Papers on the Relative Sensitivity of Males and Females

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be done with more expedition and greater cheapness. The author in his paper certainly advocated abandoning both hammering and cogging. In his paper he said, "Cogging, as it is at present carried on, with its consequent reheating, is a cumbersome, almost an ugly operation, and from the arguments I have endeavoured to adduce, an unnecessary one. How much smarter and cheaper it will be to take the ingots and roll them right off into plates, and I commend this to your earnest attention." Yet in the discussion which followed, Mr. Muirhead said that he did not in his system do without cogging. The point is one of considerable importance, and, Mr. Muirhead's position as the manager of an important steel-producing plant commands for him attention. If the same results can be got from the ingot without cogging and reheating, undoubtedly a great step in advance will have been taken; but the majority of steel-makers—perhaps we might say all, with the exception of Mr. Muirhead—think that cogging or hammering is a necessary though expensive process. Of course, if the author can show that he is right, and the rest of the steel world wrong, he will have performed a signal service to the industry. If we were the owners of steel works, however, we should prefer the experiments to be carried out by other manufacturers. It may be added that what is known as the direct process of rolling is not a new thing, and for Mr. Muirhead to succeed he will have to introduce some entirely fresh element into his procedure.

The last paper read at the meeting was Mr. Clarkson's contribution, in which he described his ore sampling machine. It would seem a small matter, at first glance, to sample ore, but it is by no means an easy thing to do. The variations in quality or composition are arbitrarily distributed, and it may easily be that a sample made up from portions from several different positions in the mass to be sampled, may not be a fair representation of the whole. Machines have been before used, by means of which small portions of a falling mass of ore may be abstracted at regular intervals. It would be difficult to describe this device without the aid of diagrams, but it may be stated that though they appear to work fairly and equitably at first sight, they are in reality partial in their selection. Mr. Clarkson has brought a trained mind to bear upon this subject, and has produced a really scientific instrument. The mass of ore is caused to fall in an annular stream, descending into a hopper, which is made to revolve at great speed. By a suitable mechanism small portions of the ore are abstracted at regular intervals, and from the fact that the falling mass takes the form of an annulus in place of a solid stream, the tendency of certain qualities to gather in the middle of the stream is obviated. A small-sized apparatus was shown in the theatre, and the author was able to practically demonstrate the accuracy with which it worked, so far as the exact percentage of the material abstracted from the whole was concerned. The demonstration, it may be said, was perfectly successful. The apparatus has another useful field in distribution of a mass into equal parts, so that by it a number of bottles or boxes can be filled without the tedious process of weighing being gone through, and yet each receptacle will have its due share of the material. The error of the ore separator is less than at present.

This was the last paper read at the meeti[ng] with the usual votes of thanks.

THEORIES OF THE ORIGIN O[F] RANGES.

IN his presidential address, delivered be[fore] Association for the Advancement of Sci[ence] Le Conte dealt with theories of mountain[s] which lies at the very foundation of theoretical geology. Want of space forbids us printing the address in full, but the most salient points are contained in the extracts from it that are here given.

Prof. Le Conte began by stating those fundamental features of the structure of mountain ranges on which every true theory of their origin must be founded. These features are: (1) Thickness of mountain sediments; (2) coarseness of mountain sediments; (3) folded structure of mountains; (4) cleavage structure; (5) granite or metamorphic axis; (6) asymmetric form. Another type of mountain, the main characteristics of which are not included under the above heads, are those only found in the Basin and Plateau regions, and therefore termed the Basin region type. In fact, "mountains may be divided into two types, viz. mountains formed by folding of strata, and mountains formed by tilting of crust-blocks. The structure of the one is anticlinal or *di*clinal, of the other, *mono*clinal. The Sierra probably belongs to both types. It was formed at the end of the Jurassic as a mountain of the first type, but the whole Sierra block was tilted up on its eastern side without folding at the end of the Tertiary, and it then became also a mountain of the second type. A complete theory must explain this type also; but since from the exceptional character it must be regarded as of subordinate importance, we shall be compelled to confine our discussion to mountains of the usual type."

Before going any further, however, Prof. Le Conte made a digression in order to clearly lay down what he meant by theory. After facts have been collected they must be explained, and the explanation, which merely gives the laws of the immediate phenomena in hand, is called the *Formal Theory*. The next step towards the perfection of knowledge consists in explaining the cause of the[se] laws, and is termed the *Causal* or *Physical Theory*. The following is an illustration of this distinction:—

"All the phenomena of the drift are well explained by the former existence of an ice-sheet moving southward by laws of glacial motion, scoring, polishing, and depositing in its course. This is the formal theory. But still the question remains, What was the cause of the ice-sheet? Was it due to northern elevation, or to Aphelian winter concurring with great eccentricity of the earth's orbit? And if due to northern elevation, what was the cause of that elevation? A perfect theory must answer all these questions."

". . . . I wish to keep clear in the mind these two stages of theorising in the case of mountain origin. The formal theory is already well advanced toward a satisfactory condition; the physical theory is still in a very chaotic state. But these two kinds of theories have been often confounded with one another in the popular and even in the scientific mind, and the chaotic state of the latter has been carried over and credited to the former also; so that many seem to think that the whole subject of mountain origin is yet wholly in the air, and without any solid foundation."

Bearing in mind that "a true formal theory, keeping close to the immediate facts in hand, must pass gradually from necessary inferences from smaller groups to a wider theory which shall explain them all," Prof. Le Conte showed the inferences that could be made from the characteristic features of mountain structure, and he then grouped those inferences and summed up his views as to the mode of mountain formation as follows:—

Summary Statement of the Formal Th[eory].

(1) "Mountain ranges, while in preparation for future birth, were marginal sea-bottoms receiving abundant sedi[ment] an adjacent land-mass and slowly subsiding under [the] weight. (2) They were at last formed and [began] to grow, by lateral pressure crushing up [the] horizontally and swelling the [crust] ding. (3) [The] the hydr[ostatic] of thicke[ned] mes ab[ove] g th[e] mentary cyn[clinal] asymmetric."

Several An[ticlinal] then given, and it was sh[own] mineral veins, co[ntact] ated with [the] Prof. L[e Conte] seems t[o] and m[ountain] mount[ain] acting

sea-bottoms, and softened by invasion of interior heat. This view is therefore satisfactory as far as it goes, and brings order out of the chaos of mountain phenomena. It has successfully directed geological investigation in the past, and will continue to do so in the future.

