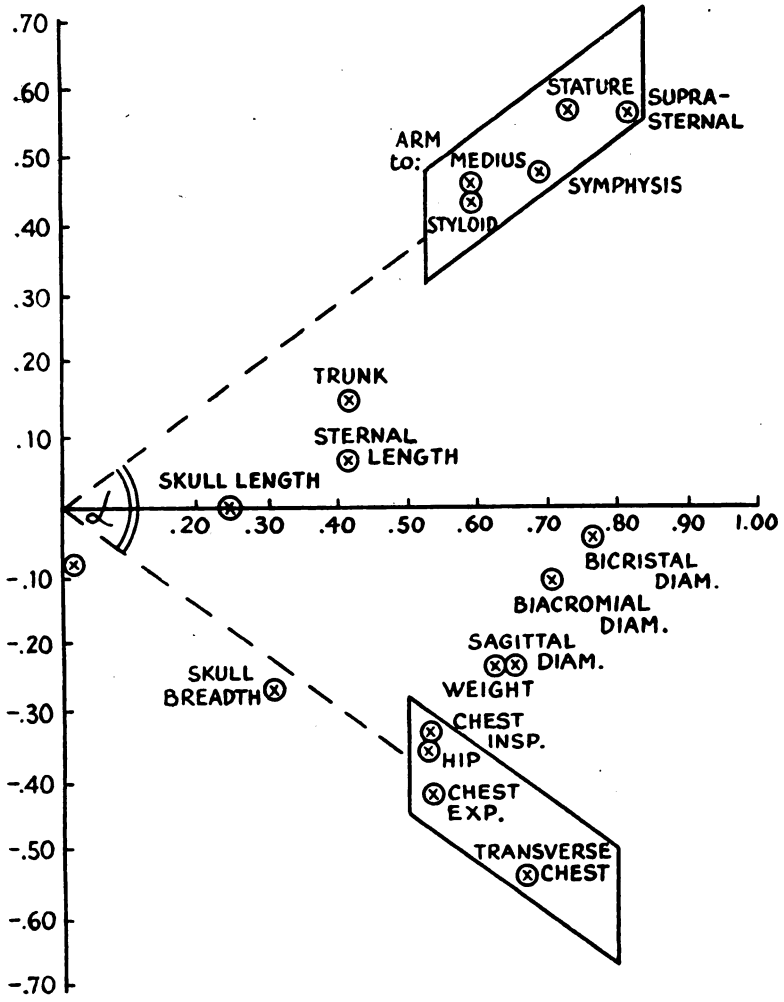

FIG. 1.

The first of these four requirements has been fulfilled by factor-analysing the observed correlations between the measurements taken, and we are left with the task of devising a simple yet accurate and discriminative index from the factor saturations as set out in Table III. The most obvious method would be that of forming a regression equation including all the measurements significantly correlated with the type-factor. This method would lead to a cumbersome formula, however, and we have preferred a simpler but probably no less accurate method.

Reference to Fig. 1 will show that we have two measurements which (1) have correlations with the first factor which are equal in size and similar in sign, and

