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# BODY-BUILD IN ILLINOIS CONVICTS WITH SPECIAL REFERENCE TO AGE<sup>1</sup>

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H GRAY<sup>2</sup>

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## INTRODUCTION

Many people believe that they can estimate the mental characteristics of a person by looking at the shape of the eyes, mouth or ears; and furthermore a good many physicians for more than a century have believed that they could form an opinion on the ailments likely in patients with certain kinds of body build. The natural developments of these beliefs have been photographs and physical measurements.

## AIMS

Crime like disease has been studied in relation to physical build, but about as imperfectly. The tedium of measuring a wide enough assortment of traits to represent build and of tabulating a large enough number of individuals to provide measures of human variation for statistical study, has militated against this method of investigation in medicine. Goring published 20 years ago his monumental work on the English Convict, in which (p. 370) he concluded that "the criminal of English prisons is markedly differentiated by defective physique, as measured by stature and body weight."

Such series with the eternally changing conditions of racial stock, age and secular time rendered as constant as possible, will round out our knowledge of the behavior of human build, so that the study of physique in disease will become more fruitful.

The suggestion and opportunity of studying simultaneously a series of convicts and of insane was presented in 1927 by Dr. Herman M. Adler, then director of the Institute for Juvenile Research in Chicago. Part of the observations on psychotic patients were published in 1931,<sup>3</sup> and more is in progress of analysis.

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<sup>1</sup>Presented before the American Association for the Advancement of Science, at Berkeley, June 21, 1934. From the Illinois Institute for Juvenile Research, aided by the Behavior Research Fund; and from Stanford University School of Medicine, aided by the Rockefeller Fluid Research Fund.

<sup>2</sup>Stanford University.

<sup>3</sup>Gray, H., and Ayres, J. G.: *Body-Build in Manic-Depressive Psychosis*, Proc. of Assoc. for Research in Nervous and Mental Disease, Meeting Dec. 30, 1930, published by Williams and Wilkins Co., Baltimore, 11: p. 65 (Oct.) 1931.

## MATERIAL

*Subjects.*—Convicts.

*Source.*—The state penitentiary at Joliet, Illinois.

*Sex.*—Males only.

*Age.*—20 to 80 years.

*Epoch.*—The period of time during which the observations were made was from July, 1927 to January, 1929.

*Exclusions.*—Persons suffering from any congenital defect or acquired deformity, or who were rickety, syphilitic or tuberculous in such a manner as directly to affect their anthropometric characters.

*Race and Numbers.*—There were 587 whites and 248 negroes. This paper treats only whites.

## METHODS OF MEASUREMENT

*Anthropological manuals and instruments.*—Hrdlička's were used.

*Observers.*—The observations could not all be made by one individual. At various times I had the aid of James G. Ayres, M. B. Dodds and S. O. L. Robinson, all college graduates, whose help I wish to acknowledge gratefully. As each new worker came along measurements were made in duplicate until agreement was satisfactory.

*Precision of measurements.*—The importance of what is variously called the personal equation, the error in measuring, or the observational error, may be determined in two ways. Fisher prefers the standard error from the mean of two measurements made on the same subject, either by the same observer or by two different observers. Unfortunately, I have no records of such paired observations to analyze.

Another method is to compare mean values on a series of individuals measured at one time by one or more observers, with a mean on a presumably like series at another time by a single observer. Some such records are available on the convicts. The first series was measured in 1927 by several observers, and the second series was measured in 1928 by a single observer, J. G. Ayres. The positive findings will be discussed first, and after that the traits which were measured with essentially the same results in both series. Under the positive findings may be considered, first, the means, then the variabilities.

The means ran smaller for the absolute measurements in the series measured by the single observer for the following traits: chest transverse diameter, nose breadth, bi-acromial diameter, head height; chest

index—depth over breadth AP/T, trunk index of pelvis to shoulder BC/BA; all these are essentially attributable to firmer pressure on the part of the single observer than on the part of the team who measured in the previous year. The effect of these differences on the average measurements for the whole two series of about equal size, as given in the published tables for the convicts, seems, on the whole, not to have caused a definite bias toward too high or too low values; therefore, while it would be better to have had more perfect agreement in technic, I do not feel that the pooled results are invalidated by these differences.

The variabilities, as measured by the standard deviations and the co-efficients of variation, were significantly smaller for the series measured by the one observer for the items: chest transverse diameter, nose breadth, and the index bi-zygomatic over head breadth; and were also smaller, though not mathematically so, for all the other items compared.

The traits compared but showing no significant differences, either in means or variabilities, were the following: sitting height, face length MN, relative chest depth AP/S, and the nasal index NB/NH.

The details of the differences which were statistically significant are shown in Table 1, in which the first line was based on white con-

TABLE 1.

Trait	Means			Standard Deviation in mm.			Coefficient of Variation in %		
	Diff.	± PE	D/PE	Diff.	± PE	D/PE	Diff.	± PE	D/PE
Chest transverse T	20.5 mm.	1.4	15.1	7.48	.35	21.3	2.89	.31	9.3
Nose breadth NB	1.07 mm.	.18	6.0				1.49	.35	4.2
Nose breadth NB				1.42	.19	7.3	3.30	.50	6.7
Bi-acromial BA	7.0 mm.	1.7	4.2						
Head-height OH	5.12 mm.	.40	13.0						
Relative OH/S	.30 %	.03	9.5						
Relative MN/S							1.23	.36	3.4
Index AP/T	7.90 %	.42	18.9						
Index BC/BA	1.86 %	.37	5.0						
Index BZ/B				.42	.09	4.5			

victs aged 20 to 60, 348 in number in 1927 and 220 in number in 1928; the second line on white convicts aged 20 to 30 with respective N's 165 and 115; and, finally, for all the subsequent lines on negro convicts aged 20 to 60 with N's respectively of 142 and 106.

*Units of measurement.*—Metric throughout, kilograms and millimeters.

*Units of age.*—Birth dates were recorded and ages calculated to the nearest year, so that 19.5 plus to 20.5 minus was called 20, and so forth; the age-group 20-30 years, more exactly 19.5 to 29.5, then had a mid-point 24.50 years.

*Clothing.*—None was worn; all measurements are net.

*Time of day.*—It was impossible to do all the work at the same hour of the day; in fact the work went on through a great part of the day. With regard to weight I am not aware of any tendency for persistent bias to be introduced through relation to meals during any part of the series. With reference to stature, which shrinks about a centimeter between rising and about four hours later, I assume that my means were affected by the diurnal variation no differently from most heights, which ordinarily are taken at least an hour after rising and presumably approach the subject's minimum rather than maximum stature.

*Time of year.*—The season likewise varied through the year.

*Choice of measurements.*—On starting an anthropological project one often wishes to consider the choice of measurements and method made by earlier students of growth and build. This topic in detail was discussed by Ayres and me in 1931,<sup>4</sup> and the following may be added with respect to head-height.