"But there still remains the question, 'What is the cause of the lateral pressure?' The answer to this question constitutes the *physical theory*.

"Thus far I suppose there is little difference of opinion. I have only tried to put in clear condensed form what most geologists hold. But henceforward there are the most widely diverse views, and even the wildest speculations. But let us not imagine, on that account, that we have made no progress in the science of mountain origin. The formal theory already given is really for the geologist by far the most important part of the theory of mountain origin. For I insist that for the geologist, *formal* theories are usually more important than *physical* theories of geological phenomena. That slaty cleavage is the result of a mashing of strata by a force at right angles to the cleavage-planes, is of capital importance to the geologist, for it is a guide to all his investigations. To what property of matter this structure is due, is of less importance to him, though of prime importance to the physicist. That the phenomena of the drift is due to the former existence of a moving ice-sheet is the one thing most important to the geologist, guiding all his investigations. Whether this ice-sheet was caused by geographical or astronomical changes, is a question of wider but of less direct interest to him. So in the case of mountain ranges, the most important part of the theory is their origin by *lateral pressure* under the conditions given above. The *cause* of lateral pressure, though still of extreme interest, is certainly of less immediate importance in guiding investigations."

The Contraction Theory.

"The most obvious view of the cause of lateral pressure refers it to the *interior contraction of the earth*. This theory is so well known that I will give it only in very brief outline. It assumes that the earth was once an incandescent liquid, and has cooled and solidified to its present condition. At first it cooled most rapidly at the surface, and must have fissured by tension. But there would inevitably come a time when the surface, being substantially cool, and, moreover, receiving heat also from the sun, its temperature would be fixed, or nearly so, while the incandescent interior would be still cooling and contracting. Such has probably been the case ever since the commencement of the *recorded* history of the earth. The hot interior now cooling and contracting more rapidly than the cool crust, the latter, following down the ever-shrinking nucleus, would be thrust upon itself by lateral pressure with a force which is simply irresistible. If the crust were ten times, yea, one hundred times more rigid than it is, it must yield. It does yield along the lines of greatest weakness, *i.e.* along marginal [illegible] atoms, as already explained. As a first attempt at a [illegible] theory, it seems reasonable, and therefore until re[illegible] generally accepted."

[illegible] to the Contraction Theory.

[illegible] t American geologists have taken a very [illegible]ly of mountain structure and mountain [illegible]l that the lateral pressure theory in [illegible]erior contraction as its cause, have [illegible]erican theory.' It is also well [illegible]ers—especially Dana's—has [illegible]ll I claim is to have put the [illegible]al theory, in a clearer light [illegible]ormal theory I regard as a [illegible]ction theory may not be so. [illegible]ion with it, that I should be [illegible]re that I am willing to do [illegible]e all dearly love our own [illegible]orn of much labour and [illegible]e Jephtha of old, [illegible] the sacred [illegible]nd fast [illegible]moved, [illegible]cience, [illegible]'s Sur[illegible]re and

and may indeed eventually prove fatal. Time alone can show. I state briefly some of these objections."

(1) "Mathematical physicists assure us that on any reasonable premises of initial temperature and rate of cooling of the earth, the amount of lateral thrust produced by interior contraction would be wholly insufficient to account for the enormous foldings (*Cam. Phil. Trans.* vol. xii. Part 2, December, 1873). Let us admit—surely a large admission—that this is so. But this conclusion rests on the supposition that the whole cause of interior contraction is *cooling*. There may be other causes of contraction. If cooling be insufficient, our first duty is to look for other causes. Osmund Fisher has thrown out the suggestion (a suggestion, by the way, highly commended by Herschel) that the enormous quantity of water vapour ejected by volcanoes, and the probable cause of eruptions is not meteoric in origin as generally supposed, but is original and constituent water occluded in the interior Magma. (*Cam. Phil Trans.* vol. xii. Part 2, February, 1875. "Physics of the Earth's Crust," p. 87.) Tschermak has connected this escape of constituent water from the earth with the gaseous explosions of the sun (*Geol. Mag.* vol. iv. p. 569, 1877). Is it not barely possible that we have in this an additional cause of contraction, more powerfully operative in early times, but still continuing? See the large quantity of water occluded in fused lavas to be 'spit out' in an act of solidification! But much still remains in volcanic glass which by refusion intumesces into lightest froth. Here, then, is a second probable cause of contraction. If these two be still insufficient, we must look for still other causes before rejecting the theory.

(2) "Again, Dutton (*Am. Jour.* vol. viii. p. 13, 1874; *Penn. Monthly*, May 1876) has shown that in a rigid earth it is impossible that the effects of interior contraction should be concentrated along certain lines so as to form mountain ranges, because this would require a shearing of the crust on the interior. The yielding would be evenly distributed everywhere, and therefore imperceptible anywhere. This is probably true, and therefore a valid objection in the case of an earth equally rigid in every part. But if there be a subcrust layer of liquid or semiliquid or viscous, or even more movable or more unstable matter, either universal or over large areas, as there are many reasons to think, then the objection falls to the ground. For in that case there would be no reason why the effects of general contraction should not be concentrated on weakest lines, as we have supposed.

(3) "But again, it has been objected that the lines of yielding to interior contraction ought not to run in definite directions for long distances, but irregularly in all directions. I believe we may find the answer to this objection in the principle of flow of solids under very slow heavy pressure. The flow of the solid earth, under pressure in many directions, might well be conceived as being deflected to the direction of least resistance, *i.e.* of easiest yielding.

(4) "But again, it will be objected that the amount of circumferential shortening necessary to produce the foldings of some mountains is simply incredible, for it would disarrange the stability of the rotation of the earth itself. According to Claypole, in the formation of the Appalachian range the circumference of the earth was shortened 88 miles, and in the formation of the Alps 72 miles. Now this would make a decrease of diameter of the earth of 28 miles in the one case, and 23 in the other. This would undoubtedly seriously quicken the rotation and shorten the day. This seems indeed startling at first. But when we remember that the tidal drag is all the time retarding the rotation and lengthening the day, and much more at one time than now, we should not shrink from acceptance of a counteracting cause hastening the rotation and shortening the day, and thus giving stability instead of destroying it. We must not imagine that there would be anything catastrophic in this readjustment of rotation. Mountains are not formed in a day, nor in a thousand years. It requires hundreds of thousands, or even millions of years—if physicists allow us so much.

