From the EDITOR.—Revue d'Anthropologie. 1884, Parts 3, 4.
—— Revue d'Ethnographie. 1884, Nos. 2, 3.
—— Revue Politique. Tom. XXXIII, Nos. 25, 26; Tom. XXXIV, Nos. 1–18.
—— Revue Scientifique. Tom. XXXIII, Nos. 25, 26; Tom. XXXIV, Nos. 1-18.
—— "Science." Nos. 71–76, 78–89.
—— The Illustrated Science Monthly. Vol. II, Nos. 9–11.
—— Timehri. Vol. III, Part 1.
—— American Antiquarian. Vol. VI, No. 4.

The election of the following new Members was announced:—
Mrs. ERMINNIE A. SMITH; F. A. COLBY, Esq., M.D.; HORATIO HALE, Esq., and D. H. TALBOT, Esq.

Mr. FRANCIS GALTON exhibited and described a collection of composite photographs of skulls, made by Dr. Billings, of the United States, which he presented to the Institute.

Mr. H. O. FORBES read some "Ethnological Notes on the "People of the Island of Buru."

The following paper was read by the author:—

On the ANTHROPOMETRIC LABORATORY *at the late* INTERNATIONAL HEALTH EXHIBITION. By FRANCIS GALTON, M.A., F.R.S.

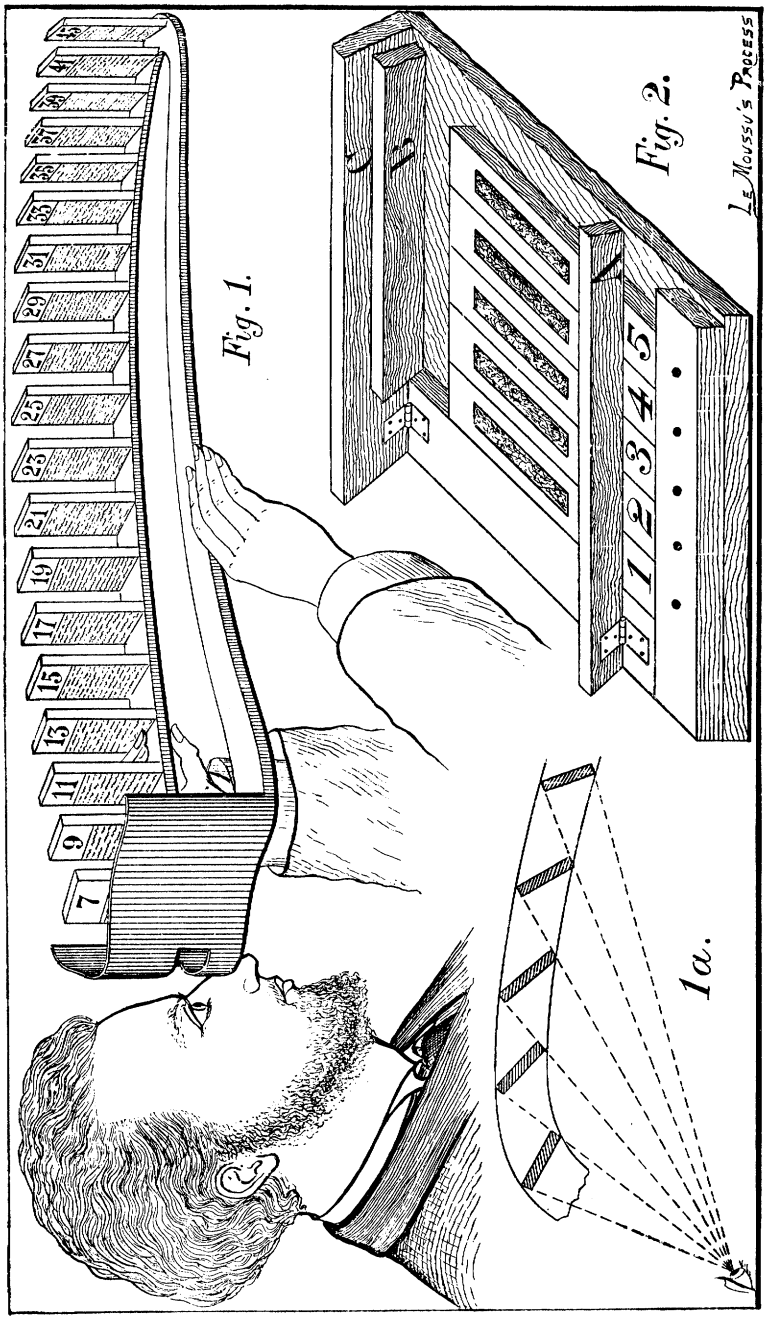
[WITH PLATES XII AND XIII.]