*Head-height from the earhole (OH).*—The auricular head height OH throughout this paper follows that favored in recent years by the majority of anthropologists, namely the porion (highest point of the external auditory meatus) to apex (the intersection of the mid-sagittal plane of the head with a frontal plane perpendicular both to the biporion axis and the left Frankfurt Horizontal). Alternative methods have been elaborately compared in earlier papers, which satisfied us that Todd's head-spanner is much the most accurate method, and therefore it was used in nearly all our work.

For comparison with the Illinois convicts, the head-heights obtained by other writers with different instruments and landmarks have been converted to OH equivalents, on the basis of the following con-

<sup>4</sup>Gray and Ayres, *Growth in Private School Children*, p. 28. Behavior Research Fund Monograph, published by University of Chicago Press, p. 28, Dec., 1931.

siderations. Goring<sup>5</sup> took "the vertical distance of the centre of the external auricular meatus below a horizontal plane tangential to the top of the head." His landmarks seem equivalent to those defined by Robinson and me<sup>6</sup> as meation (me) and tangential-vertex (TV). Now TV coincides with apex (A) in many white skulls, but in some (and particularly in negro skulls) lies about a centimeter in front or behind A; specifically, in 100 skulls (more accurately measureable than the living head) Becker and I<sup>7</sup> found that the chord TV to A averaged  $8.5 \pm 0.4$  mm. *behind* Apex, with a maximum of 28 mm. Further we found<sup>8</sup> that TV lay *skyward* of A by an average of  $0.92 \pm .059$  mm. (TV-A). Furthermore the radius from the porion-axis to TV (Po-TV) averaged  $1.14 \pm .09$  mm. larger than the standard OH (porion-axis to Apex), a statistically significant divergence; or when the radius from porion-axis to bregma (Po-Bg) was examined, it was less than OH (=Po-A) by an average of  $0.90 \pm .08$  mm.

Since the kind of cephalometer used by Goring does not strictly tell whether his upper landmark was bregma (which we found anterior to apex by  $20.8 \text{ mm.} \pm .5$ ), or TV (behind A by  $8.5 \text{ mm.} \pm 0.4$ ) we shall for the present purposes assume that such of his heights as happened to approximate bregma (probably smaller than our apex height by about 0.9 mm.<sup>9</sup>) occurred in equal numbers and therefore balanced such of his heights as happened to approximate TV (probably larger than our apex height by 1.1 mm.), and accordingly that any error caused by his upper landmark is negligible. Important however is his lower landmark, centre of meatus (meation=me) which Dodds and I<sup>10</sup> found to lie approximately three millimeters lower than porion. Goring's head-heights have consequently been here decreased to OH equivalents by subtracting 3 mm.

Insufficient upward traction deserves special emphasis. It has been, even with Todd's head-spanner, the main difficulty in technique for the beginner. Not only that, but after long experience it remains a slip easy to make. Conviction has grown increasingly keen as, in the course of measuring over 6000 persons (2872 boys, 1234 girls, 583 white and 248 negro convicts, 318 schizophrenics, 126 maniac-depressives, 192 miscellaneous psychoses, 109 football players, 253 feeble-minded boys), my associates and I have periodically controlled our traction by re-applying the tongs to one another. Lapses from

<sup>5</sup>The English Convict, p. 39. London, 1913.

<sup>6</sup>Robinson and Gray, p. 326.

<sup>7</sup>Becker and Gray, p. 305.

<sup>8</sup>*Ibid.*, pp. 302, 304.

<sup>9</sup>*Ibid.*, p. 307.

<sup>10</sup>Dodds and Gray, p. 316.

incessant vigilance yield head-heights which are falsely large. The reason is that the thickness of covering of the roof of the external auditory meatus is variable, as is the upward movement of the external ear, as reviewed by Dodds and one in 1928.<sup>11</sup> Firm, gentle, gradual continued traction must scrupulously be applied until the cartilaginous opening be displaced upward and the soft tissues compressed as much as the patient will permit, in order that the ear-tip may rest as close as possible to the bony roof. Anxiety as to short-coming in this regard must necessarily arise when OH values are reported above 130, and reassurance is wanted for values above 134.

### STATISTICAL METHODS

The simpler of the conventional biometric methods, which were detailed in our book on Growth in Private School Children, may be summarized.

*Statistical arithmetic.*—For those rusty in these matters it may be convenient to give brief definitions of the so-called statistical constants.

N=the number of observations in a given group. This constant is useful to evaluate the reliability of the results.

f=number of observations in a sub-group or class.

M=the arithmetic mean. This constant tells us the average size for any trait such as stature.

SD or  $\sigma$ =the standard deviation or sigma. This constant tells us how much the individuals in the distribution vary around the mean. Two groups may have the same average but one may be much more variable than the other. The range, so often used in the past, is frowned on by statisticians, because rare outlying values receive undue attention. The SD is calculated by noting the deviation of the measurement (e. g., of stature) of person number one, number two, and so on, from the average, then squaring each deviation, adding these squares, dividing by the number of measurements N, and extracting the square root of the quotient. It is therefore called the root-mean-square-deviation, and is preferred by statisticians to the average deviation obtained by the simpler method of directly adding and averaging the deviations, without squares and square roots. Now the SD states the variation in *absolute* units such as millimeters; and since a variation of say 50 mm. is much more significant if the average happens to be 500 mm. than if the average be 1000 mm., the SD is usually

<sup>11</sup>*Ibid.*, p. 315.

more comprehensible when transmuted into a percentage, on dividing it by the mean  $M$ .

CV or  $V$ =then the coefficient of variation, that is, the *percentage* or relative variation  $100 \text{ SD}/M$ .

PE or  $E$ =the probable error. This term is generally agreed to be unsatisfactory but hallowed by use. It is calculated for each of the three constants  $M$ ,  $SD$  and  $CV$ , by multiplying 0.6745 times the standard error for that constant. These three standard errors are all derived from the  $SD$  by the use of formulae found in sundry manuals, most easily in Pearson's Tables for Statisticians. In publication it is usually desirable to follow each constant by a plus-minus sign  $\pm$ , followed in turn by the PE of that constant; a few authorities, notably Boas, use  $\pm \text{SD}$ .

The probable error does not refer to possible inaccuracies of measurements because these are assumed to have been reduced to a minimum and to have been kept free from bias by care in the anthropological technique. The term does refer to probable errors of random sampling, that is to say the variations (due to unknown causes) between the constants for successive samples (groups of persons) taken at random (without selection). The PE therefore is a measure of the reliability of results. Its commonest use in medicine is to enable one to judge whether the difference found between two averages (or other parameters), a difference which to ordinary inspection appears of doubtful significance, be according to the experiences of probability (the laws of chance) statistically significant. The judgment is based on the critical ratio, obtained by dividing the difference by the PE of that difference. If this ratio is 3 or more, that is if the difference is three times its PE, it is customary to call the difference statistically significant. When one wishes a more refined judgment, one can look up the quotient in a table of the normal curve and read off the exact probability as so many per hundred or per thousand.