"The objections thus far brought forward, though serious, are by no means unanswerable. But there is one brought forward very recently which we are not yet fully prepared to answer, and may possibly prove fatal. I refer of course to the level of no strain."

Level of No Strain.

"Until recently the interior contraction of the earth was considered only roughly and without analysis. It was seen that the

Relative Sensitivity of Males & Females

(1)

The difference in the relative sensitivity of the two sexes has been often discussed of late, from various points of view but as it would seem, on hardly adequate data. Observations of more kinds being needed, I venture to submit the following results, partly for such small value as they may have in themselves, and partly to show one easy and efficient method of observation by which one form of sensitivity may be measured, and partly as a good illustration of the convenience of the method of Percentiles.

(The experiments ... depend on ...)

... a particular application of the well known test made with the points of a pair of compasses, which is usually associated with the name of Weber. If one person becomes just conscious of the doubleness of the two pricks, when the interval between the points is a, and another person does so when the interval is b, the pressure being applied similarly & to a similar parts of the body, then the ratio of a to b may be fairly taken to represent the relative obtuseness of that form of sensitivity, of the two persons, and that of b to a to represent its delicacy.

(Mo ... 1400) I caused a test of this kind to be carried on at my Anthropometric laboratory during a few months, but under conditions (are worth recording as they) which require exceptional minuteness

(1. ... 2. ... 3. ...) (these have peculiar advantages and are therefore worth recording. They)

accuracy in measuring, and no uncovering such as would prevent their being carried on publickly. The test consists in pressing the points of the compasses against the nape of the neck along the line of the spine. Here the sensitivity (in the particular respect we are now considering) is very small, the compass points having on the average to be separated more than half an inch before their simultaneous pressures give the feeling of doubleness.

It is therefore far less needed when dealing with the nape of the neck than it is when making the similar & commoner experiments on the tips of the fingers, to have Accuracy in measurements of doubleness; again, the width of the interval much reduces the influence of the thickness of the cuticle to a considerable extent, which is apt to cause serious error when the test is applied to highly sensitive parts. As the gloved finger fails to perceive doubleness where the same fingers on being bared can just perceive it distinctly, so a finger clothed with a thick cuticle (due perhaps to hard work only,) is less sensitive to the test, than one with a thin skin, though they may both be similarly supplied with nerves. Lastly, it is a great advantage in point of trustworthiness that the experimentee sits in a posture which entirely prevents his observing what the experimenter is doing, ~~and such precaution being a very important condition for procuring trustworthy data~~.

~~Before the results are given, it should be mentioned~~ The observations included stature, but having failed on examination to discover any notable relation between stature and the just-perceptible interval on the nape of the neck, I have disregarded stature altogether (and age too within reasonable limits) in the following summary.

The observations were made by Serjeant Randall (the Superintendent of the Laboratory), who used the two points of a Flower's craniometer, which was handy for the purpose, as that instrument was employed for other measurements of the same persons. The tests were continued until a sufficient number had accumulated to justify discussion.

They will now be dealed with by the method of Percentiles. The observations as recorded in the first of these tables are reduced, as there shown, afterwards and arranged in Table I, they are laid down to a true scale, as dots in diagram I. All the dots are joined by straight lines, (the reading of this diagram) whence the "deciles" are read off and entered at the points where each successive decile meets the Calculated Curves at their right places. Thus it turns out of any large number of persons, one tenth of all the males are able to perceive as small an interval as 7.5 millimetres, while one tenth of the females are able to perceive the still smaller interval of 6.0. Fifty per cent or one half of the males can perceive 13.8, while half the females can perceive 11.8 millimetres, & so on. If we accept the median values of 13.8 and 11.8 as the average values of these two series which we may do without sensible error, it follows that the sensitiveness of an average male is to that of an average female in the ratio of 13.8 to 11.8 or as 7 to 6. This proportion is however by no means maintained throughout all the class places who occupy the same class places at the earlier half or two thirds of the series, but the difference decreases as the grade increases, until at 90° or thereabouts the difference becomes nil. In the other words the 17 per cent of the two sexes are alike in sensitivity. The differences in sensitivity are given in the last column of Table II; they steadily lessen as the class place increases, and at a little beyond grade 90° the difference disappears.

The data are treated by the method of Percentiles. The observations summarized in the Table are protracted, (in diagram I) from the lines which ~~the~~ deciles (which are entered in it) are ~~cut~~ graphically derived, ~~which appear in it~~. the decimals being only roughly approximate. ~~The~~

2	2	(32)	3	(21)	——	1872
186,	157,	470,	103,	276:	f.	
R	(La)	(La)	——	U	(La)	L
19k,	18y,	11v	——	·k·,	2y·,	vy·

Lefevre 31443237

3	2	1872
103,	276:	[illegible]
U	(La)	L
·k·,	2y·,	vy·
	31432378	

(text is spaces)

10 20 30 40 50 60 70 80 90

84 84	116 116	170 170	193 193	239 239	267 267	305 305	344 344	
38 61 75	84 113	146 151	170 188	212 226	239 264	290 302	326 339	377
23 90	32 30	24 190	23 50	27 130	28 30	15 30	18 50	
6 =10	7.4	8.1	10.8	11.2	13.5	14.1	16.2	19.3

Females

84 75	116 113	170 151	193 188	239 226	267 264	305 302	344 339	
61 61	84 84	146 146	170 170	212 212	239 239	290 290	326 326	
23 140	32 290	24 50	23 180	27 140	28 250	15 120	18 130	
7.6	8.9	10.2	11.8	13.5	14.9	16.8	19.7	

M 13.50 M 12

M = 2.25 male M = 3.70 fem

5° -2.44 -7.96 -9.00

5.54 3.00

more obtuse of either sex appear to be identical in their powers. //

It ~~is reasonable from~~ A wide ~~analogy~~ [Enlarge this] leads us, to expect that the variations in sensitivity would conform with useful closeness to the law of frequency of error, and they do so; it will be seen from tables 2 & diagrams 2, so ~~fairly~~ very ~~well~~, within the limits of the 1st & the 9th decile and indeed beyond the latter. This ~~which~~ is quite as much as could have been expected ~~from~~ in the present case. The following remarks will be based on those smoothed & regular curves ~~or~~ ~~argument~~.