TABLE

	34·	33·5	33	32·5	32	31·5	31	30·5	30	29·5	29
185 .	91·8	92·0	93·4	94·8	96·3	97·8	99·4	101·0	102·7	104·5	106·3
184 .	90·1	91·5	92·9	94·3	95·8	97·3	98·9	100·5	102·2	103·9	105·7
183 .	89·7	91·0	92·4	93·8	95·3	96·8	98·3	100·0	101·6	103·3	105·1
182 .	89·2	90·5	91·9	93·3	94·7	96·2	97·8	99·4	101·1	102·8	104·5
181 .	88·7	90·0	91·4	92·8	94·2	95·7	97·3	98·9	100·5	102·2	104·0
180 .	88·2	89·5	90·9	92·3	93·7	95·2	96·7	98·3	100·0	101·6	103·4
179 .	87·7	89·0	90·4	91·7	93·2	94·7	96·2	97·8	99·4	101·1	102·8
178 .	87·2	88·5	89·8	91·2	92·7	94·1	95·6	97·2	98·8	100·5	102·2
177 .	86·7	88·0	89·3	90·7	92·1	93·6	95·1	96·7	98·3	100·0	101·7
176 .	86·2	87·5	88·8	90·2	91·6	93·1	94·6	96·1	97·7	99·4	101·1
175 .	85·7	87·0	88·3	89·7	91·1	92·5	94·0	95·6	97·2	98·8	100·5
174 .	85·2	86·5	87·8	89·2	90·6	92·0	93·5	95·0	96·6	98·3	100·0
173 .	84·8	86·0	87·3	88·7	90·1	91·5	93·0	94·5	96·1	97·7	99·4
172 .	84·3	85·5	86·8	88·2	89·5	91·0	92·4	93·9	95·5	97·1	98·8
171 .	83·8	85·0	86·3	87·6	89·0	90·4	91·9	93·4	95·0	96·6	98·2
170 .	83·3	84·5	85·8	87·1	88·5	89·9	91·3	92·8	94·4	96·0	97·7
169 .	82·8	84·0	85·3	86·6	88·0	89·4	90·8	92·3	93·8	95·4	97·1
168 .	82·3	83·5	84·8	86·1	87·5	88·8	90·3	91·8	93·3	94·9	96·5
167 .	81·8	83·0	84·3	85·6	86·9	88·3	89·7	91·2	92·7	94·3	95·9
166 .	81·3	82·5	83·8	85·1	86·4	87·8	89·2	90·7	92·2	93·7	95·4
165 .	80·8	82·0	83·3	84·6	85·9	87·3	88·7	90·1	91·6	93·2	94·8
164 .	80·3	81·5	82·8	84·1	85·4	86·7	88·1	89·6	91·1	92·6	94·2
163 .	79·9	81·0	82·3	83·5	84·8	86·2	87·6	89·0	90·5	92·0	93·6
162 .	79·4	80·5	81·8	83·0	84·3	85·7	87·0	88·5	90·0	91·5	93·1
161 .	78·9	80·0	81·3	82·5	83·8	85·1	86·5	87·9	89·4	90·9	92·5
160 .	78·4	79·6	80·8	82·0	83·3	84·6	86·0	87·4	88·8	9013	91·9

(2) have correlations with the second factor which are equal in size and opposite in sign. These two measurements are Stature and Transverse Chest Diameter. By dividing one by the other we can eliminate the influence of the general factor on our index, while the size of the fraction indicates the relative position of the subject measured on the body-type continuum. If in addition we multiply the Transverse Chest measurement by 6 (because Stature is on the average six times as large as Transverse Chest Diameter) and multiply the whole fraction by 100, we obtain an index which has a mean of approximately 100, a coefficient of variation of over 5, and which accordingly fulfils all our requirements. (The average Index of Body-Type for 100 normal soldiers was 100·1, with a S.D. of 5·82.)

The complete formula for our index, hereafter simply referred to as the Index of Body-Type, or I.B., is therefore:

$$\text{I.B.} = \frac{\text{Stature} \times 100}{6 \times \text{Transverse Chest Diameter}}.$$

In order to facilitate calculation of this index, we offer Table V, in which indices have been calculated for every combination of stature and transverse chest measurement within the limits indicated in the Table. In order to find the appropriate I.B., it is only necessary to enter the Table with the Stature measurement nearest the desired one, and go along the row till the column containing the appropriate "Transverse Chest" measurement is reached. The figure at the intersection of row and column is the desired I.B.*

The distribution of indices for 400 neurotic soldiers is given below, in Fig. 2. It will be seen that the distribution is approximately normal, with a marked positive skewness. ($\text{Sk} = \frac{3(\text{M}-\text{Mdn})}{6} = 1{\cdot}28$.) There is no evidence of bimodality, and thus no evidence of "types," except in so far as types are regarded as merely the extremes of a normal distribution. The mean I.B. for this sample of neurotics is 102·44, with a S.D. of 6·974. The mean of this sample does not differ significantly from that of the normal group cited above. The difference in S.D. between the two groups is significant, however, the Critical Ratio being 2·3. This indicates

* Stature is taken as the height of the vertex above the ground with the individual standing in stockinged feet. Transverse chest diameter is taken at the fourth costo-chondral junction (nipple level may be taken in males), midway between inspiration and expiration.

V.