$\text{PE} (M_1 - M_2) =$  the probable error of the difference between two averages. It is usually derived from the following formula, letting  $\text{PE}_1$  be the PE of the one mean and  $\text{PE}_2$  be the PE of the second mean:  $\sqrt{(\text{PE}_1)^2 + (\text{PE}_2)^2}$ . If there were a relationship between the observations composing a first mean and those composing a second, e. g., brothers and sisters respectively, one should use the somewhat more complex formula recommended by Yule chap. XIII, section 13, case II (5).



TABLES OF CONSTANTS

The raw original measurements and even the frequency distributions cannot here be published owing to lack of space. The reduced data will be presented in tables of constants grouped by age. Afterward, more interesting comparisons will be shown. A synopsis of these basal tables follows:

GROUP	AGE				
Decades	20 - 30	30 - 40	40 - 50	50 - 60	
	av. 24.9	av. 34.5	av. 44.0	av. 53.0	
	N 281	N 155	N 93	N 46	
20-Year Lots	20 - 40 av. 28.3, N 429		40 - 60 av. 47.0, N 139		60 - 80 av. 65.8, N 19
40-Year Pool	20 - 60 average age 32.9, N 568				
60-Year Pool	20 - 80 average age 33.9, N 587				

TABLE OF CONSTANTS

Convicts  
Illinois

Age = 24.9 years (20-30)

N = 281

Racial Stocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE		SD ± PE		CV ± PE	
Weight in k.	W	65.793	310	7.701	.219	11.705	.338
Stature in mm.	S	1715.036	2.645	65.742	1.870	3.833	.109
Sitting height	Si	912.491	1.304	32.404	.922	3.551	.101
Chest Circumf.	C	905.142	1.862	48.757	1.387	5.387	.154
Trans.	T	310.380	1.066	26.489	.754	8.535	.245
Ant. post.	AP	219.374	.602	14.948	.425	6.814	.195
Module	ChM	265.174	.689	17.115	.487	6.454	.184
Shoulder Biacromial	BA	382.868	.780	19.380	.551	5.062	.144
Pelvis Bicristal	BC	286.674	.553	13.686	.391	4.774	.137
Head Length	L	192.813	.281	6.983	.199	3.621	.103
Breadth	B	153.347	.215	5.355	.152	3.492	.099
Height	OH	127.950	.212	5.271	.150	4.120	.118
Module	CM	157.989	.165	4.097	.117	2.593	.074
Face Height	MN	125.438	.272	6.763	.192	6.392	.154
Breadth	BZ	139.193	.203	5.038	.143	3.619	.103
Module	FM	132.659	.178	4.419	.126	3.334	.095
Nose Height	NH	56.464	.161	3.996	.114	7.078	.203
Breadth	NB	56.307	.096	2.359	.067	6.498	.186
Above - named measurements in percent of Stature	W/S	38.427	.161	4.009	.114	10.433	.300
	Si/S	53.249	.053	1.327	.038	2.492	.071
	C/S	52.847	.127	3.163	.090	5.984	.171
	T/S	18.120	.068	1.679	.048	9.264	.266
	AP/S	12.823	.035	.858	.024	6.692	.191
	ChM/S	15.480	.045	1.111	.032	7.175	.205
	BA/S	22.340	.046	1.155	.033	5.171	.148
	BC/S	16.740	.028	.703	.020	4.201	.120
	L/S	11.264	.021	.530	.015	4.701	.134
	B/S	8.948	.018	.449	.013	5.015	.143
	OH/S	7.481	.015	.365	.010	4.875	.139
	CM/S	9.229	.015	.372	.011	4.033	.115
	MN/S	7.322	.017	.423	.012	5.782	.165
BZ/S	8.142	.016	.400	.011	4.913	.140	
FM/S	7.746	.014	.338	.010	4.358	.124	
NH/S	3.288	.011	.266	.008	8.077	.232	
NB/S	2.119	.007	.163	.005	7.693	.221	
Index Chest	AP/T	71.244	.257	6.384	.182	8.962	.257
Trunk breadth	BC/BA	75.093	.176	4.357	.124	5.803	.166
Cephalic	B/L	79.548	.150	3.718	.106	4.673	.133
Facial	MN/BZ	90.226	.228	5.666	.161	6.279	.179
Face/Head L	MN/L	65.057	.147	3.665	.104	5.634	.161
Face/Head B	BZ/B	91.039	.124	3.070	.087	3.372	.096
Nasal	NB/NH	64.763	.250	6.202	.176	9.576	.275

TABLE OF CONSTANTS

Convicts  
Illinois

Age = 34.5 years (30-40)

N = 155

Racial Stocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in k.	W	66.323 .479	8.838 .339	13.325 .519
Stature in mm.	S	1701.129 3.699	68.273 2.615	4.013 .154
Sitting height	Si	903.613 1.715	31.661 1.213	3.504 .134
Chest Circumf.	C	912.161 3.158	58.296 2.233	6.391 .246
Trans.	T	310.568 1.532	28.285 1.084	9.107 .352
Ant.post.	AP	226.581 .974	17.978 .689	7.935 .306
Module	ChM	268.581 1.109	20.476 .784	7.624 .294
Shoulder Biacromial	BA	377.742 1.056	19.490 .747	5.154 .198
Pelvis Bicristal	BC	287.613 .822	15.165 .581	5.273 .203
Head Length	L	192.242 .407	7.513 .288	3.908 .150
Breadth	B	152.816 .303	5.599 .214	3.664 .141
Height	OH	127.127 .284	5.212 .201	4.100 .158
Module	CM	157.431 .239	4.382 .169	2.783 .107
Face Height	MN	126.165 .372	6.871 .263	5.446 .209
Breadth	BZ	140.423 .305	5.633 .216	4.012 .154
Module	FM	133.439 .257	4.743 .182	3.554 .136
Nose Height	NH	56.723 .210	3.878 .149	6.837 .263
Breadth	NB	36.129 .187	2.895 .111	8.014 .309
Above-named measurements in percent of Stature	W/S	39.019 .260	4.798 .184	12.295 .478
	Si/S	53.129 .076	1.407 .054	2.648 .102
	C/S	53.755 .817	4.001 .153	7.442 .287
	T/S	18.287 .101	1.872 .072	10.236 .396
	AP/S	13.325 .062	1.146 .044	8.601 .332
	ChM/S	15.839 .073	1.345 .052	8.492 .328
	BA/S	22.255 .069	1.274 .049	5.725 .220
	BC/S	16.929 .045	.824 .032	4.869 .187
	L/S	11.316 .029	.528 .020	4.670 .179
	B/S	9.020 .027	.498 .019	5.517 .212
	OH/S	7.493 .020	.369 .014	4.919 .190
	CM/S	9.276 .021	.393 .015	4.234 .164
	MN/S	7.430 .022	.411 .016	5.534 .213
BZ/S	8.265 .024	.445 .017	5.384 .207	
FM/S	7.862 .019	.354 .014	4.503 .173	
NH/S	3.335 .013	.232 .009	6.948 .267	
NB/S	2.129 .011	.194 .007	9.119 .352	
Index Chest	AP/T	73.384 .335	6.177 .237	8.417 .325
Trunk breadth	BC/BA	76.252 .248	4.583 .176	6.010 .231
Cephalic	B/L	79.761 .215	3.973 .152	4.981 .191
Facial	MN/BZ	90.074 .296	5.467 .209	6.069 .233
Face/Head L	MN/L	65.748 .204	3.756 .144	5.713 .220
Face/Head B	BZ/B	91.729 .153	2.825 .108	3.079 .118
Nasal	NB/NH	64.029 .379	6.999 .268	10.931 .424