Now that the International Health Exhibition is over, and the Anthropometric Laboratory there established has done its appointed work, it is desirable to put on record its methods and experiences. As for the statistical results they are still under discussion and I shall not speak of them now, but I hope before long to communicate these also to the Institute.[1]

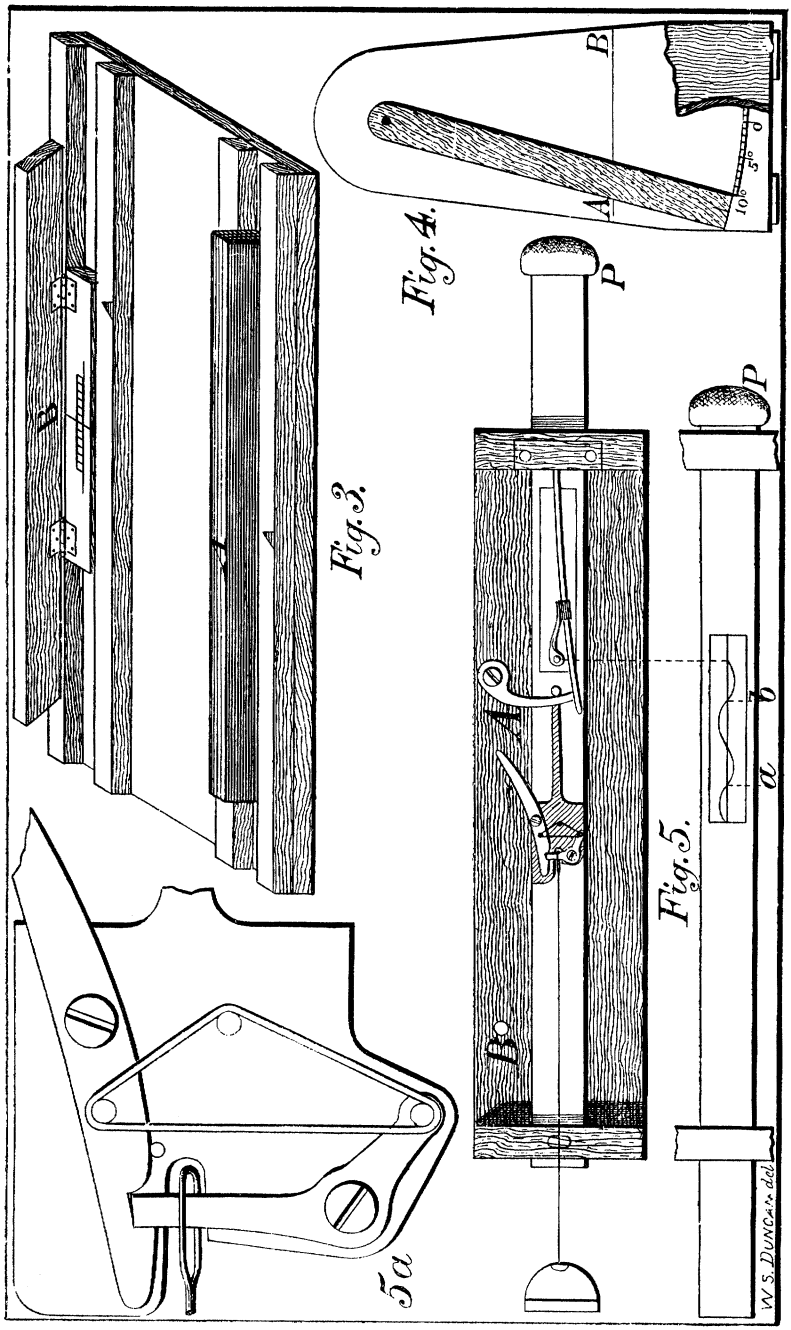
The object of the laboratory was to show to the public the simplicity of the instruments and methods by which the chief physical characteristics of man may be measured and recorded. The instruments in action dealt with keenness of sight; colour-sense; judgment of eye; hearing; highest audible note; breathing power; strength of pull and squeeze; swiftness of blow; span of arms; height, standing and sitting; and weight. Some other apparatus not in actual use was also exhibited.