28·5	28	27·5	27	26·5	26	25·5	25	24·5	24	23·5	23
108·1	110·1	112·1	114·1	116·3	118·5	120·9	123·3	125·8	128·4	131·2	134·0
107·6	109·5	111·5	113·5	115·7	117·9	120·2	122·6	125·1	127·7	130·4	133·3
107·0	108·9	110·9	112·9	115·0	117·3	119·6	122·0	124·4	127·0	129·7	132·6
106·4	108·2	110·3	112·3	114·4	116·6	118·9	121·3	123·8	126·3	129·0	131·8
105·8	107·7	109·6	111·7	113·8	116·0	118·3	120·6	123·1	125·6	128·3	131·1
105·2	107·1	109·0	111·1	113·2	115·3	117·6	120·0	122·4	125·0	127·6	130·4
104·6	106·5	108·4	110·4	112·5	114·7	116·9	119·3	121·7	124·3	126·9	129·7
104·0	105·9	107·8	109·8	111·9	114·1	116·3	118·6	121·0	123·6	126·2	128·9
103·5	105·3	107·2	109·2	111·3	113·4	115·6	118·0	120·4	122·9	125·5	128·2
102·9	104·7	106·6	108·6	110·6	112·8	115·0	117·3	119·7	122·2	124·8	127·5
102·3	104·1	106·0	108·0	110·0	112·1	114·3	116·6	119·0	121·5	124·1	126·8
101·7	103·5	105·4	107·4	109·4	111·5	113·7	116·0	118·3	120·8	123·4	126·0
101·1	102·9	104·8	106·7	108·8	110·8	113·0	115·3	117·6	120·1	122·6	125·3
100·5	102·3	104·2	106·1	108·1	110·2	112·4	114·6	117·0	119·4	121·9	124·6
100·0	101·7	103·6	105·5	107·5	109·6	111·7	114·0	116·3	118·7	121·2	123·9
99·4	101·1	103·0	104·9	106·9	108·9	111·1	113·3	115·6	118·0	120·5	123·1
98·8	100·5	102·4	104·3	106·2	108·3	110·4	112·6	114·9	117·3	119·8	122·4
98·2	100·0	101·8	103·7	105·6	107·6	109·8	112·0	114·2	116·6	119·1	121·7
97·6	99·4	101·2	103·0	105·0	107·0	109·1	111·3	113·6	115·9	118·4	121·0
97·0	98·8	100·6	102·4	104·4	106·4	108·4	110·6	112·9	115·2	117·7	120·2
96·4	98·2	100·0	101·8	103·7	105·7	107·8	110·0	112·2	114·5	117·0	119·5
95·9	97·6	99·3	101·2	103·1	105·1	107·1	109·3	111·5	113·8	116·3	118·8
95·3	97·0	98·7	100·6	102·5	104·4	106·5	108·6	110·8	113·1	115·6	118·1
94·7	96·4	98·1	100·0	101·8	103·8	105·8	108·0	110·2	112·5	114·8	117·3
94·1	95·8	97·5	99·3	101·2	103·2	105·2	107·3	109·5	111·8	114·1	116·6
93·5	95·2	96·9	98·7	100·6	102·5	104·5	106·6	108·8	111·1	113·4	115·9

that the neurotic population contains more extremes than does the normal population—a finding of particular interest in view of the fact that precisely the same relation holds true in the field of intelligence testing, where some 3,000 neurotics were found to have the same mean but a higher S.D. than a comparable normal population (Eysenck (11)).

Many investigators believe with Kretschmer that no formula or index can achieve as accurate an appraisal of such a complex entity as human body-type as can the experienced investigator in his subjective judgment or rating. While we cannot agree with this argument, and while we deprecate the subjectivity inherent in all somatoscopic ratings, we decided that it might be of some interest to see how our index, and a number of other indices, correlated with a somatoscopic rating of a sample of 100 normal soldiers.

In Table VI below are set out the various indices used, the product-moment correlations of these indices with the somatoscopic rating, the percentage of causal factors measured by the indices, and their respective indices of forecasting efficiency ($100r^2$ and $100\ (1-\sqrt{1-r^2})$ respectively), when the somatoscopic rating is taken as the validating criterion. It will be seen that the I.B. has a correlation of ·96 with the criterion, an index of forecasting efficiency of 73, and measures 92 per cent. of the causal factors, while the next-best index, the Stromgren, has a correlation of ·81, an index of forecasting efficiency of 42, and measures 66 per cent. of the causal factors. All the other indices show even less agreement with the somatoscopic ratings than does the Stromgren. On the basis of these correlations, then, we may conclude that our index reduplicates the intuitive judgment of the anthropometric worker more faithfully than any of the other indices examined.