TABLE OF CONSTANTS

Convicts

Age = 44.0 years ( 40-50)

N = 93

Illinois

Racial Stocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in k.	W	69.065 .699	10.000 .495	14.479 .731
Stature in mm.	S	1690.269 4.812	68.808 3.403	4.071 .202
Sitting height	Si	893.871 2.316	33.119 1.638	3.705 .184
Chest Circumf.	C	935.753 4.028	57.590 2.848	6.154 .306
Trans.	T	314.473 1.794	25.648 1.269	8.156 .406
Ant. post.	AP	235.516 1.395	19.947 .987	8.470 .422
Module	ChM	275.226 1.314	18.789 .929	6.827 .339
Shoulder Biacromial	BA	377.839 1.466	20.964 1.037	5.548 .275
Pelvis Bicristal	BC	293.656 1.228	17.554 .868	5.978 .297
Head Length	L	192.360 .488	6.974 .345	3.625 .180
Breadth	B	154.199 .411	5.873 .290	3.809 .189
Height	OH	127.609 .386	5.490 .273	4.302 .214
Module	CM	158.022 .309	4.391 .218	2.779 .138
Face Height	MN	124.554 .480	6.857 .339	5.505 .273
Breadth	BZ	140.726 .405	5.785 .286	4.111 .204
Module	FM	133.086 .351	5.020 .248	3.772 .187
Nose Height	NH	56.849 .265	3.793 .188	6.672 .331
Breadth	NB	36.946 .188	2.672 .133	7.232 .361
Above - named measurements in percent of Stature	W/S	40.742 .391	5.586 .276	13.710 .691
	Si/S	52.914 .092	1.318 .065	2.490 .123
	C/S	55.419 .271	3.881 .192	7.003 .348
	T/S	18.676 .118	1.687 .083	9.036 .451
	AP/S	13.945 .087	1.247 .062	8.940 .445
	ChM/S	16.323 .089	1.276 .063	7.816 .389
	BA/S	22.394 .092	1.318 .065	5.887 .292
	BC/S	17.377 .063	.903 .045	5.196 .258
	L/S	11.403 .036	.517 .026	4.532 .225
	B/S	9.137 .035	.498 .025	5.449 .270
	OH/S	7.560 .028	.392 .019	5.179 .258
	CM/S	9.359 .027	.391 .019	4.174 .208
	MN/S	7.402 .031	.443 .022	5.980 .297
BZ/S	8.356 .033	.465 .023	5.570 .276	
FM/S	7.892 .027	.387 .019	4.907 .243	
NH/S	3.367 .016	.234 .012	6.943 .345	
NB/S	2.188 .013	.180 .009	8.244 .413	
Index Chest	AP/T	75.081 .483	6.907 .342	9.199 .459
Trunk breadth	BC/BA	77.812 .359	5.128 .254	6.590 .327
Cephalic	B/L	80.194 .260	3.714 .184	4.631 .230
Facial	MN/BZ	88.591 .365	5.225 .258	5.897 .293
Face/Head L	MN/L	64.968 .258	3.682 .182	5.668 .281
Face/Head B	BZ/B	91.473 .198	2.838 .140	3.403 .154
Nasal	NB/NH	64.891 .454	6.463 .321	9.960 .500

TABLE OF CONSTANTS

Convicts

Age = 53.0 years ( 50-60)

N = 46

Illinois

Racial Stocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight	W	71.239 1.051	10.571 .743	14.839 1.066
Stature in mm.	S	1691.957 6.056	60.894 4.282	3.599 .258
Sitting height	Si	897.391 2.093	31.098 2.187	3.465 .244
Chest Circumf.	C	948.043 5.854	58.861 4.139	6.209 .438
Trans.	T	316.565 2.544	25.583 1.799	8.082 .574
Ant. post.	AP	239.435 1.612	16.213 1.140	6.771 .478
Module	ChM	277.826 1.709	17.184 1.208	6.185 .437
Shoulder Biacromial	BA	376.000 1.888	18.779 1.335	4.995 .356
Pelvis Bicristal	BC	296.217 1.756	17.661 1.242	5.693 .421
Head Length	L	192.196 .705	7.092 .499	3.690 .260
Breadth	B	155.413 .518	5.204 .366	3.348 .236
Height	OH	128.022 .600	6.035 .424	4.714 .332
Module	CM	158.478 .432	4.348 .306	2.743 .193
Face Height	MIN	126.674 .734	7.385 .519	5.830 .411
Breadth	BZ	141.804 .507	5.095 .358	3.593 .253
Module	FM	134.370 .454	4.570 .321	3.401 .259
Nose Height	NH	37.500 .397	3.988 .280	6.935 .490
Breadth	NB	37.457 .294	2.954 .208	7.886 .558
Above - named measurements in percent of Stature	W/S	42.000 .541	5.437 .382	12.946 .926
	Si/S	53.065 .111	1.113 .078	2.098 .148
	C/S	56.109 .332	3.338 .235	5.949 .420
	T/S	18.761 .147	1.481 .104	7.893 .558
	AP/S	14.148 .099	.998 .070	7.051 .498
	ChM/S	16.465 .103	1.033 .073	6.276 .443
	BA/S	22.253 .108	1.079 .077	4.648 .346
	BC/S	17.502 .094	.944 .066	5.394 .380
	L/S	11.376 .044	.440 .031	3.870 .273
	B/S	9.189 .040	.402 .028	4.373 .308
	OH/S	7.572 .038	.383 .027	5.060 .357
	CM/S	9.380 .033	.331 .023	3.526 .248
	MIN/S	7.502 .043	.434 .031	5.787 .408
	BZ/S	8.376 .036	.358 .025	4.277 .301
FM/S	7.954 .030	.298 .021	3.742 .264	
NH/S	3.399 .022	.219 .015	6.446 .455	
NB/S	2.214 .019	.193 .014	8.709 .617	
Index Chest	AP/T	75.848 .652	6.558 .461	8.646 .613
Trunk breadth	BC/BA	78.944 .590	5.871 .417	7.437 .532
Cephalic	B/L	80.848 .368	3.701 .260	4.577 .323
Facial	MIN/BZ	89.630 .581	5.844 .411	6.521 .461
Face/Head L	MIN/L	66.022 .447	4.494 .316	6.807 .481
Face/Head B	BZ/B	91.130 .259	2.601 .183	2.854 .201
Nasal	NB/NH	65.543 .667	6.705 .471	10.230 .727