The chief motive of this memoir is to invite criticism and

[1] A general statement of the results is printed among the "Miscellanea" at the end of this number of the Journal.



ANTHROPOMETRIC INSTRUMENTS.



suggestions. Duplicates of the instruments have been ordered by executive officers in foreign countries, and considerable interest has been expressed in the collection by the authorities of many places of education in this country, as well as by numerous private individuals. It seems, therefore, well to lose no time in considering whether any and what improvements should be made in their scope and design before they or any others may be so widely used that it would become difficult to make a change. We want a set of standard apparatus of as appropriate a pattern as can be devised, for the sake of uniformity in the methods of measurement and facility in statistical comparisons. I have therefore brought all my instruments to this room, together with the attendants who had charge of them in the Exhibition, availing myself very gladly of the opportunity afforded by this meeting of submitting my method and appliances to discussion.

The number of persons measured in the laboratory from first to last was no less than 9,337, and each of them in 17 different ways. The only attendants were Serjeant Williams, who was permanently on duty, Mr. Gammage (optical instrument maker, 172, Brompton Road), who came for some hours every evening to assist and supervise, and who maintained the instruments in efficiency, and a doorkeeper provided by the executive, who admitted visitors, received the admission fee of 3*d.*, supplied the blank forms, and saw that the required particulars were written down by them. The doorkeeper also made himself useful in many other details. With this small staff, and in a compartment only 6 feet wide and 36 feet long, about ninety persons were measured daily in an elaborate manner.

It was not possible to work so rapidly at first, but the process gradually improved. Thus it was found best to take two persons through the laboratory together at the same time, and to keep parents and their children apart, as the old did not like to be outdone by the young, and insisted on repeated trials.

Hardly any trouble occurred with the visitors, though on some few occasions rough persons entered the laboratory who were apparently not altogether sober. On the whole, the laboratory worked with astonishing smoothness, and its popularity was extraordinary. Its door was thronged by applicants waiting patiently for their turn, or after a while turning away seeing that it was almost a hopeless task to wait. If there had been more accommodation there would have been a large increase in the number measured. The small admission fee of 3*d.* did more than cover every charge connected with the maintenance of the laboratory and I have therefore little doubt that a smaller number of careful measurements might be made periodically at

large schools under skilled supervision for a very minute charge per head, if the system of doing so was well methodised, and if the masters, older pupils, and school attendants gave willing help.

There is a vast field for work among the millions of school boys and girls of all degrees, with the object of keeping an adequate oversight upon their physical well-being by a judicious series of physical measurements. I do not see why it should be either difficult or costly to the schools of the upper and middle classes, to whom a charge of two or three pence per head is a matter of no moment whatever, to institute periodical measurements even of a somewhat elaborate character under skilful itinerant supervision, and to register them in a methodical and uniform manner. It should, I think, become a recognised part of school discipline to have this regularly done; the more so as the experience of this laboratory, confirmed by those of many American colleges, makes it certain that the innovation would be popular. One of the conditions that a standard set of instruments ought to fulfil is, that it should admit of being readily packed, carried about from place to place, and quickly set up anywhere for temporary use by a professional measurer.

We have now to consider what we should measure. One object is to ascertain what may be called the personal constants of mature life. This phrase must not be taken in too strict a sense, because there is nothing absolutely constant in a living body. Life is a condition of perpetual change. Men are about half an inch shorter when they go to bed than when they rise in the morning. Their weight is affected by diet and habit of life. All our so-called personal constants are really variables, though a large proportion of their actual variations may lie between narrow limits. Our first rule then is, that the trouble of measurement is best repaid when it is directed upon the least variable faculties.

There are many faculties that may be said to be potentially constant in adults though they are not developed, owing to want of exercise. After adequate practice, a limit of efficiency would in each case be attained, and this would be the personal constant; but it is obviously impossible to guess what that constant would be from the results of a single trial. No test professes to do more than show the efficiency of the faculty at the time it was applied, and many tests do even less than this, being so novel to the person experimented on that he is maladroit, and fails to do himself justice; consequently the results of earlier trials with ill-devised tests may differ considerably from those of later ones. The second rule then is, that the actions required by the tests should be as familiar as possible.