~~we~~ ~~making~~ the usual calculations (Table II), ~~it proves~~ show that the variability of females in the respect we are now considering, distinctly exceeds that of males. ~~Being it is measured in a usual way, the ratio between the by quartiles (or probable errors) or any multiple of them being~~ ~~the ratio between the two is as 3.70 (females) to 3.25 (males), say as 8 : 7~~

in the usual way by the ratio between ~~the~~ quartiles (or probable errors) or by any simple multiple of these, as by ~~the~~ mean errors, the ~~[illegible]~~ variability of females is to that of the males as 3.70 to 3.25, say as 8 to 7

The question then arises as to the cause of this, & whether ~~it~~ this is indicates a physiological ~~reality~~ reality or not. ~~In the first place I am inclined to think that~~ I believe it to be Women are more variable in ~~this respect~~ their sensitivity in certain respects such as obesity and now a days in stature, for under the modern conditions of life of the upper classes the number of very tall girls has become large than men, as they are ~~certainly~~ more variable in some ~~other respects~~ as in morality, & in respect to vision according to common opinion, thus Tennyson says —

"for men at most differ as heaven & earth - but women first and last, as heaven and hell". ~~Another respect in which they greatly vary is~~ the habit of careful attention, the painstaking accuracy of some girls being as remarkable as the frivolity of others. It is not improbable that part of the ~~apparently low sensitivity~~ variability which is shown by the above experiments of women, -

~~towards the bottom end of the scale~~ may be due to inattention and to inaccuracy

There is ~~still~~ another possibility in the peculiar ~~fatness~~ obesity and ~~thickness of~~ of some women, which may interfere with the sensitivity in question in a somewhat similar way to that of thickness of cuticle.

We have ~~next~~ now to ~~consider~~ find the ratio between the sensitivity of the two sexes, it has already been determined for the average man & the average women, but that is a very inadequate ~~discuss solut answer~~ solution of the problem, for, What is true for the men & women who respectively occupy ~~the 50~~ grade 50° of their respective series, is by no means true for those who occupy the remaining grades (we see in Table 2 that ~~that the most differences between that (A–B) are very large and vary from 2.3 to 0.7~~ The curves actually coincide at one end) and the ratios ~~between~~ $\frac{7.3}{5.0}$ and $\frac{19.7}{19.0}$ :: x : 1 ~~1:... 7.5~~

5/7.3(1.46 19/19.7(1

$7.3 \times 19 : 19.7 \times 5$ :: x : 1

:: 138.7 : 98.5

The ratio that we want is ~~that~~ between the areas bounded by the base & ~~the two lateral~~ sides of the Scheme and the ~~traces of the~~ two curves, which ~~would be troublesome~~ is ~~easily obtained~~ (approximated) (taking a mean of the ratios between the sum of the deciles ~~but~~ two sets) ~~to the percentiles though troublesome to arrive at in other ways~~. This gives the ratio of 121 to 109 ~~say~~ or as 10 to 9 very nearly.

121.3 | 121.5 ‖ 109.4 | 108.1 ‖ 13.4

121 : 109 :: 10 : x

121/1090(9
1089

& 2 Tables
& 2 diagrams

Curves of error are true (Expressed) effects – their elements.
The following deductions from them correctible by the ~~Tables~~ Tables; they are

(a) Average difference
(b) Mean difference
(c) different variability & ~~reasons~~ for it
suggested reasons for it.
(d) advantage of method for future enquiry.

f.10v

who is interested in anthropology & who are the same time has opportunity of carefully testing large numbers of adults of either sex may verify ~~them~~ or correct them. It is a very simple and cheap observation to make. If I were to undertake it I should take a common bow-compass (and think it is so called) with a spring and an adjusting screw, such as carpenters use, to afford the two points. For measurement a piece of metal? graduated to millimeters with a shallow hole at Zero into which one point of the compasses would be laid while the measurement was read off with the other.

Grade	Observed	Percentile obs	Calc	Female Observed	Percentile obs	Calc	M–F obs	Calc
20°	280	9.3	9.4	113	7.6	7.4	1.7	2.0

The least perceptible sense of separateness was given by the distance of two points along the back of the neck, ~~at~~ ... [illegible]

~~The dots show the observed values on a scale of $\frac{100}{932}$ for the males, & $\frac{100}{337}$ for the females.~~

The figures ~~are~~ the percentiles, or ordinates to the curve ~~at the~~ specified Grades from 0° to 100° (drawn at each tenth)

The ~~dots~~ show the positions of the observed values, ~~the~~ ... ~~abscissa for the males being drawn on a scale of $\frac{100}{932}$~~ & those of ... & 6th lines of the Table ~~the females on a scale of $\frac{100}{337}$~~ they are connected by a trace

The figures show the value of ~~the~~ Percentiles ~~at each tenth~~ or decile. That is ~~grade~~ ... the lengths of the ordinates, that are ~~drawn~~ ... ~~successive~~ tenth of ~~the~~ length of ~~the base~~ ~~the trace~~, that ~~...~~ connect the ~~dots of the male & female~~ two series of dots, & which are erected ... which are drawn at each successive tenth part of the length of the base

(Observations & Deciles* by interpolation)

The Figures are the values of each tenth Percentile, a "Decile". ~~These are~~ The Deciles are the lengths of the ordinates ~~that connect the~~ to the two traces, ~~that are~~ ... drawn at ~~...~~ each ~~...~~ tenth division of the base

(Deciles* by calculation
Males – Median = q = ; Females – Median = q =)

It would I think repay an inquirer who had the opportunity of making the necessary measurements to pursue this subject further. If anyone does so I would suggest that he should use the common spring bow-compasses employed by carpenters. ~~With arms one screwed out on in~~ The distance between its points is varied by ~~working~~ turning a thumb screw, and can be measured off on a scale. One of ~~4~~ ~~inches long~~ (say 1½ inches) long 40 millimetres would suffice, and if the zero of the scale corresponded with the centre of a little pit, into which one leg of the compasses ~~fitted~~ rested, the measurement would be easily made with much accuracy.