While we have failed to find any evidence for definitely segregated types of the kind envisaged by Kretschmer, it will be helpful to divide our population into three " types " on the basis of the curve presented in Fig. 2. We propose to call those individuals whose I.B. is more than one S.D. above the mean " leptomorphs," those whose I.B. is within one S.D. either way of the mean " mesomorphs," and those whose I.B. is more than one S.D. below the mean " eurymorphs." We do not mean to imply any lack of continuity between these three groups, and have only separated them out in this fashion for the sake of convenience, drawing quite arbitrary dividing lines at the points which suited our purpose. To emphasize the essential difference between our approach and that of Kretschmer, we have

preferred to use some neutral terms rather than adopt terms reminiscent of his system, or indeed of any other system. And while our " types " are of course similar in many ways to those of Kretschmer and many other workers (*cf.* Tables III and VI), our work with psychotics, which will be reported in another paper, pointed to essential differences between our types and those of others, differences which it would be undesirable to gloss over by adopting a terminology implying relations not in actual fact observed by us.

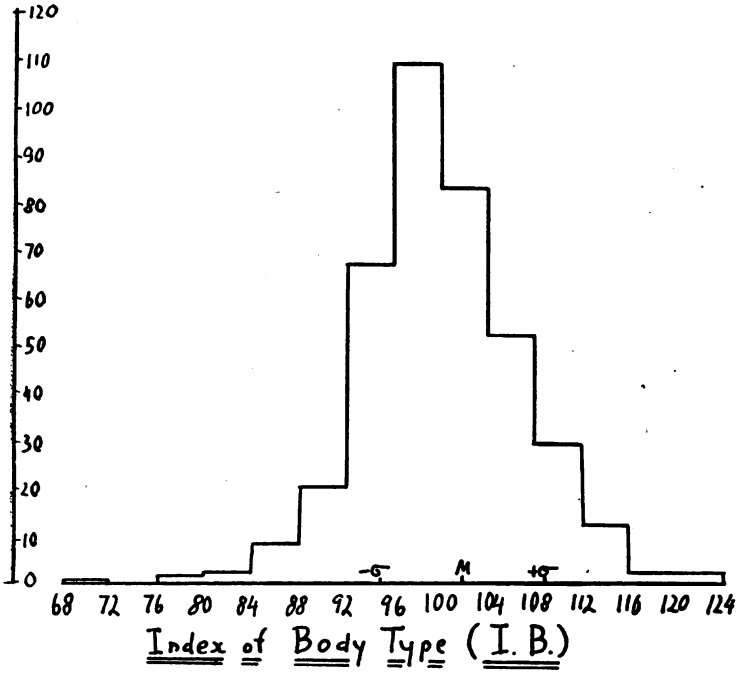

FIG. 2.

TABLE VI.

Index.	Correlation.	Percentage of causal factors measured.	Index of forecasting efficiency.
1. Rees-Eysenck, I.B.	·96	92·5	73
2. Bornhardt, A.	·50	25·4	14
3. Rohrer	·26	6·8	3
4. Brugsch	·70	49·6	29
5. v. Rohden	·74	54·7	33
6. Lucas and Pryor	·30	9·0	5
7. Pignet-Ver Vaeck	·76	57·7	35
8. Martin	·08	0·6	0
9. Stromgren	·81	66·2	42
10. Pignet	·79	62·4	39
11. Morphological index	·78	60·8	37
12. $\frac{\text{Stature}}{\text{Sagittal chest diameter}}$	·67	44·9	26

(A full description of these indices, with references, is given in the Appendix.)

5. *Psychological factors.*—In order to study the correlations of body-type with psychological factors, we divided our experimental population of 389 neurotic soldiers into three groups, as described in the previous section: 60 leptomorphs, 241 mesomorphs, and 88 eurymorphs. These 389 patients had been rated by the psychiatrist in charge on some 200 points, relating to personality, temperament, syndrome, diagnosis, schooling, upbringing, work history, etc., and we tried to

determine those points on which significant or suggestive differences appeared between the groups. The percentage of times each item was noted in the three groups was calculated, and differences tested by means of the Critical Ratio, i.e., the ratio of the difference to its standard error.*

The findings are set out in Table VII. Items marked with one cross (+) are suggestive, with a C.R. somewhat less than 2; items marked with two crosses (++) are significant, with a C.R. of between 2 and 3; items marked with three crosses (+++) are very significant, with a C.R. of over 3. Significance also derives from the fact that differences tend to be consistent; this fact, however, has not been taken into account in the calculation of significance.

