

ANTHROPOMETRIC LABORATORY;

ARRANGED BY

FRANCIS GALTON, F.R.S.,

FOR

THE DETERMINATION OF HEIGHT, WEIGHT, SPAN, BREATHING
POWER, STRENGTH OF PULL AND SQUEEZE, QUICKNESS
OF BLOW, HEARING, SEEING, COLOUR-SENSE,
AND OTHER PERSONAL DATA.

THE LABORATORY IS SITUATED IN THE EAST CORRIDOR ANNEXE,
ENTRANCE FROM THE SOUTH GALLERY.

*Admission to the Laboratory 3d., for which a Schedule filled up with
the above details will be furnished.*

LONDON:
WILLIAM CLOWES AND SONS, LIMITED,
INTERNATIONAL HEALTH EXHIBITION,
AND 13, CHARING CROSS, S.W.

1884.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
STAMFORD STREET AND CHARING CROSS.

International Health Exhibition,
LONDON, 1884.

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ANTHROPOMETRIC LABORATORY

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THE object of the Anthropometric Laboratory is to show to the public the great simplicity of the instruments and methods by which the chief physical characteristics may be measured and recorded. The instruments at present in action deal with Keeness of Sight ; Colour-Sense ; Judgment of Eye ; Hearing ; Highest Audible Note ; Breathing Power ; Strength of Pull and Squeeze ; Swiftmess of Blow ; Span of Arms ; Height, standing and sitting ; and Weight.

Such is the ease of working the instruments that a person can be measured in these respects, and a card containing the results furnished to him, and a duplicate made and preserved for statistical purposes, at a total cost of 3*d.*

The use of periodical measurements is two-fold, personal and statistical. The one shews the progress of the individual ; the other, that of portions of the nation, or of the nation as a whole. We will consider these two uses separately.

Personal use.—Periodical measurements afford a sure test whether the physical development of the child or

youth is proceeding normally. They draw attention to faults in rearing to be diligently sought for and remedied, lest the future efficiency of the child, when it grows to manhood or womanhood, be compromised. There are hundreds of thousands of cases in which eye-sight has been heedlessly injured beyond repair by pure neglect ; of lopsided growth, and of stunted chest capacity, which measurement would have manifested in their earlier stages, and which could have been checked if attended to in time. The necessity of periodical measurement is thoroughly recognised by those who have studied the subject of health, but it has not yet obtained that hold on popular opinion which it deserves, and which it will hereafter undoubtedly exercise.

Statistical use. — Anthropometric records are treated statistically to discover the efficiency of the nation as a whole and in its several parts, and the direction in which it is changing, whether for better or worse. They enable us to compare schools, occupations, residences, races, &c. The Anthropometric Committee of the British Association took great pains to collect available data for inquiries of this kind, but their returns were by no means adequate to solve even the more important national questions, although many interesting facts were derived from them. There is great need for a more systematic registration of physical measurements. Their value is indisputable, the cost of making them is trifling, and the facility of registration in any permanent institution is obvious. It seems strange that they should be neglected at any school or university.

To show the use of preserving even the minor personal data, it will be well to dwell for a moment on the colour of the Eyes and Hair, which might be thought at first sight to have no obvious bearing on the general efficiency of the nation. This is far from being the case. The British nation is partly a blend and partly a mosaic of very distinct types. The short black-haired ancient British race unites imperfectly with the tall fair-haired Danish or Scandinavian. Their union resembles what druggists call an emulsion, that is, a

mixture of oil and water, so well shaken together that they form an apparently homogeneous substance ; but the combination is not durable. Leave the emulsion alone, and after a longer or shorter time it will separate into its component elements. Types are stable, but the forms of their mongrel offspring are not ; and whenever the external features of the old types are found in something of their original purity, it is reasonable to suppose that their inward characteristics are present also.