TABLE OF CONSTANTS

Convicts

Age = 28.3 years (20-40)

N = 429

Illinois

Racial Stocks: All White

Measurements metric &amp; without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in k.	W	65.965 .266	8.166 .188	12.380 .289
Stature in mm.	S	1710.781 2.183	67.040 1.544	3.919 .090
Sitting height	Si	909.744 1.052	32.318 .744	3.552 .082
Chest Circumf.	C	907.471 1.724	52.945 1.219	5.854 .135
Trans.	T	505.874 .899	27.600 .656	9.023 .209
Ant. post.	AP	222.152 .540	16.582 .382	7.464 .173
Module	ChM	266.291 .611	18.774 .432	7.050 .165
Shoulder Diacromial	DA	380.959 .645	19.747 .455	5.184 .120
Pelvis Bicurial	BC	286.856 .468	14.326 .351	4.995 .116
Head Length	L	192.635 .254	7.179 .165	3.727 .086
Breadth	B	153.288 .178	5.475 .126	3.571 .082
Height	OH	127.739 .175	5.352 .124	4.190 .097
Module	CM	157.805 .137	4.202 .097	2.663 .062
Face Height	FM	125.693 .222	6.831 .157	5.455 .126
Breadth	BZ	139.777 .173	5.304 .122	3.794 .088
Module	FM	132.831 .150	4.598 .106	3.461 .080
Nose Height	NH	56.542 .130	3.975 .092	7.030 .163
Breadth	NB	36.220 .084	2.567 .059	7.086 .164
Above - named measurements in percent of Stature	W/S	38.611 .141	4.330 .100	11.215 .268
	Si/S	53.198 .044	1.361 .031	2.558 .059
	C/S	53.131 .114	3.504 .081	6.596 .153
	T/S	18.173 .057	1.754 .040	9.654 .224
	AP/S	13.001 .035	1.063 .024	8.180 .190
	ChM/S	15.609 .040	1.226 .028	7.856 .182
	BA/S	22.294 .039	1.202 .028	5.390 .125
	BC/S	16.798 .025	.752 .017	4.476 .104
	L/S	11.280 .017	.532 .012	4.719 .109
	B/S	8.973 .015	.474 .011	5.280 .122
	OH/S	7.484 .012	.366 .008	4.596 .113
	CM/S	9.243 .012	.382 .009	4.137 .096
	FM/S	7.358 .014	.423 .010	5.751 .133
	BZ/S	8.183 .014	.423 .010	5.168 .119
FM/S	7.784 .011	.349 .008	4.485 .104	
NH/S	3.260 .008	.256 .006	7.844 .182	
NB/S	2.122 .006	.175 .004	8.225 .191	
Index Chest	AP/T	72.006 .208	6.393 .147	8.879 .206
Trunk breadth	BC/BA	75.460 .146	4.496 .104	5.945 .138
Cephalic	B/L	79.615 .125	3.827 .088	4.806 .111
Facial	FM/BZ	90.113 .153	5.610 .129	6.225 .144
Face/Head L	FM/L	65.296 .122	3.735 .086	5.720 .132
Face/Head B	BZ/B	91.280 .098	3.018 .070	3.306 .076
Nasal	NB/NH	64.551 .215	6.594 .152	10.215 .238

TABLE OF CONSTANTS

Convicts

Age = 47.0 years (40-60)

N=139

Illinois

Racial Stocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in k.	W	69.633 .581	10.162 .411	14.594 .603
Stature in mm.	S	1690.468 3.840	67.122 2.715	3.971 .161
Sitting height	Si	895.036 1.860	32.506 1.315	3.632 .147
Chest Circumf.	C	940.540 3.334	58.275 2.357	6.196 .252
Trans.	T	310.935 1.458	25.477 1.031	8.194 .334
Ant. post.	AP	236.856 1.074	18.775 .759	7.927 .323
Module	ChM	276.504 1.060	18.523 .749	6.699 .272
Shoulder Biacromial	BA	377.471 1.159	20.179 .819	5.346 .218
Pelvis Bicristal	BC	294.698 1.022	17.865 .723	6.082 .246
Head Length	L	192.572 .405	7.074 .286	3.673 .149
Breadth	B	154.601 .325	5.689 .230	3.680 .149
Height	OH	127.688 .335	5.842 .237	4.575 .186
Module	CM	158.174 .252	4.382 .178	2.770 .113
Face Height	MN	125.637 .403	7.044 .285	5.606 .227
Breadth	BZ	141.320 .324	5.661 .229	4.006 .162
Module	FM	133.579 .283	4.953 .200	3.708 .150
Nose Height	NH	57.065 .221	3.871 .157	6.783 .276
Breadth	NB	37.116 .160	2.780 .115	7.489 .306
Above - named measurements in percent of Stature	W/S	41.158 .319	5.569 .225	13.530 .557
	Si/S	52.957 .072	1.253 .051	2.366 .096
	C/S	55.647 .213	3.724 .151	6.692 .272
	T/S	18.692 .094	1.643 .066	3.794 .358
	AP/S	14.001 .066	1.157 .047	3.267 .337
	ChM/S	16.370 .069	1.203 .049	7.348 .299
	BA/S	22.348 .072	1.247 .051	5.580 .227
	BC/S	17.418 .053	.919 .037	5.274 .214
	L/S	11.394 .028	.494 .020	4.336 .176
	B/S	9.154 .027	.471 .019	5.151 .209
	OH/S	7.559 .022	.390 .016	5.156 .210
	CM/S	9.366 .021	.372 .015	3.971 .161
	MN/S	7.435 .025	.442 .018	5.949 .241
	BZ/S	8.363 .025	.433 .018	5.178 .210
FM/S	7.913 .021	.361 .015	4.565 .185	
NH/S	3.334 .013	.232 .009	6.954 .293	
NB/S	2.198 .011	.185 .008	8.409 .344	
Index Chest	AP/T	75.363 .388	6.781 .274	8.998 .367
Trunk breadth	BC/BA	78.181 .312	5.428 .220	6.943 .283
Cephalic	B/L	80.410 .213	3.722 .151	4.629 .192
Facial	MN/BZ	88.975 .313	5.468 .221	6.145 .250
Face/Head L	MN/L	65.317 .229	4.000 .162	6.124 .249
Face/Head B	BZ/B	91.360 .158	2.767 .112	3.028 .123
Nasal	NB/NH	65.442 .376	6.555 .266	10.016 .411

TABLE OF CONSTANTS

Convicts

Age = 65.8 years (60-80)