The items in the Table are grouped into five sets. The items in the first set were largely taken from the results of a factorial study, reported elsewhere, carried out on 39 personality traits and 700 neurotic soldiers (Eysenck (10)). In this study, a strong bipolar factor emerged which appeared to differentiate the "hysterical" traits from the affective or dysthymic, i.e., from the anxiety, depressed and obsessional traits. High intelligence correlated positively with dysthymia, and much unemployment positively with "hysteria." It will be seen from the Table that leptomorphs tend to suffer from the various "affective" symptoms, while eurymorphs tend to suffer from the various "hysterical" symptoms. Mesomorphs are intermediate between the other two groups for frequency of the two kinds of symptoms. The finding that intelligence is positively correlated with leptomorphic body-build confirms similar findings by Naccarati (21), Sheldon (26), and others, as well as Viola's belief that the microsplanchnic is a hyperevolute, and more intelligent than the macrosplanchnic.

The items in the second set all have reference to what may be called "seriousness of abnormality," as defined by hereditary and home factors, as well as by the psychiatrist's estimate of the patient's present personality. It will be seen that there are hardly any differences between leptomorphs and mesomorphs on this score, while eurymorphs show a much higher percentage of individuals with evidence of "serious" abnormality. The selection of items as well as the interpretation is to some extent arbitrary, of course, but the findings are fairly consistent.

In the third set we have items which we considered to be characteristic of the so-called "schizoid personality"; again there is a considerable measure of arbitrariness in the allocation of an item to this ill-defined group. Again, however, the findings are in agreement with expectation; leptomorphs tend to be more schizoid than eurymorphs, and in several instances than mesomorphs.

In set four we have set down a number of items of general interest which differentiate between the morphological groups, but which cannot easily be fitted into one of the previous sets. In the fifth set we have put items on which mesomorphs on the one hand differentiated from leptomorphs and eurymorphs on the other. The meaning and interpretation of these items, many of which show significant and very significant differences, is not very clear.

Taking these results all in all, and basing our interpretation not on isolated results so much as on the congruence of several different pointers, we may conclude that in the sample examined the eurymorphs tend towards hysteria, show a more serious "level of abnormality" and contain fewer schizoid personalities than do the leptomorphs, who tend towards the affective disorders and contain a comparatively high percentage of schizoid personalities.† Various other differences reached the level of statistical significance, but do not fall into any definite pattern. Mesomorphs tend to be intermediate between eurymorphs and leptomorphs with regard to the majority of the traits examined, just as they are intermediate with regard to body-build. On the whole, these data are presented not as final proof, but as evidence, both confirmatory and suggestive, of complex relations between body-type and personality.

6. *Discussion.*—The results reported in this paper, together with results from previous work from this laboratory, seem to indicate strongly the existence of two temperamental "types," characterized by specific personality traits (10), specific

* Differences were tested between *leptomorph* and *eurymorph* groups, except in Set V, where *mesomorphs* on the one hand were contrasted with the two extreme groups on the other.

† These findings would appear to corroborate Jung's dictum regarding the "essential relationship" between psychasthenia and schizophrenia; his psychasthenia corresponds roughly to our "affective disorder" or "dysthymia."

TABLE VII.

Personality trait rating.	Leptomorph.	Mesomorph.	Eurymorph.	Standard of significance.
Set One.	%	%	%	
Consistently depressed.	38	34	27	+
Anxious	67	63	54	+
Obsessional	25	16	10	++
Somatic anxiety (autonomic imbalance)	58	55	43	+
Reactive depression	27	20	12	++
Intelligence above average	30	23	18	+
Much unemployment	12	18	27	++
Very hysterical	2	4	14	++
Set Two.				
Psychosis in near relatives	5	9	28	+++
Pronounced neurosis in same	42	40	55	+
Unsatisfactory home	22	27	33	+
Normal before present illness	89	87	79	+
Unstable, ill-adjusted	42	40	50	+
Boarded out of the army	52	51	62	+
Set Three.				
Single	35	24	23	+
Teetotal or abstemious	60	59	43	++
Narrow hobbies and interests	75	76	24	+++
Weak, dependent	60	38	41	++
Inert, without initiative	33	33	26	+
Muscular tone and posture good	13	32	40	+++
Age below 25	43	32	25	++
Set Four.				
Rebellious, aggressive	8	19	16	+
Elementary education only	80	86	93	++
Past health good	48	54	59	+
Loss of weight	18	12	5	++
Psychopathic personality	12	8	3	++
Set Five.				
Unskilled	48	36	41	+
Sex inhibited	8	13	7	++
Severe head injury part of present illness	8	12	5	++
Other physical diseases, relevant to present illness	2	7	1	++
Severe headaches	10	15	9	++
Fatigue, effort intolerance	65	55	62	+
Fainting fits	27	10	16	+++