Whether it be as a race peculiarity or not, the colour of the hair is related, at least in America, to certain forms of immunity from disease or susceptibility to it. This is shown by the statistics published by the American War Office in 1875, under the direction of Dr. Baxter. At the time of the war of their rebellion all male citizens of the United States between the ages of 20 and 45 years were medically inspected with great minuteness, to learn how many were fit for service. About one quarter of those examined were rejected, and the diseases that incapacitated them are specified in Dr. Baxter's book, together with various particulars, including the colour of the hair and eyes. It appears from an analysis of between 330,000 and 340,000 of the best reported cases of invalidism, that the proportion of the light complexioned men who were unfit for service was larger than that of the dark. The light haired men in America were more affected than the dark haired by every form of disease except chronic rheumatism. A diagram in which these proportions are shown is hung up in the laboratory.

It follows that even the colour of the hair is a proper subject for anthropometric record ; much more may we feel assured that obviously important personal data deserve measurement and registration.

DESCRIPTION OF THE LABORATORY.

A space 36 feet long by 6 feet wide is fenced off from the side of a gallery by open lattice-work. It is entered by a door at one end, and is quitted by a second door at the other. The public can easily see through the lattice work, while they are prevented from crowding too close. A narrow table runs half-way down the side of the laboratory, on which the 'smaller instruments are placed. The measurements with the larger ones take place beyond the table.

The successive stations for the various operations lie in the following order :—

1. Desk at which the newly-entered person writes down certain data concerning himself.
 2. Standard colour for eyes and hair.
 3. Sight : (*a*) its keenness ; (*b*) the colour-sense ; (*c*) judgment of the eye in estimating length and squareness.
 4. Hearing : (*a*) its keenness (scarcely practicable on account of the noise and echoes) ; (*b*) highest audible note.
 5. Touch (exhibition of various apparatus).
 6. Breathing capacity.
 7. Swiftmess of blow with fist.
 8. Strength : (*a*) of pull ; (*b*) of squeeze with right and with left hands.
 9. Height : (*a*) when sitting, measured from the seat of the chair ; (*b*) standing in shoes ; (*c*) the thickness of the heel of the shoe.
 10. Span of the arms.
 11. Weight.
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PROCESS GONE THROUGH.

1. THE DESK.—On payment of 3*d.* at the door, the applicant is admitted to the desk, and given a frame which contains a card, over which thin transfer paper is stretched. Carbonised paper is placed between them. Thus a duplicate copy of the entries is obtained, to be kept for statistical purposes. The card with the entries upon it is given to the person measured.

No *names* are asked for. The following plan is adopted to secure such data for the duplicate copy as are needful for its use as a statistical document, without annoying the applicant, who may be disinclined to parade his or her age, &c., on the card. The transfer paper is doubled over the back of the card, and no carbonized paper is put behind the flap; consequently what may be written upon it will not appear on the card. The particulars required on the flap, are: Age last birthday; birthplace; state (married, unmarried, or widowed); residence, whether urban, suburban or country; occupation. All this takes place at the first station, which is partially curtained for the sake of privacy.

When these data have been written, the frame is turned over, and the other side is henceforth uppermost. On this the attendant marks the sex, and the applicant writes his initials or other distinguishing mark, to guard against any accidental interchange of the frames belonging to different persons who are simultaneously undergoing measurement.

At this same station is suspended a card with specimens of wool of various shades of green worked upon it. Attention is directed to these specimens, that the applicant may clearly understand what will be required of him a few stations on, when his colour-sense is tested by his being asked to pick out all the green shades from among many wools of different colour. It is important that he should appreciate the wide variety of shades that are used,

otherwise, he may fail in the test, owing to a misunderstanding of what he is wanted to do.

2. COLOUR OF EYES AND HAIR.—Artificial eyes of standard colours are exhibited, together with the following list of descriptive names—dark-blue, blue, grey, dark-grey, brown-grey (green, light hazel), brown, dark-brown, black. The attendant will note the colour of the eyes, but no entry is made regarding the colour of the hair, for the reason that what with the darkening effect of pomades, and of dyes, and the misleading appearances of false hair, no useful results could be arrived at. However, for the convenience of the visitor, samples of standard colour of hair are exhibited, and the names are attached by which the chief varieties of colour are usually described. They are flaxen, light-brown, brown, dark-brown, fair red (golden), red, dark red (chestnut auburn), black.