For example, in testing the delicacy of the various senses I think we should do wrong if we pursued the strict methods appropriate to psycho-physical investigations. We do not want to analyse how much of our power of discriminating between two objects is due to this, that, or the other of the many elementary perceptions called into action. It is the total result that chiefly interests us. Thus in measuring the delicacy with which a person can estimate the difference between weights, I think he ought to be allowed to handle them in the way he prefers and that we may disregard the fact that his judgment rests on a blend of many different data, such as pressure, muscular exertion, and appreciation of size.

There is some hope that we may in time learn to eliminate the effect of an unknown amount of previous practice by three or more distinct sets of trials. There exists a rough relation between practice and proficiency which ought to be apparent wherever progress is not due to acquiring a succession of new knacks, but proceeds regularly. When no practice has previously taken place, the progressive improvement will be very rapid; then its rate will smoothly decrease until it comes to an entire stop. I suspect that a curve might be drawn, representing the relation between proficiency and practice, and that the data afforded by at least three successive series of tests would roughly determine the position in the curve of the person who was being tested. They would show what he was capable of at the time, and approximately how much conscious or unconscious practice he had already gone through, and the maximum efficiency to which his faculty under test admitted of being educated.

An ideally perfect laboratory, whether a plain or an elaborate one, would admit of a stream of persons passing continuously through it. There would be no gaps and no blocks by the way, because the number of such instruments as might necessitate two, three, or more units of delay would be multiplied in that proportion. Again, there would be no waste of the attendant's time in idly watching examinees puzzling over tests that required a prolonged judgment, because those tests would be so contrived that the examinee might be left to himself until he had performed the specified act, after which the attendant would return and note the result. To exemplify what I mean, I will describe the test (Plate XII, fig. 2) for colour-sense by the use of wools, which is further explained on p. 215. A set of Holmgren's patterns were wound each through two holes in a separate rod, much as a net maker winds string on his netting needle, and each rod had a separate number stamped on it. A row of these rods were laid in any order side by side in a frame, with a long narrow flap above and below.

When the flaps were shut, the rods were nipped fast and their numbers were hid; when the lower flap was opened the numbers were exposed. The test consisted in telling the examinee that there were four tints of green, and he was required to point them out. Then the lower flap was opened, and the truth of his choice was tested by the correctness of the exposed numbers.

If this had been the process pure and simple, the test would have occupied an undue amount of the attendant's time, who would have had to stand by doing nothing while the examinee was hesitating. It is probable that two minutes might have been so wasted, in which case the ninety persons who daily required between them about thirteen hours of direct supervision in performing seventeen tests, would have required twice ninety minutes, or three hours, for this test alone. Such a sacrifice would have been inadmissible and it was easily avoided by a simple contrivance. Holes were bored below the bottom flap, one opposite to each rod, and four pegs were tied to the instrument. The attendant directed the examinee to put a peg into the hole opposite to each of the four greens, and then left him to ponder over his task at leisure, while he attended to others. After awhile the attendant returned, found the pegs set, and noted the result in a couple of seconds.

A similar plan was adopted in two instruments (Plate XIII, figs. 3 & 4) that I used, less for the intrinsic value of their results than as examples of the way in which a large class of tests might be methodised. They were to test the judgment of the eye in dividing a line into equal parts and in estimating squareness. The accuracy of the result was in each case measured by graduations that were hidden under a closed flap, while the examinee was left by himself to make the required adjustments. Here, again, the examiner returned after awhile, and noted the results of a prolonged pondering in a very few seconds.

On this principle very elaborate tests might be introduced into a well furnished laboratory without adding to the cost of the course by taking up the valuable time of a skilled supervisor, or of diminishing the rate at which applicants might be admitted. The stream of them would still pass regularly through, but the length of the stream included between the entrance and the exit doors would be longer.