neurotic disorders (10), specific body-build, specific autonomic reactivity (12*a*), and specific response to psychological tests.* These types are conceived, not as entirely separate categories into which human beings can be classified dichotomously, but as the extreme ends of a normal trait-continuum, stretching from the typical representative of the "hysterical" or extraverted type on the one side, to the typical representative of the "affective" or introverted type on the other.

This type-continuum was established entirely with reference to neurotic patients, and it may well be objected that no typology thus derived can be considered adequate for the normal, non-neurotic population. In a previous paper, in which an attempt was made to establish the existence and nature of the two main neurotic syndromes, a number of references was given to work with normal subjects which showed that there also similar trait-constellations could be observed (10). Similarly, in this paper several references have been given to show that the relations found

* As shown in unpublished work on Level of Aspiration, Persistence, Oscillation, Speed, Accuracy, etc., by H. Himmelweit, A. Petrie, and other members of the Department.

by us between body-build and intelligence, etc., were also found by other investigators using normal subjects rather than neurotics.

Of particular interest in this connection is a study which came to hand only after the present account of our work had already been completed (*24a*). This research was carried out by a group of psychologists, psychiatrists, pediatricians and other biological experts on a group of fifty children over a period of three years; it was completed under the auspices of the Psychological Clinic, Harvard, and the Department of Child Hygiene, Harvard, and complements our own work in many ways.

Where we dealt with neurotics throughout, they dealt with normals; where we dealt with adults only, they dealt with children; where we dealt with large numbers of subjects in an inevitably rather superficial manner, they dealt with small numbers of subjects in a very intensive manner; where we used common psychological and psychiatric concepts in ordering our material, they used the concepts and terms introduced by H. A. Murray; where we used factorial methods, they used special methods of their own devising. If, in spite of these differences between our two approaches, similar results emerged, we may justifiably claim that the types delineated in our studies are of general validity, and of fundamental importance in the field of psychological classification.

When such a comparison is carried out, the similarity found between the results is very close indeed, particularly when allowance is made for differences in terminology. As it is impossible to review a book of over 700 pages in a few paragraphs, attention will here be drawn to only a few of the most important points of comparison.

In the first instance, Sanford and his collaborators give a table of intercorrelations of 18 body measurements, almost identical with those used by us; from this table they deduce the existence of two contrasted body-types: tall-narrow and wide-heavy. From the actual figures given by them, it is clear that these types are practically identical with our own leptomorph and eurymorph types.

Measurements of various autonomic reactions (pupillary size dilation, pallor, flushing, sweating, odour, acne, pulse, etc.) disclose the existence of a syndrome of autonomic imbalance, which is positively correlated with tall-narrow body-build, and negatively with wide-heavy body-build.

Both tall-narrow body-build and autonomic imbalance correlate positively with success in various tests of intelligence, and also with school abilities and cultural stimulation in the home. Wide-heavy body-build on the other hand correlates negatively with intelligence, school abilities, and cultural stimulation.

Lastly, tall-narrrow body-build and autonomic imbalance correlates positively with personality-syndromes characterized by self-sufficiency, guilt-feelings, remorse, and counteractive endocathection, this syndrome is clearly similar to our affective or dysthymic type-factor. On the other hand, wide-heavy body-build and lack of autonomic imbalance correlate positively with good fellowship, social feeling, and lively self-expression.

As the authors point out, "it is possible . . . to compose a broader picture of inner life, tallness, thinness, and parasympathetic response, and to contrast this picture with one of social responsiveness, shortness, wideness and absence of parasympathetic activity" (p. 528). The picture thus revealed agrees in many ways with that shown in our own work, which is schematically reproduced below:

TABLE VIII.