N = 19

Illinois

Racial Stocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in kg.	W	68.421 1.139	7.359 .805	10.755 1.190
Stature in mm.	S	1661.842 7.808	50.460 5.521	3.036 .333
Sitting height	Si	878.947 3.140	20.289 2.220	2.308 .253
Chest Circumf.	C	939.211 7.943	51.331 5.617	5.465 .600
Trans.	T	318.632 3.952	25.541 2.795	8.016 .883
Ant. post.	AP	244.526 2.302	14.877 1.628	6.084 .668
Module	ChM	281.842 2.659	17.184 1.880	6.097 .670
Shoulder Bicromial	BA	374.579 2.411	15.582 1.705	4.160 .456
Pelvis Bicristal	BC	298.368 1.986	12.833 1.404	4.301 .473
Head Length	L	194.447 1.124	7.265 .795	3.736 .409
Breadth	B	156.605 .808	5.219 .571	3.333 .365
Height	OH	127.921 .716	4.624 .506	3.615 .396
Module	CM	159.579 .495	3.201 .350	2.006 .220
Face Height	MN	122.447 .965	6.236 .682	5.093 .559
Breadth	BZ	143.342 .986	6.375 .698	4.447 .488
Module	FM	133.158 .799	5.163 .565	3.878 .425
Nose Height	NH	56.895 .524	3.386 .370	5.951 .653
Breadth	NB	39.211 .544	3.518 .385	8.872 .990
Above-named measurements in percent of Stature	W/S	41.263 .658	4.253 .465	10.307 1.140
	Si/S	52.789 .165	1.066 .117	2.012 .221
	C/S	56.632 .468	3.012 .330	5.519 .584
	T/S	19.132 .226	1.459 .160	7.624 .839
	AP/S	14.721 .118	.760 .083	5.163 .566
	ChM/S	16.921 .144	.933 .102	5.513 .605
	BA/S	22.553 .157	1.013 .111	4.490 .492
	BC/S	17.955 .129	.834 .081	4.647 .510
	L/S	11.703 .079	.511 .056	4.364 .478
	B/S	9.429 .068	.440 .048	4.669 .512
	OH/S	7.711 .060	.385 .042	4.594 .548
	CM/S	9.574 .066	.429 .047	4.481 .491
	MN/S	7.395 .068	.438 .048	5.527 .651
	BZ/S	8.579 .075	.487 .053	5.680 .624
FM/S	8.021 .067	.430 .047	5.360 .588	
NH/S	3.449 .036	.234 .026	6.791 .747	
NB/S	2.354 .035	.224 .025	9.508 1.050	
Index Chest	AP/T	76.553 1.060	6.848 .749	8.945 .987
Trunk breadth	BC/BA	79.763 .496	3.206 .351	4.020 .441
Cephalic	B/L	80.737 .617	3.985 .436	4.935 .541
Facial	MN/BZ	85.605 .809	5.225 .572	6.104 .670
Face/Head L	MN/L	63.158 .762	4.923 .539	7.795 .858
Face/Head B	BZ/B	91.632 .311	2.011 .220	2.195 .240
Nasal	NB/NH	69.395 1.203	7.772 .850	11.200 1.241



TABLE OF CONSTANTS

Convicts

Age = 32.9 years (20-60)

N = 568

Illinois

RacialStocks: All White

Measurements metric & without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in k.	W	66.863 .250	8.839 .177	13.220 .269
Stature in mm.	S	1705.808 1.914	67.626 1.353	3.964 .079
Sitting height	Si	906.161 .933	32.975 .660	3.639 .073
Chest Circumf.	C	914.882 1.561	55.150 1.104	6.028 .121
Trans.	T	311.593 .763	26.972 .540	8.656 .175
Ant. post.	AP	225.664 .517	18.282 .366	8.102 .165
Module	ChM	268.574 .533	18.835 .377	7.013 .141
Shoulder Biacromial	BA	379.799 .561	19.816 .397	5.217 .105
Pelvis Bicristal	BC	288.610 .445	15.694 .315	5.438 .109
Head Length	L	192.412 .202	7.132 .143	3.707 .074
Breadth	B	153.609 .157	5.557 .111	3.617 .072
Height	OH	127.688 .152	5.350 .107	4.190 .084
Module	CM	157.895 .121	4.249 .085	2.691 .054
Face Height	MN	125.486 .195	6.903 .138	5.501 .110
Breadth	BZ	140.155 .154	5.434 .109	3.877 .078
Module	FM	133.032 .132	4.664 .093	3.506 .070
Nose Height	NH	56.670 .112	3.956 .079	6.981 .141
Breadth	NB	36.438 .075	2.648 .053	7.268 .146
Above - named measurements in percent of Stature	W/S	39.234 .136	4.791 .096	12.210 .248
	Si/S	53.139 .038	1.339 .027	2.520 .050
	C/S	53.745 .105	3.721 .074	6.923 .139
	T/S	18.298 .049	1.734 .035	9.476 .191
	AP/S	13.246 .033	1.169 .022	8.827 .178
	ChM/S	15.795 .036	1.264 .025	8.000 .161
	BA/S	22.307 .034	1.213 .024	5.438 .109
	BC/S	16.951 .024	.840 .017	4.953 .100
	L/S	11.308 .015	.527 .011	4.658 .093
	B/S	9.017 .014	.480 .010	5.329 .107
	OH/S	7.502 .011	.374 .008	4.982 .100
	CM/S	9.273 .011	.384 .008	4.156 .083
	MN/S	7.377 .012	.429 .009	5.818 .117
	BZ/S	8.227 .012	.432 .009	5.248 .105
FM/S	7.816 .010	.356 .007	4.561 .091	
NH/S	3.322 .007	.254 .005	7.647 .154	
NB/S	2.140 .005	.179 .004	8.354 .169	
Index Chest	AP/T	72.792 .187	6.598 .132	9.064 .183
Trunk breadth	BC/BA	76.125 .138	4.874 .098	6.403 .129
Cephalic	B/L	79.810 .108	3.817 .076	4.782 .096
Facial	MN/BZ	89.863 .160	5.638 .113	6.274 .126
Face/Head L	MN/L	65.301 .108	3.801 .076	5.821 .117
Face/Head B	BZ/B	91.299 .084	2.958 .059	3.240 .065
Nasal	NB/NH	64.708 .188	6.614 .133	10.221 .207

TABLE OF CONSTANTS

Convicts

Age = 33.9 years (20-80)