It will be remembered that in the laboratory at the Exhibition, ninety persons passed through daily, and that the amount of skilled attendance given to them amounted in the aggregate to about thirteen hours: that is, seven minutes to each. But the time each person was occupied in the laboratory was fully twenty-one minutes, and often half-an-hour. In the first place, the persons to be tested were taken in pairs, that one explanation

and illustration might suffice for both, and since the promptest minded man of the two was usually the one who presented himself first, the less prompt man had the advantage of seeing his companion perform the test before he was called upon to do so himself. This duplex system changed the seven minutes into fourteen. Then there was the time occupied by each examinee in reading notices, writing down particulars of his age, state, occupation, and birth-place, in puzzling alone over set tasks, and in amusing himself by watching others.

I have dwelt at length on this because the necessity of labour-saving arrangements must be carefully borne in mind when devising a standard laboratory outfit, in which a large number of persons may be elaborately measured at a minimum of cost.

In the Appendix to this paper will be found a brief but sufficient description of the instruments used in the laboratory. I will now call attention only to those points which appear especially in need of criticism.

One omission in the laboratory has been noticed by many. I had decided, perhaps wrongly, after much hesitation, not to measure the head. My reason was, that the results would, under the peculiar circumstances of a mixed crowd of persons, each measured only once, be of little or no profit, and I feared it would be troublesome to perform on most women on account of their bonnets, and the bulk of their hair, and that it would lead to objections and difficulties. In the case of periodical measurements at schools, the head measurement would be of primary importance, and I should propose to take its maximum length and breadth with graduated calipers, and its maximum height above the plane that passes through the upper edges of the orbits and the orifices of the ears.[1]

I measured the chief dimensions of the body, the weight and the breathing capacity, but could devise no good method, other than what these implicitly afford, of ascertaining the bulk, and its distribution in muscle or fat. Stripping was of course inadmissible, and measurements of girth, whether of body or limb, taken over the clothes, are rather fallacious. The excess due to the presence of the clothes, and supposing no wrinkles, is six times their thickness, taking the circumference of the limb as equal to six times its mean radius. The wrinkles add an unknown amount to the error.

For the first time such a thing has been attempted, I measured swiftness of blow as distinguished from force of blow, the latter

[1] I have designed and made the necessary instruments since this memoir was read. They are now being constructed solidly for me by the Scientific Instrument Company at Cambridge, and they will be in use at Cambridge in the beginning of 1885.

of which is a compound result of swiftness, weight, and knack. The instrument was based upon a very pretty principle first applied by Exner in his little apparatus for measuring reaction-time. It was a matter of surprise to myself, who was born in the days of pugilism, to find that the art of delivering a clean hit, straight from the shoulder, as required by this instrument, is nearly lost to the rising generation. My instrument (Plate XIII, fig. 5) consisted of a rod, padded at one end, and running quite freely between guides. The person to be tested was asked to hit the pad which fronted him, and to drive the bar forwards with as much swiftness as he could. The rate of progress of the rod was marked by a pencil attached to a vibrating spring that had been bent to one side and was retained by a catch to be set free by the moving rod. Notwithstanding the simplicity of the test, a large proportion of persons bungled absurdly over it. They could not or would not strike straight at the pad, but punched its side, and often broke the rod and hurt their knuckles. I had the deal rod replaced by an oaken one, and they still broke it and hurt their knuckles all the more. I then, in despair, reversed the action, by passing the looped end of a string round a catch (fig. 5*a*), forming part of an apparatus that was fixed to the opposite end of the rod, and I attached a stirrup to the other end of the string which the examinee held in his hand while he struck out into space, pulling the rod after him. While the rod was in motion, and before it was pulled home, the free end of the lever that retained the catch struck against a peg B in the frame of the apparatus; the catch was thereby released and the string (or rather the steel wire, which I used at last) was disengaged, and there was nothing left to break. On this plan all went well. This instrument has given beautifully accordant results in successive trials, but I propose to supersede it by another pattern, not yet quite complete in details, but primarily consisting of a light hoop turning round a horizontal axis, the string disengaging itself as it does from a humming-top.

I employed only a few tests for the delicacy of the various senses, but many others might be added with advantage to a fully equipped laboratory if they were constructed on the labour-saving principle I have described.