A line drawn freely and smoothly between the male and female ~~Curves~~ traces in the diagram, forms a very fair "normal" curve, having for its median 12.8 millimetres and for its quartile 3.5

Males

	10	20	30	40	50	60	70	80	90
	7.5	9.2	10.5	12.2	13.8	14.7	15.8	17.5	20.0
~~Calc~~	7.62	9.74	11.23	12.53	13.80	14.97	16.37	17.86	19.98
dif	0.12	0.54	0.73	0.33	0.0	0.20	0.57	0.36	1.02
4.7	7.32	9.44	10.93	12.23	−0.30 13.50	14.77	16.07	17.56	19.68
	7.3	9.4	10.9	12.2	13.5	14.8	16.1	17.6	19.7

	10°	20°	30°	40°	50°	60°	70°	80°	90°
Males Obs:	7.4	9.3	10.6	12.3	13.8	14.7	15.8	17.4	20.0
Calc (q = 3.25, m = 13.50)	7.3	9.4	10.9	12.2	13.5	14.8	16.1	17.6	19.7
	−0.1	+0.1	+0.3	−0.1	−0.3	+0.1	+0.3	+0.2	−0.3
Females obs	6.0	7.6	8.9	10.2	11.8	13.5	14.9	16.8	19.7
Calc (q = 3.70, m = 12.00)	5.0	7.4	9.1	10.6	12.0	13.4	14.9	16.7	19.0
	−1.0	−0.2	+0.2	+0.4	+0.2	−0.1	0.0	−0.1	−0.7
Diffce of smoothes	2.3	2.0	1.8	2.6	1.5	1.4	1.2	0.9	0.7
of obs	1.5	1.6	1.6	2.6	2.0	1.2	0.9	0.7	0.0

~~13.8~~

$Q = 3.25$?
$m = 13.80$?

	q = 1.8	q = 3.25	m = 13.80	~~m = 13.80~~	m = 13.50
10	−1.90	−6.18	7.62	~~7.62~~	7.32
20	−1.25	−4.06	9.74	~~9.74~~	9.44
30	−0.78	−2.57	11.23	~~11.23~~	10.93
40	−0.38	−1.27	12.53	~~12.53~~	12.23
50	0.00	~~13.80~~	13.80		13.50
60	+0.38	+1.27	14.97		14.77
70	+0.78	+2.57	16.37		16.07
80	+1.25	+4.06	17.86		17.56
90	+1.90	+6.18	19.98		19.68

sum 9 | 14.4 over / 1.6 aver! for smooths } say 1.5

9 | 11.5 / 1.3 for obsns }

I sh^d mention one

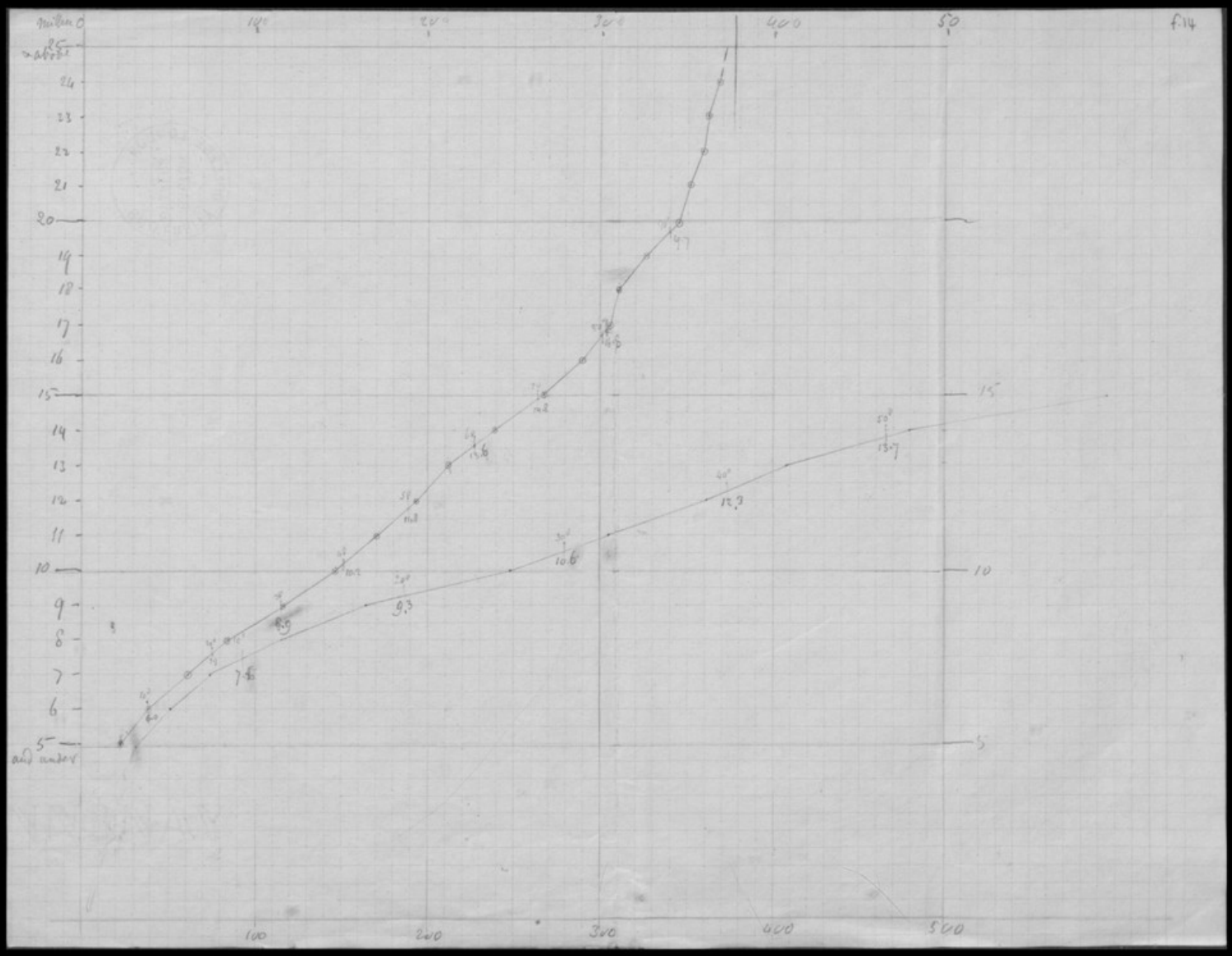
The trifling liberty that has been taken with the data in drawing the diagram, namely in disregarding the difference between percentages of the tabular entries of under 20 mm, of 90 & 91 respectively, that have been treated as if they were both 90.5. ~~Had the former numbers been followed there would have been some confusion~~ It would have been difficult to show with the diagram which curve the 90 & 91 respectively belonged. The [illegible] of the figures that precede & follow these entries are identical in both series, viz 82, 87 ( ) 93 95 96 98; then makes the correction reasonable, while on the other hand [illegible]. On these grounds the small and unimportant liberty may well be pardoned.