N = 587

Illinois

Racial Stocks: All White

Measurements metric &amp; without clothing

MEASUREMENT		MEAN ± PE	SD ± PE	CV ± PE
Weight in k.	W	66.913 .245	8.800 .173	13.151 .263
Stature in mm.	S	1704.387 1.882	67.597 1.331	3.966 .078
Sitting height	Si	905.281 .918	33.000 .650	3.645 .072
Chest Circumf.	C	915.613 1.537	55.199 1.087	6.029 .119
Trans.	T	311.809 .751	26.976 .531	8.651 .172
Ant. post.	AP	226.274 .515	18.488 .364	8.171 .162
Module	ChM	269.003 .527	18.930 .373	7.037 .139
Shoulder Biacromial	BA	379.800 .549	19.718 .388	5.192 .103
Pelvis Bicristal	BC	288.889 .437	15.686 .309	5.424 .107
Head Length	L	192.478 .199	7.145 .141	3.712 .073
Breadth	B	153.706 .155	5.572 .110	3.625 .071
Height	OH	127.696 .149	5.329 .105	4.173 .083
Module	CM	157.949 .118	4.233 .084	2.680 .053
Face Height	MN	125.388 .192	6.903 .136	5.505 .109
Breadth	BZ	140.258 .153	5.497 .108	3.919 .077
Module	FM	133.026 .130	4.681 .092	3.518 .069
Nose Height	NH	56.677 .110	3.939 .078	6.950 .138
Breadth	NB	36.528 .076	2.726 .054	7.462 .148
Above - named measurements in percent of Stature	W/S	39.300 .133	4.788 .094	12.182 .245
	Si/S	53.128 .037	1.333 .026	2.509 .049
	C/S	53.838 .104	3.735 .074	6.938 .137
	T/S	18.325 .048	1.782 .034	9.452 .188
	AP/S	13.293 .032	1.187 .025	8.935 .177
	ChM/S	15.803 .035	1.253 .025	7.929 .157
	BA/S	22.317 .034	1.212 .024	5.432 .107
	BC/S	16.983 .024	.858 .017	5.053 .100
	L/S	11.321 .015	.531 .010	4.690 .093
	B/S	9.030 .014	.485 .010	5.364 .106
	OH/S	7.509 .011	.376 .007	5.007 .099
	CM/S	9.283 .011	.389 .008	4.186 .083
	MN/S	7.378 .012	.430 .008	5.822 .115
	BZ/S	8.238 .012	.438 .009	5.318 .105
FM/S	7.822 .010	.361 .007	4.614 .091	
NH/S	3.326 .007	.254 .005	7.651 .152	
NB/S	2.147 .005	.184 .004	8.588 .171	
Index Chest	AP/T	72.914 .185	6.640 .131	9.106 .181
Trunk breadth	BC/BA	76.243 .136	4.875 .096	6.394 .127
Cephalic	B/L	79.840 .107	3.826 .075	4.792 .095
Facial	MN/BZ	89.725 .158	5.670 .112	6.320 .125
Face/Head L	MN/L	65.233 .107	3.858 .076	5.914 .117
Face/Head B	BZ/B	91.310 .082	2.934 .058	3.213 .063
Nasal	NB/NH	64.861 .187	6.706 .132	10.339 .206

*Adult Age-groups Necessary.*—The significance even for adults of separate tables of constants for different ages must first be shown. Groups of one or five years were hardly warranted by the number of observations; even decades showed from 60-70 years only 15 men and from 70 to 80 years only 5 men so that for this range of 20 years one table only is published.

*Statistically Significant Age Differences.*—For each pair of successive decades, and also for each pair of successive 20 years lots, and for each of the 42 characters, the critical ratio was computed, to wit, the difference between two means divided by its probable error. Following the common practice of assuming any ratio of 3 or more (odds 22 to 1) to be significant, the material showed a considerable number of age-important items (details in the following table); or if one should be satisfied with a ratio of say 2.5 (odds 10 to 1) a good many more traits would have required notice. The briefer table is enough to prove the point.

*Graphic Differences.*—Furthermore, the statistically significant differences do not give a complete picture by any means. The reason is that many another difference between a pair of age groups, while too small to be mathematically significant by itself, becomes nevertheless clearly of moment when considered together with the differences between other pairs of age-groups. As examples of these trends of change in age-important traits, weight increased markedly with age while height decreased amazingly. These alterations parallel two controls: U. S. Army officers and English convicts, but on the whole emphasize age more vigorously. See Diagrams 1 and 2.