The construction of an absolute and convenient test for delicacy of hearing, quite baffles me. I mean an apparatus that any instrument maker might construct from description, every specimen of which should emit a sound always of the same loudness and quality. Identity in the striking bodies may be ensured by using coins, and the arrangement of two pennies (that is two short cylinders) striking crossways is theoretically perfect as ensuring that the locus of contact shall be a point. But the

trouble is to hold the pence firmly and conveniently by rods, too slight to increase the sound either by echoes or by their own vibrations caused by the concussion. The rods should nip the pence at their nodal points so as not to hinder the vibrations. I should be very grateful for useful suggestions.

The sickle-shaped hand instrument (Plate XII, fig. 1) used for reading small test type, first with one eye and then with the other, acted excellently, but the light in the laboratory was often bad. I used pages cut out of the shilling diamond edition of the Prayer Book, because it was easily accessible, and to enable persons who had been tested at the laboratory to repeat the identical experiment at home with their friends. But printed sentences, especially when they are so generally well known as those in the Prayer Book, are objectionable: a page of logarithms would be much better.

I exhibited, but did not use, a model of a test for delicacy of touch, so far as pressure is concerned, which has merits, but would I feared have occupied too much time. It is a "Roberval" balance, like a common letter weigher; the finger is laid on one scale pan, and the object of the instrument is to increase or diminish the weight in the other pan with perfect smoothness and at any desired rate. I effected this by placing a light cylindical glass vessel, half filled with water, in the other scale pan, and suspended a broad plunger above it on the "Roberval" principle.

When the plunger was depressed, the water rose in the graduated glass cylinder, and the effect was exactly the same as if an equivalent amount of water had been poured in; conversely, the water sank when the plunger was raised. The action of the instrument seems perfect, but it exists as yet only as a working model.

A useful set of tests of judgment of absolute weights might be added, such as by requiring vessels to be filled with sand, till in the judgment of the examinee the one should weigh a pound, and the other an ounce, and then setting them in scales and recording the percentage of error. Similarly as regards absolute length, as by pulling out slides until they measured respectively a yard, a foot and an inch, and then opening a flap and displaying the test graduations in percentages of the yard, foot, and inch.

I will not take up time by describing other contrivances more or less promising that I have thought of but not actually used, and will now conclude by submitting the points on which I have dwelt to discussion, adding that I should also feel sincerely obliged by any helpful remarks that may be sent to me in writing

APPENDIX

(*Chiefly extracted from the* 1*d. book sold by Authority at the Exhibition*).

The object of the Anthropometric Laboratory is to show to the public the great simplicity of the instruments and method by which the chief physical characteristics may be measured and recorded. The instruments at present in action deal with Keenness of Sight; Colour-Sense; Judgment of Eye; Hearing; Highest Audible Note; Breathing Power; Strength of Pull and Squeeze; Swiftness 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 all these respects, and a card containing the results furnished to him, while a duplicate is 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 shows the progress of the individual; the other that of portions of the nation, or of the nation as a whole.

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 in the open space 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 specimens for colour of 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. Swiftness 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.

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 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 will be made regarding the colour of the hair, for the reason that what with the darkening effects 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*) *Keenness 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 (Plate XII, fig. 1) is a long and light frame with a single eye-hole. Blocks of wood about $1\frac{1}{4}$ inch wide and $2\frac{1}{2}$ inches high, each with a sentence in diamond print pasted upon its face, are fastened square to the line of sight at distances of 7, 9, 11, and so on up to 41 inches. The number of inches is painted in bold figures on the upper part of the face of each block. The blocks are disposed in a curve, so that when viewed from the eye-hole each stands just clear of the preceding one (see fig. 1*a*); the curve of the frame is, in fact, an equiangular spiral. 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 cross is marked on the schedule.

b. Colour-Sense.—A series of bars are packed closely side by side in a frame, looking something like the keys of a pianoforte. Fig. 2, Plate XII, shows only a portion of the instrument, as the right hand part has been broken off in order to exhibit its construction more distinctly. The two flaps are half opened for the same reason. When the upper flap is closed, the part B keeps the bars in an even row, and the part C nips their tops. When the lower flap is closed, the numbers on the bars are hidden. 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 the flap A, and he is required to insert a peg opposite each of the bars that has any shade of green wound round 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 (Plate XIII, fig. 3) 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 is a movable pointer attached to the lower of each pair of strips. The position of the pointers is shown in the figure, but the scale of the drawing is too small to show the slot and the rest of the easily-to-be-imagined arrangement by which they are rendered movable. In the one pair, the pointer 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 hundreth part of the total length of the rod.