Whether we accept the smoothed values or not as a fair rendering of the observed ones, it is clear that the female sensitivity as measured by this test considerably exceeds that of the male. ~~The median constant of the former~~ The average woman can perceive doubleness when the points are 11.8 mm. apart but the average man cannot do so till they are 13.1 apart, the ratio of these values being about 6 to 7 & the same proportion or thereabouts holds fairly well among the more sensitive [illegible] 9.2

However for some reason which I can only guess at, this proportion does not hold among the coarsest of the two sexes. Their performances gradually grow more similar the coarser their faculties & the lowest 10 per cent or thereabouts are identically alike. The best guesses I can make are that these low values are partly due to a more or less equal degree of stupidity in either sex and to carelessness especially in women, and secondly that the variability of women in this sense of touch is a little greater than that of men. Both these surmises being justifiable on other grounds. I cannot accept the observed male curve as a normal one; the female comes out better but an average between the two happens to be the best. It is given in diagram 2 merely as a brief method of representing the general run of the figures to be taken in accordance with the ± small correction on account of sex, and by no means as having any distinct physiological meaning.

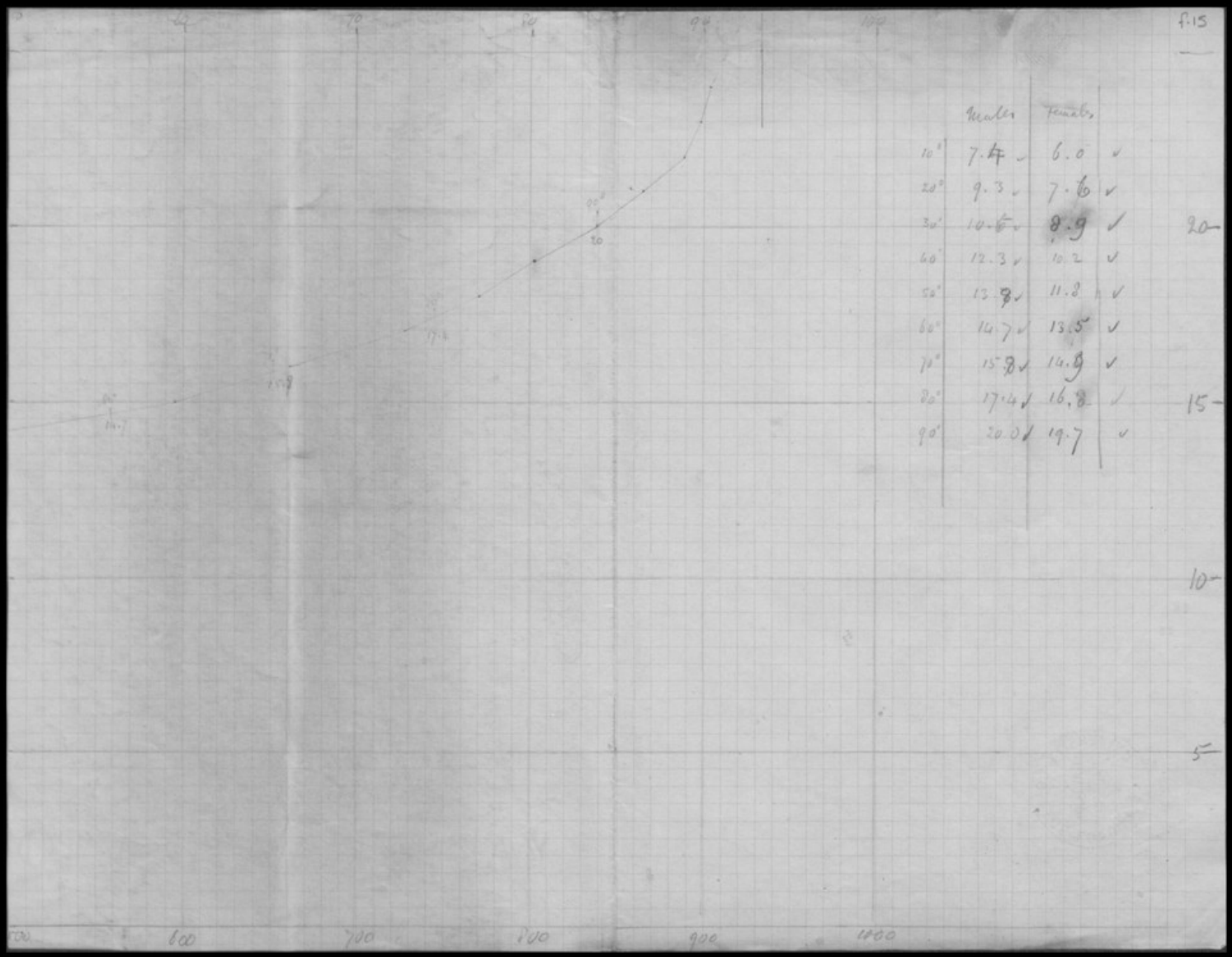
I should be sorry if these results were accepted too implicitly for they are given largely in the hope that some person

	Inches	Centimeters
10°	93.2	37.7
20°	186.4	75.4
30°	279.6	113.1
40°	372.8	150.8
50°	466.0	188.5
60°	559.2	226.2
70°	652.4	263.9
80°	745.6	301.6
90°	838.8	339.3
95°	885.4	358.1
100°	932.0	377.0


f.14
100
200
300
400
500
10
15
20
25
5
10
15

f.15

	Males	Females	
10°	7.4 ✓	6.0	✓
20°	9.3 ✓	7.6	✓
30°	10.6 ✓	8.9	✓
40°	12.3 ✓	10.2	✓
50°	13.8 ✓	11.8	✓
60°	14.7 ✓	13.5	✓
70°	15.8 ✓	14.9	✓
80°	17.4 ✓	16.8	✓
90°	20.0 ✓	19.7	✓



Sense of Touch — by Flowers
Craniometer "one or two points touching"
at ~~base~~ nape of neck —

Males 932
Females 377
} Measurements 1,309

f.16v

Abstract of "Sense of Touch"