Body-build	Leptomorph	Eurymorph
Clinical syndrome	Dysthymia	Hysteria
Intelligence	High	Low
Schooling	Good	Bad
Autonomic activity	Unbalanced	Normal
Work record	Satisfactory	Unsatisfactory

While this table is at fault in presenting as absolute what are in fact only tendencies, and may thus be misleading unless carefully interpreted, there can be little doubt that these tendencies do in fact form two syndromes which are roughly identifiable not only in our neurotic army group, but also in groups different in age, social background, mental health, and the various other ways already enumerated.

7. *Summary and conclusions.*—A factorial analysis was carried out on the intercorrelations of 18 body-measurements taken on 200 neurotic soldiers, and an Index of Body-Type derived from the results of this analysis. This Index was calculated for altogether 400 neurotic soldiers and for 100 non-neurotic soldiers, compared with other indices, and with somatoscopic ratings. Body-type as determined by the Index was correlated with some 200 psychiatric trait ratings on the 400 neurotic soldiers, and significant findings noted. The following are the main findings of this study:

(1) Two main factors, accounting together for 46 per cent. of the variance, are sufficient to account for all the correlations found within the limits of the probable error.

(2) The first factor appears to be one of general body-size, has positive saturations throughout, and accounts for 34 per cent. of the variance.

(3) The second factor appears to be one of specific body-type, has both positive and negative saturations, and accounts for 12 per cent. of the variance.

(4) An Index of Body-Type can be derived from the results of this analysis, which gives an accurate picture of the " type " to which the patient who is being measured belongs, the " type " being defined in terms of the curve of distribution of the indices.

(5) The indices are distributed roughly in accordance with the normal curve, markedly skewed towards the positive end.

(6) Of all the indices examined, the Index here suggested correlated best with an independent somatoscopic examination, the correlation being +0·962.

(7) The body-types isolated by the factorial analysis and by our Index are characterized respectively by a preponderant growth in length or a preponderant growth in breadth, and are shown to be similar in many ways to various classical types.

(8) For the sake of convenience, the continuous sequence of Indices has been split into three parts, using the +1 S.D. and the −1 S.D. levels as arbitrary marking-off points for three main types; these have been called the leptomorph, the mesomorph, and the eurymorph respectively, and are defined as having an Index of Body-Type of more than 1 S.D. above the mean, between +1 S.D. and −1 S.D. from the mean, and more than 1 S.D. below the mean respectively.

(9) Leptomorphs show a marked tendency towards the affective group of symptoms, i.e., anxiety, depression, and obsession, while eurymorphs show a marked tendency towards the hysterical group of symptoms.

(10) Eurymorphs tend to show a much more serious " level of abnormality," as defined by seriousness of present disease, and by hereditary and home factors, than do the other two groups.

(11) Leptomorphs tend to show a higher proportion of schizoid personality traits than do the eurymorphs.

(12) The neurotics as a whole are slightly more leptomorph than the normal soldiers examined, but the difference is not statistically significant.

(13) The neurotic group contains a significantly higher number of leptomorphs and eurymorphs and a significantly smaller number of mesomorphs than does the normal group.

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APPENDIX.

Indices of Body-Build.

Pignet Index = Stature cm. (chest circumference, cm. + weight, kgm.).

Morphological Index is a modification of that of Wertheimer and Hesketh (1926):

$$\frac{\text{Symphysis height} \times 10^3}{\text{Transverse chest diameter} \times \text{sagittal chest diameter} \times \text{trunk length}}.$$

Stromgren Index = $-\cdot 04$ stature $+ \cdot 127$ transverse chest diameter $+ \cdot 156$ sagittal chest diameter.

The following indices are quoted by Tucker and Lessa (1940):

Bornhardt, A. $= \dfrac{\text{Stature} \times \text{chest circumference}}{\text{Weight}}$.

Rohrer $= \dfrac{\text{Weight} \times 100}{\text{Stature} \times \text{shoulder breadth} \times \text{sagittal chest diameter}}$.

Von Rohden $= \dfrac{\text{Symphysis height}}{\text{Chest circumference} \times \text{anterior trunk height}}$.

Lucas and Pryor $= \dfrac{\text{Bi-iliac diameter} \times 1{,}000}{\text{Stature}}$.

Pignet-Ver Vaeck $= \dfrac{\text{Weight} + \text{chest circumference} \times 100}{\text{Stature}}$.

Martin $= \dfrac{\text{Bicristal diameter}}{\text{Shoulder breadth}}$.

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