3. SIGHT.—(a) *Keeness of eye-sight* is measured by the greatest distance at which the small print known as "diamond" type can be read.

The eyes are tested separately, as it often occurs that they differ considerably in efficiency without the person being aware of the fact, who ought in that case to use appropriate glasses.

The apparatus is a long and light frame with a single eye hole. Blocks of wood, each with a sentence in diamond print pasted upon its end, are fastened square to the line of sight at measured distances along the frame. First the right eye is tested, and then the left eye, and the greatest distance at which the type can be read by each of them is recorded. If the print cannot be read at all by the unaided eye, a note is made to that effect.

b. *Colour-sense*.—A series of bars are packed closely side by side in a frame, looking something like the keys of a pianoforte. Along the middle part of each of these bars a differently coloured wool is wound lengthways, and

the foot of each bar is stamped with a separate number. In the frame there are as many peg-holes as there are bars, one hole to each bar. The order of the bars can be changed when the instrument is unlocked. The frame is placed before the person to be tested, the numbers are hidden by a flap, and he is required to insert a peg opposite each of the bars that has any shade of green wool wound upon it. After he has leisurely done this to his satisfaction, the attendant lifts up the flap and displays the numbers of the chosen colours, and records the fact of his having judged rightly or wrongly as the case may be.

c. Judgment of Eye as regards length.—A board has two pairs of parallel strips of wood fastened across it, between each of which a bar slides freely. In each case a square rod, 15 inches long and somewhat longer than the bar, is hinged to it along its edges, and, when closed down upon it, hides it altogether. There are moveable pointers attached to the lower of each pair of strips. In the one pair, it is set somewhere about midway, and the person to be tested is desired to slide the rod until its middle is brought as nearly as he can judge opposite the pointer. When he has done this, the hinged rod is lifted and the face of the bar is exposed. This has a central fiducial mark, and bears graduations on either side of it, each equal to $\frac{1}{100}$ of the total length of the rod. The error of adjustment is thus determined in percentage.

The second rod has to be set so that the pointer shall correspond to one-third of its length, and the error of adjustment is similarly read off in units, each equal to a hundredth part of the total length of the rod.

As regards Squareness.—A board including a sector of a circle, has an arm movable about the centre of the circle, while a broad flap hides its free end. A black line is drawn across the board. The person tested is desired to set the arm as squarely as he can to the black line. When he has done this, the attendant lifts the flap and exposes a scale of degrees graduated on the foot of the

board, and reads off the error of the setting of the arm in degrees.

HEARING.—(a) *Its keenness.*—Some apparatus is exhibited by which at least the relative acuteness of hearing can be tested ; but it will not be used, as the noises and echoes of the building render such determinations untrustworthy.

(b) *Highest audible note.*—An indiarubber tube communicates through 5 others with 5 fixed whistles of small bore, and of depths that will give 50, 40, 30, 20, and 10 thousand air vibrations in a second respectively—that is, of the several depths of 0·067, 0·084, 0·113, 0·169, and 0·380 inch. Each tube is nipped by a separate clamp. These are numbered in order, 5, 4, 3, 2, 1, and serve as keys. When any one of them is depressed, air is blown through the corresponding whistle, and is thrown into vibrations that can be heard by some as a shrill and pure note, while others hear merely a puff or nothing at all. Every person has his limits of power of hearing high notes, quite independently of the general acuteness of his hearing. The test lies in ascertaining which is the shrillest of the five notes that is audible. The precise limit of audible sound may be found by using a whistle that has a movable plug for its base.

TOUCH, &c.—Several instruments are exhibited, but it is not proposed to test with them, as the requisite time cannot be spared.

BREATHING CAPACITY.—A spirometer is used, made by a counterpoised vessel suspended in water. When the air is breathed through a tube the vessel rises, and the scale at its side shews the number of cubic inches of displacement. The person to be tested fills his chest and expires deeply three or four times for practice, then, after a few seconds rest, he tries the spirometer.