As regards Squareness.—A board (Plate XIII, fig. 4), including a sector of a circle, has an arm movable about the centre of the circle, while a broad flap of which the last part is supposed in the figure to have been broken off, hides its free ends. A black line AB 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 india-rubber 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 which 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. The larger of the small whistles are made by Messrs. Tisley & Co., 172, Brompton Road; the smaller and more delicate ones are made by Mr. Hawkesley, 357, Oxford Street.

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 into it through a tube, the vessel rises, and the scale at its side shows 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. Spirometers are usually furnished with a stop-cock to the breathing tube, which is intended to be closed when the expiration has ceased. An inverted glass syphon with a little water in it is connected with the breathing tube beyond the stop-cock. If the water does not stand at the same level in the two arms of the syphon it would show that the air in the spirometer was somewhat compressed or dilated as the case might be, and the air cylinder would have to be slightly adjusted before reading off. However, the error caused by neglect-

ing this manometer rarely exceeds 4 cubic inches, and may be disregarded.

SWIFTNESS OF BLOW.—A flat bar (Plate XIII, fig. 5) with a pad, P, 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, or else the blow is converted into a pull by holding a stirrup attached to a string, and striking out into space. The stirrup is attached to a string or, better, to a piece of steel pianoforte wire which is looped round a catch that forms part of a little apparatus attached to the bar, and which is shown enlarged in fig. 5*a*. When the bar is in full motion the catch releases the string or wire, so that there is nothing to break. The swiftness of the motion of the bar is registered 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, an arm, A, turning round a pin fixed in the framework is set so as to push the spring forcibly to one side, but as soon as the bar begins to move, a stud that is fixed to the bar strikes the arm from before it, and so releases 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 prepared cardboard used for white flexible slates. The pencil leaves a sinuous trace on the strip as shown in the lower figure, 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 well-known instrument with a spring, dial, and pointer, made by Salter, 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, also made by Salter, 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.

On the opposite page is a *fac simile* of the Schedule which was retained at the Anthropometric Laboratory. The card that was presented to each person examined was a duplicate of all the entries in the Schedule, except those printed crosswise at the right hand side.

Explanation of Plates XII and XIII.

(*For description, see both the Memoir and the Appendix to it.*)

Fig. 1. Instrument for testing keenness of sight.

„ 1*a*. Diagram showing how each of the blocks appears to stand just free of the preceding one when they are viewed through the eye-hole.

„ 2. Part of the apparatus for testing colour-sense by various samples of coloured wools. The right hand portion is supposed to be broken off.

„ 3. Apparatus for testing the accuracy of the judgment of the eye, in dividing a rod into two, and into three equal parts.

„ 4. Apparatus for testing the judgment of the eye as regards squareness. The left hand portion of a flap that conceals graduations is supposed to be broken off.

„ 5. Apparatus for testing swiftness of blow or pull.

„ 5*a*. Shows the mechanism of a self-acting catch, which releases the string by which the rod is pulled just before the rod comes home.

ANTHROPOMETRIC LABORATORY,

Arranged by Francis Galton, F.R.S.

Sex	Colour of eyes	Date	Initials

EYESIGHT.

	right eye	left eye
Greatest distance in inches, of reading "Diamond" type		
Colour-sense, goodness 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.

Keenness 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

SWIFTNESS

of blow of hand in feet per second

STRENGTH

of squeeze in lbs. of	right hand	of pull in lbs.
	left ,,	

SPAN OF ARMS

From finger tips of opposite hands feet, inches.

HEIGHT

Sitting, measured from seat of chair	feet,	inches.
Standing in shoes	feet,	inches.
less height of heel....................................		inches.
Height without shoes	feet,	inches.

WEIGHT

in ordinary in-door clothing in lbs.

Age last birthday? ____________

Married or unmarried? ____________

Birthplace? ____________

Occupation? ____________

Residence in town, suburb, or country? ____________

Discussion.