Males –

Millimetres

Height in Inches	1-5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Above	Total
Below	9	5	4	10	8	13	11	5	7	6	15	6	7	7	2	3	1	2		1		124
~~59.6-60.5~~																						
~~60.6-61.5~~																						
61.6-62.5	—	—	—	2		1	2	2	2	2	3	2	2	—	2	—	—	—	—	—	—	20
62.6-63.5	2	—	1	—	1	6		4	1	6	5	3	6	2	—	—	—	3	—	—	1	41
63.6-64.5	2	1	1	4	2	5	4	4	4	3	3	2	3	4	2	5	2	2	—	—	2	55
64.6-65.5	1	2	4	3	6	11	4	6	6	7	12	10	6	2	1	4	4	1	1	1	2	94
65.6-66.5	2	2	4	2	4	7	3	10	1	4	7	3	8	9	4	4	3	3	—	—	6	86
66.6-67.5	4	1	2	4	7	4	9	6	6	13	13	9	8	6	4	3	3	2	1	—	4	116
67.6-68.5	4	2	—	3	11	5	8	5	6	9	14	11	12	5	7	5	3	1	3	1	4	119
68.6-69.5	3	3	3	1	4	12	2	5	6	7	18	9	3	1	5	3	2	3	2	2	2	96
69.6-70.5	2	1	1	3	1	4	4	6	3	6	7	6	4	1	3	6	3	2	2	—	5	70
70.6-71.5	3	1	2	2	1	3	4	2	1	2	9	2	3	6	2	—	3	3	1	1	1	52
71.6-72.5	—	—	—	5	1	4	4	1	1	2	7	1	1	—	—	—	—	—	—	—	2	29
72.6-73.5	—	1	1		2	1	1		1	2	3	1	—	—	—	—	1	1	—	—	—	15
~~73.6-74.5~~																						
above	—	—	—	2	1	1	—	2	1	2	—	2	2	1	—	—	1	—	—	—	—	15
Total	32	19	23	41	49	84	56	58	46	71	116	67	65	44	32	35	26	23	10	6	29	932
Sums fr: beginning	32	51	74	115	164	248	304	362	408	479	595	662	727	771	803	838	864	887	897	903	932	

by protraction $Q_1 = 10.0$, $M = 13.8$, $Q_3 = 16.5$ say $M = 14$ mm, $q = 3.5$ (really 3.25)

Females

Millimetres

Height in inches	1-5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Above	Total
Below	2	1		1	3	1			1	2			1									12
53.6-54.5	1						1			1												3
54.6-55.5					1	1													1			3
55.6-56.5	1					1			1	1		1								1		6
56.6-57.5	1	1			1						1			1					1			6
57.6-58.5	1		1		1	1		1		1					1							7
58.6-59.5						1	2	1	3		1	1	1	1	1						1	13
59.6-60.5			1	1	3	1	2	4	2	1		6		1		2	1	1			3	29
60.6-61.5	2	1	2	4	3	3	3	1	1	4	4	2	2				1				1	34
61.6-62.5	1	1	2	2	5	5	2	2	3	6	3	1	1			1	1	1	2			39 ✓
62.6-63.5	4	2	5	4	2	5	2	5	1	2	3	3			1	4				1	1	45 ✓
63.6-64.5	5	1	5	–	6	3	3	2		2	6	2	2	1	5	2	1	1		1		48 ✓
64.6-65.5	1	2	3	7	2	3	3	3	3	2	5	1	6		4	2		1	1	1	2	52 ✓
65.6-66.5	3	4	1	3	4	3	4	1	1	1	2	5			2	3	1	1			1	42 ✓
66.6-67.5	1		1		1	2	1	2	1	1			1		1	1	1	2				16
above		2	2	1			1	1	2	3	3	1	1	1	1	1	1				1	22
Total	23	15	23	23	32	30	24	23	19	27	28	23	15	5	16	18	7	7	5	4	10	377
Sums fr: beginning	23	38	61	84	116	146	170	193	212	239	267	290	305	310	326	344	351	358	362	367	377	

by protraction $Q_1 = 8.3$, $M = 12.0$, $Q_3 = 15.7$ say $M = 12$ mm, $q = 3.5$ (really 3.7)

∴ (delicacy of touch in Females : do. in Males :: 12 : 14 :: 6 : 7 (perceptible distance apart)

Remarks

I notice when they once find it's over one point you sh^d keep reducing the distance till the person calls one that gives a more reliable result – this was not carried out at the start

The 124 Below 61.6 consists chiefly of children

The Registr N^o for Males from 5366 to 5894 & from 6001 back to 6397 – (leaving 106 not ob[illegible] (Females have been [illegible] [illegible] of such a few)

I am still carrying on the (old form?) Touch so perhaps we shall be able to add some others – it looks a few –

The numbers inclusive are from 5366 to 6397 in registers

About 100 more forms to pass out showing "Nape of Neck" – will sure to have a few more females

Tuesday 13-3-94
1:30

Sir

The form is rather roughly executed but perhaps it will suit your purpose I can safely say its correct from the forms - The females still looks a few on paper altho you will see there are 377 measurements - I should think by the time you return I shall have measured a few more females if you do not consider the 377 sufficient? -

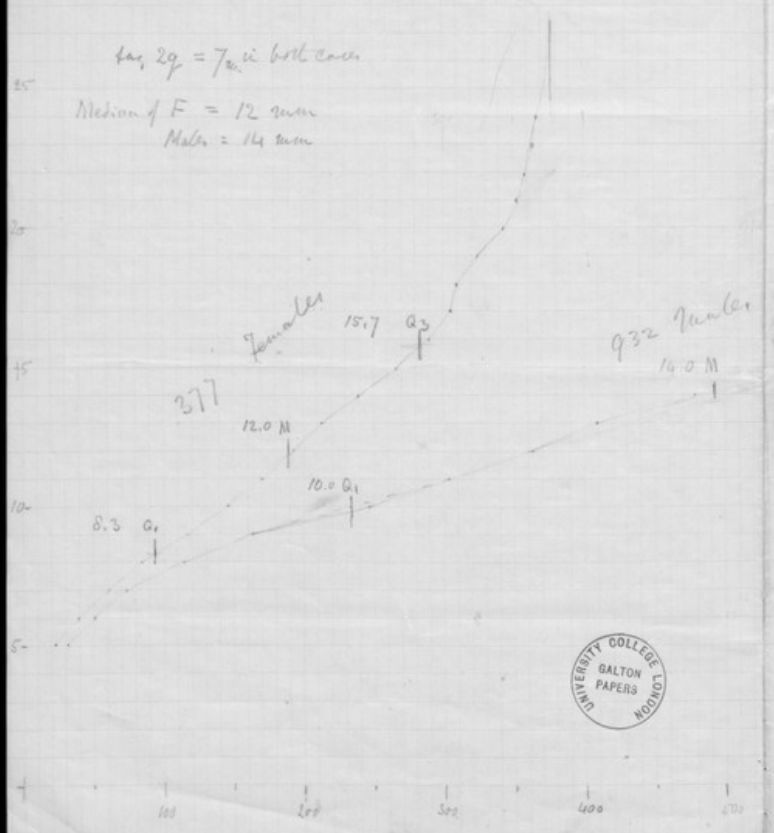
The work at the Labs goes on the same no special Enquiries or letters -
Dr Garson called yesterday evening but had heard no news from Mr. Simpson -
The museum opened till 6 p.m. last night -