SWIFTNESS OF BLOW.—A flat bar with a pad at one end

runs freely between guides. The blow is delivered with the fist straight at the pad, driving the rod nearly or quite home, and its swiftness of motion is measured as follows :— Across its path a bridge is fixed and a flat steel rod projects from the bridge, lying above the bar and parallel to it. Its free end points in the same direction as that towards which the bar is driven by the fist. When the bar is set back ready for use, a stud upon its face holds the spring forcibly to one side, but as soon as the bar begins to move, the stud leaves the spring, which thereupon vibrates transversely to the moving bar. A pencil is attached to the spring, and the upper face of the bar carries a strip of the cardboard used for white flexible slates. The pencil leaves a sinuous trace on the strip, and the points where the trace crosses its own median line can be measured with precision. The spring that is used, makes twenty-five complete vibrations in a second. Hence, if the interval between any two alternate crossing points is 0·48 inch in length, the bar is travelling 1 foot per second. A scale is constructed of which the unit is 0·48 of an inch, and the graduations upon it are in feet per second. By applying this scale to the curve, the swiftness of the corresponding blow is immediately read off.

STRENGTH (*a*) of *pull*.—The instrument is held as an archer holds his bow when in the act of drawing it, and the strength of the pull is given by the index.

(*b*) of *squeeze*.—The instrument is tried first in the right hand, secondly, in the left hand.

SPAN OF ARMS.—A pair of rods, sliding over each other and with projections at either end, is held so that the tips of the fingers press against those projections; then the arms are extended to their full stretch. The graduations show the span.

HEIGHT (*a*) *above seat of chair*.—A quickly acting measuring-rod is fastened upright to the back of a solid and narrow chair.

(*b*) *Standing in shoes*.—This is taken by a measuring-rod fixed against the wall.

(*c*) The thickness of the heel of the shoe is measured.

Lastly, *c* is subtracted from *b*, which gives—

(*d*) The Height without Shoes.

WEIGHT.—A simple commercial balance is used, as cheaper, more accurate, and much more capable of bearing hard usage than the lever balances. Its sole disadvantage lies in the necessity of handling heavy weights during its use. Overcoats should be taken off, the weight required being that of ordinary indoor clothing.

Most of the instruments in use at the Laboratory are wholly or in large part of my own designing. Those that are not, are the spirometer, the instruments for testing strength of pull and of squeeze, and the weighing machine. Mr. Gammage, of Messrs. Tisley & Co., 172, Brompton Road, assisted me in putting the instruments in working order. The larger of the small whistles are made by them; the smaller and more delicate ones are made by Mr. Hawkesley, 357, Oxford-Street.

FRANCIS GALTON.

INTERNATIONAL HEALTH EXHIBITION, 1884.

ANTHROPOMETRIC LABORATORY,

Arranged by FRANCIS GALTON, F.R.S.

Sex	Colour of eyes	Date	Initials
EYESIGHT.		SWIFTESS	
Greatest distance in inches, of reading "Diamond" type	right eye	left eye	of blow of hand in } feet per second }
Colour sense good-ness of			
JUDGMENT OF EYE.			
Error per cent in dividing a line of 15 inches	in three parts	in two parts	
Error in degrees of estimating squareness			
HEARING.			
Keeness can hardly be tested here owing to the noises and echoes.			
Highest audible note	between	0.000 and 0.000	vibrations per second.
BREATHING POWER.			
Greatest expiration in cubic inches			
		of squeeze } right hand } of pull } in lbs. of left in lbs.	
		SPAN OF ARMS	
		From finger tips of opposite hands	
		HEIGHT	
		Sitting, measured from seat of chair	
		Standing in shoes	
		less height of heel	
		Height without shoes	
		WEIGHT	
		in ordinary in-door clothing in lbs. }	

Age last birthday? _____

Married or unmarried? _____

Birthplace? _____

Occupation? _____

Residence in town, suburb or country? _____

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