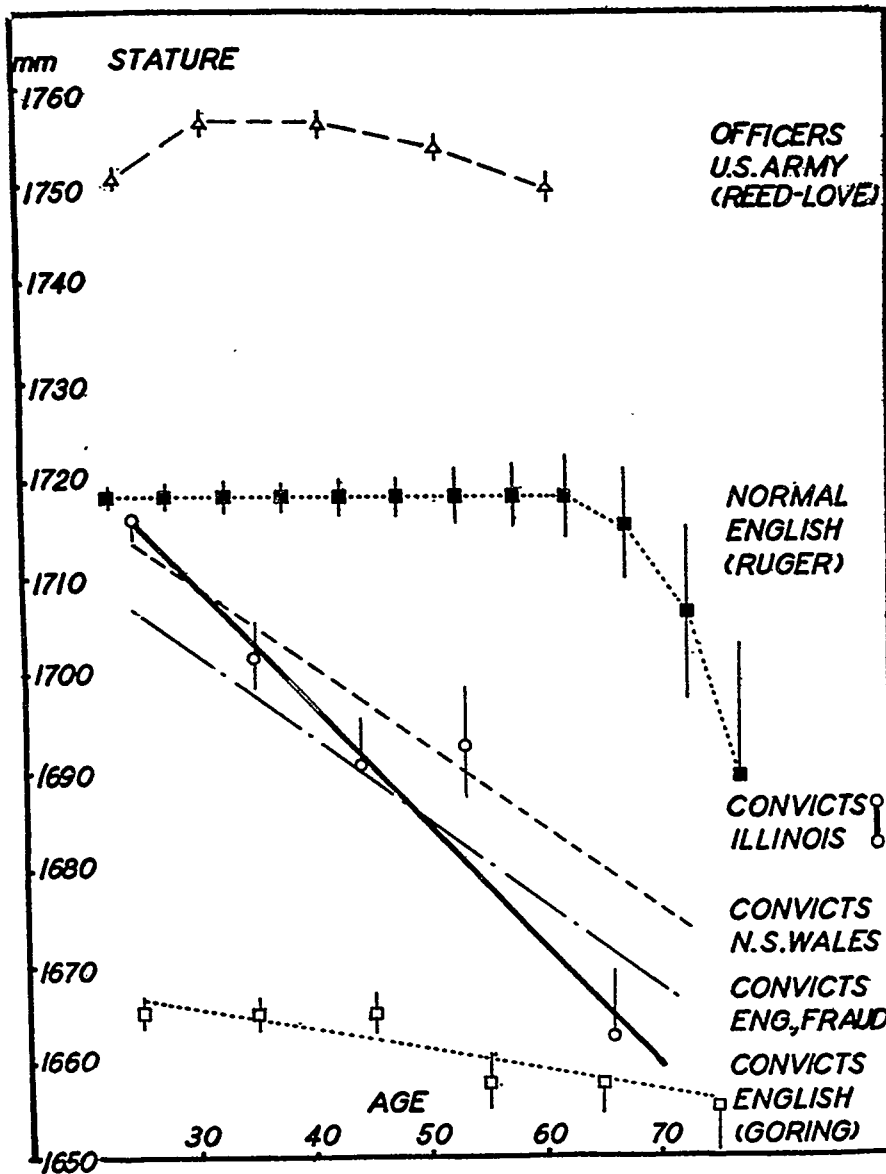
#### SUMMARY

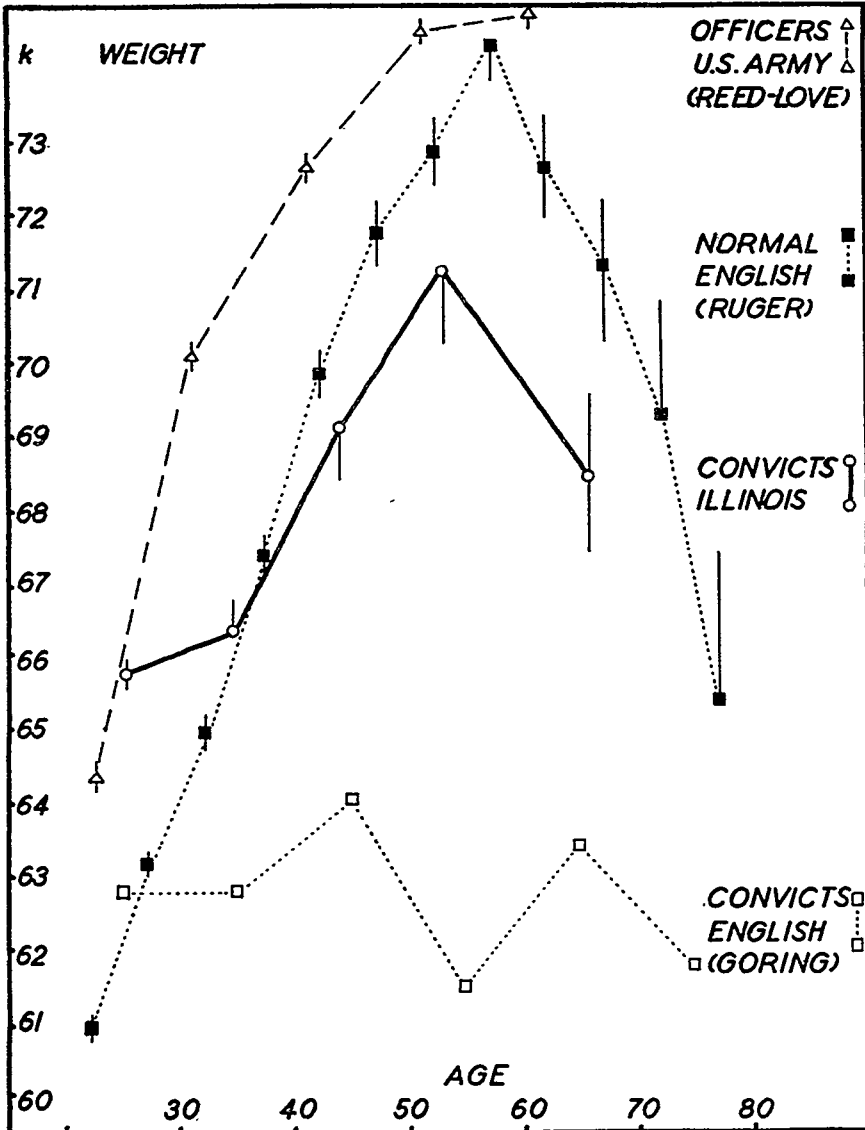
Of recent years the ancient study of body-build in relation to disease, psychosis or anti-social behavior, has made real progress. This has been due in part to completer measuring (not merely heights and weights) and in greater part to stricter selection of groups on the basis of homogeneity.

The present series consisted of 587 white male convicts at Joliet, Illinois, between the ages of 20 and 80, measured in 1927-1929. The observations were reduced to the statistical constants: means, variabilities, and probable errors. The tables of these constants are put on record for future comparison, not alone with criminals who may be studied, but as controls (not perfect, but I believe the best available) for patients with diseases affecting body-build.

TABLE 2.  
 STATISTICALLY SIGNIFICANT AGE DIFFERENCES  
 Difference between means  $\pm$  PE of the difference

	Decade named, compared with preceding decade			20-Year Lot named, compared with prior 20-year pool	
	30 - 40	40 - 50	50 - 60	40 - 60	60 - 80
W		2.7 $\pm$ .8		3.7 $\pm$ .6	
S	-13.9 $\pm$ 4.5			-20.3 4.4	-28.6 $\pm$ 8.7
Si	- 8.9 2.1	- 9.7 2.9		-14.7 2.1	-16.1 3.7
C		23.8 5.1		33.1 3.8	
T					
AP	7.2 0.6	8.9 1.7		14.7 1.2	7.7 2.5
ChM		6.6 1.7		10.2 1.2	
BA	- 5.1 1.3				
BC		6.0 1.5		7.9 1.1	
L					
B				1.3 .4	
OH					
CM					
MN					- 3.2 1.0
BZ	1.2 0.4			1.5 .4	
FM					
NH					
NB		.8 .2		.9 .2	2.1 .6
W/S		1.7 .5		2.5 .3	
Si/S					
C/S	.9 .3	1.7 .3		2.5 .2	
T/S				.5 .1	
AP/S	.5 .1	.6 .1	.8 .2	1.0 .1	.7 .1
ChM/S	.4 .1	.5 .1		.8 .1	.6 .2
BA/S					
BC/S	.19 .05	.4 .1		.6 .1	.5 .1
L/S				.11 .03	.31 .08
B/S				.18 .03	.28 .07
OH/S				.08 .02	
CM/S				.12 .02	.21 .07
MN/S	.11 .03				
BZ/S	.48 .02	- .27 .04		.18 .03	
FM/S	.11 .02			.13 .02	
NH/S				.07 .02	.12 .04
NB/S		.06 .02		.08 .01	
AP/T	2.1 .4			3.4 .4	
BC/BA	1.2 .3	1.6 .4		2.7 .3	
B/L				- 4.7 .2	5.8 .6
MN/BZ		- 1.5 .5		- 1.1 .4	- 3.4 .9
MN/L					
BZ/B	.7 .2				
NB/NH					4.0 1.3





The effect of age even in adults is demonstrated by two diagrams and a table of statistical critical ratios. In many traits the age-changes are so definite as to support strongly the contention of the Pearsonian school regarding the need of considering adults in separate age-groups.

Biological meaning. When considering an age trend found in the averages for any characteristic, it is important to remember that the phenomenon may not be a physiological alteration incident to increasing age, but may be secondary to selective mortality. For instance, the shrinkage in stature may be due in part to senile thinning of the intervertebral discs and relaxed posture, or in part to greater mortality among those who are tall.

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