Mr. C. Roberts remarked that Mr. Galton had invited the meeting to examine, criticise, and suggest such alterations as they might think desirable in the anthropometric apparatus he had set before them; but his ingenuity in the preparation of instruments of this kind was so well known that there was little room for criticism. He had, however, confessed that he had not yet been able to devise a satisfactory instrument for testing the sense of hearing, and Mr. Roberts would therefore venture to direct his attention to a little instrument sometimes used for testing the hearing of idiots, which could, he thought, in Mr. Galton's hands, be made a useful and trustworthy test. It consisted of a series of slips of very different materials, such as wood, slate, metal, &c., suspended from a bar, and used like a set of gongs. For taking the diameters of the head in a ready way, which was also a subject on which Mr. Galton asked for suggestions, the speaker had always employed a pair of wooden callipers of his own design, which answered very well; but he wished Mr. Galton would direct his attention to devising a simple form of the instrument employed by hatters for gauging the heads of their customers. With regard to some of the apparatus before the meeting, he feared that the results obtained by the very ingenious contrivances for testing the sense of weight, the sense of touch, and the capacity for determining the perpendicularity, or the division of an object, were tests of education of certain faculties, and he should expect to find a post office clerk or grocer to have a finer appreciation of weight than any one less accustomed to the handling of weights. The test for colour-blindness was hardly sufficient. It was Holmgren's light green test, which proved no more than that there was some defect of the colour-sense, but which might not amount to actual colour-blindness. The purple test could easily be arranged in the same apparatus. Purple holds the unique position of appearing blue to the red-blind, grey to the green-blind, and red to the violet-blind, and is employed as a test for all these kinds of colour-blindness. Mr. Galton had asked the speaker to explain the models for determining the colour of their eyes. The classification was made on simple anatomical grounds, and two great classes were formed dependent on the presence or absence of a layer of pigment in *front* of the iris. When this layer of pigment is present we have the whole series of *dark* eyes, varying from light brown to what is commonly called black; and when it is absent we have the series of blue and grey eyes, which result from the black pigment on the *inner* surface of the iris, showing through, with greater or less distinctness, the semi-transparent structures of the iris itself. In conclusion, Mr. Roberts observed that he should look forward to the results of the observations made in the Anthropometric Laboratory at South Kensington with great interest; and expressed his great satisfaction at the prospect which Mr. Galton

held out, that the Laboratory was likely to be established in a permanent form.

Mr. R. MELDOLA asked, with reference to the instruments for measuring the focal lengths of the eyes, whether Mr. Galton had not found it necessary to take two readings for each person, one for the right eye and the other for the left eye. He asked this question because a large number of people differed in the focal lengths of their two eyes, often to the extent of several inches, he himself being a case in point.

Miss HENRIETTA MUELLER, Mr. R. B. MARTIN, Mr. G. GRIFFITH, M. BERTIN, Mr. E. W. STREETER, Dr. GARSON, Mr. G. M. ATKINSON, Mr. BLOXAM, Prof. THANE, Dr. W. H. COFFIN, and the PRESIDENT also joined in the discussion.

Mr. GALTON, in reply, said that the method suggested by Mr. Meldola had always been adopted, and that the statistics led to the interesting result that there was no preponderating number showing that one eye had a general tendency to be longer-sighted than the other. In fact, the statistical records for the two eyes were exactly equal.

NOVEMBER 25TH, 1884.

Professor W. H. FLOWER, LL.D., F.R.S., *President, in the Chair.*

The minutes of the last meeting were read and signed.

The following presents were announced, and thanks voted to the respective donors:—

FOR THE LIBRARY.

From ADMIRAL F. S. TREMLETT.—Les Alignements de Kermario. By James Miln.

From the DEUTSCHE GESELLSCHAFT FÜR ANTHROPOLOGIE.—Correspondenz Blatt. September, 1884.

From the BERLINER GESELLSCHAFT FÜR ANTHROPOLOGIE.—Zeitschrift für Ethnologie. 1884. Heft. 4.

From the SOCIETÀ ITALIANA DI ANTROPOLOGIA.—Archivio per l'Antropologia e la Etnologia. Vol. XIV, Fas. 2.

From the AUTHOR.—Über die Zahl der Zähne bei den Hasenschartenkiefer-spalten. By Prof. Dr. Paul Albrecht.

—— Ueber die Morphologische Bedeutung der Kiefer-, Lippen-, und Gesichts-spalten. By Prof. Dr. Paul Albrecht.

—— Der Zwischenkieferknochen und seine Beziehungen zur Hasenscharte und zur schrägen Gesichtsspalte. By Prof. Dr. Paul Albrecht.