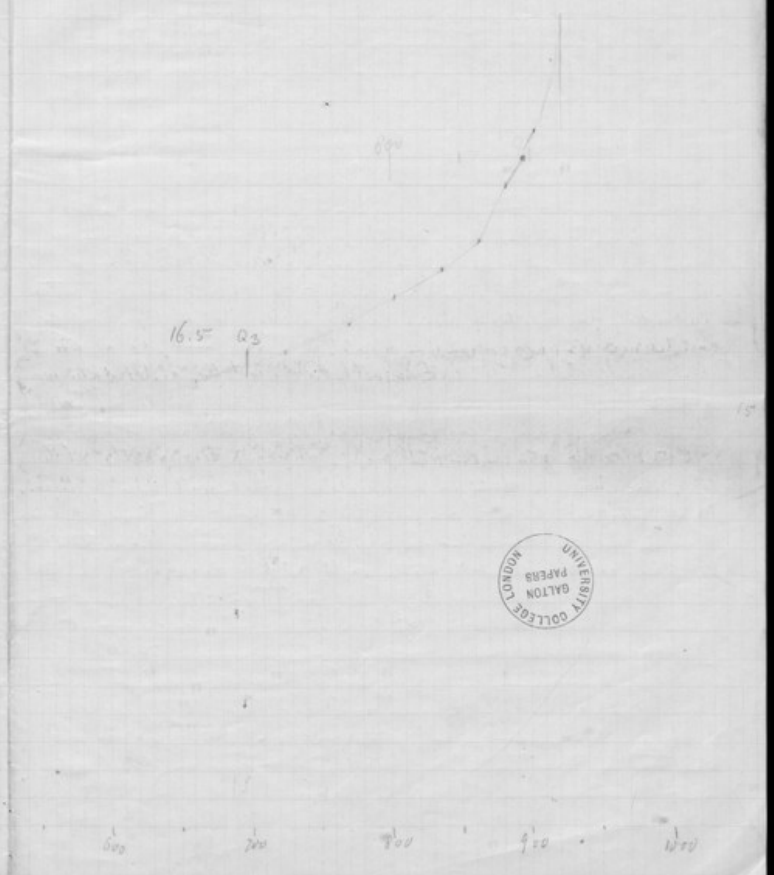
Yr Obdt
A. D. Randall

Touch — Compass points on back of neck. Centimetres

tan 2φ = 7 in both cases

Median of F = 12 mm
Male = 14 mm





(See over)

The relative sensitivity of the two sexes has been discussed of late, but perhaps on hardly adequate data; there seems need for more information on which I may contribute my data on this subject to those that are already collected. I ventured to make the following experiments, partly that such value as they may possess should be available. On thinking over the tests that were appropriate to the conditions of my laboratory, where measurements have to be rapidly made & where no undressing is permissible it struck me that the well known compass experiment would be very suitable if applied along the nape of the neck. The interval between the two points of the compass at which they can be perceived as them to be two points and not one point is very much larger at the nape of the neck than when they are applied to any other part of the head, face, hands, especially the finger tips. This fact facilitates the experiment & practically eliminates the difficulty caused by the differing thicknesses of skin of different persons, for as it is clear that a gloved hand could not discriminate such pressures as delicately as a very bared, so of two hands equally well supplied with nerves, the one with the thicker skin would discriminate less well than the other. Another great advantage of experimenting on the nape of the neck is that the experimentee cannot see what the experimenter is doing.

I therefore had this experiment made, during a few months at the end of which time the data had accumulated which will now be discussed. The apparatus used was not a compass but the two points of a "Flower's Craniometer". It seemed probable that the just-perceptible interval would be connected with the stature, at all events that the stature ought not to be disregarded and the data were originally tabulated accordingly, but, partly perhaps owing to their roughness I am unable to perceive the expected correlation therefore in the following remarks no heed of the stature has been taken.

The data have been treated by the method of Percentiles, which I have often used and explained, of which the steps are shown in Tables [illegible] & the second & third steps in the diagrams I & II. It comes to this, that if the 932 males were ranged in a row in order of the lengths of their several just-perceptible intervals, & were then divided into 10 classes, the man who stood [illegible] 248th place counting from the left would be able to perceive an interval of 10 millimetres, the 304th man would perceive [illegible] the first class being those with the most delicate apprehension & the last class those with the coarsest, then the lowest of the first class & the highest of the second would [illegible] distinguish points

	Females		Males		Diff: in emb
	Sums	per ct sums	sums	per cent sums	
1–5	23	6	32	3	3
6	38	10	57	5	5
7	61	16	74	8	8
8	84	22	115	12	10
9	116	31	164	18	13
10	146	39	248	27	12
11	170	45	304	33	12
12	193	51	362	39	12
13	212	56	408	44	12
14	239	63	479	51	12
15	267	71	595	64	7
16	290	77	662	71	6
17	305	81	727	78	3
18	310	82	771	82	0
19	326	87	803	87	0
20	344	91	838	90	1
21	351	93	864	93	0
22	358	95	887	95	0
23	362	96	897	96	0
24	367	98	903	97	1
above	377	100	932	100	0

Females

$m = 12.0$

15.7

8.3

$3 \overline{)7.4}$

$q = 3.7$

	Q=1	Q=3.7	m=12.00	m=12.5	m=12
10	-1.90	-7.04	4.96	5.3	5.0
20	-1.25	-4.62	7.38	7.8	7.4
30	-0.78	-2.87	9.13	9.5	9.1
40	-0.38	-1.44	10.56		10.6
50	0.00	0.00	12.06		12.0
60	+0.38	+1.44	13.44		13.4
70	+0.78	+2.87	14.87		14.9
80	+1.25	+4.62	16.62		16.7
90	+1.90	+7.04	19.04		19.0

$30° \ 8.9$
$70° \ 14.9$
$50° \ 11.8$
$50° \ 11.8$

$4 \overline{)47.4}$

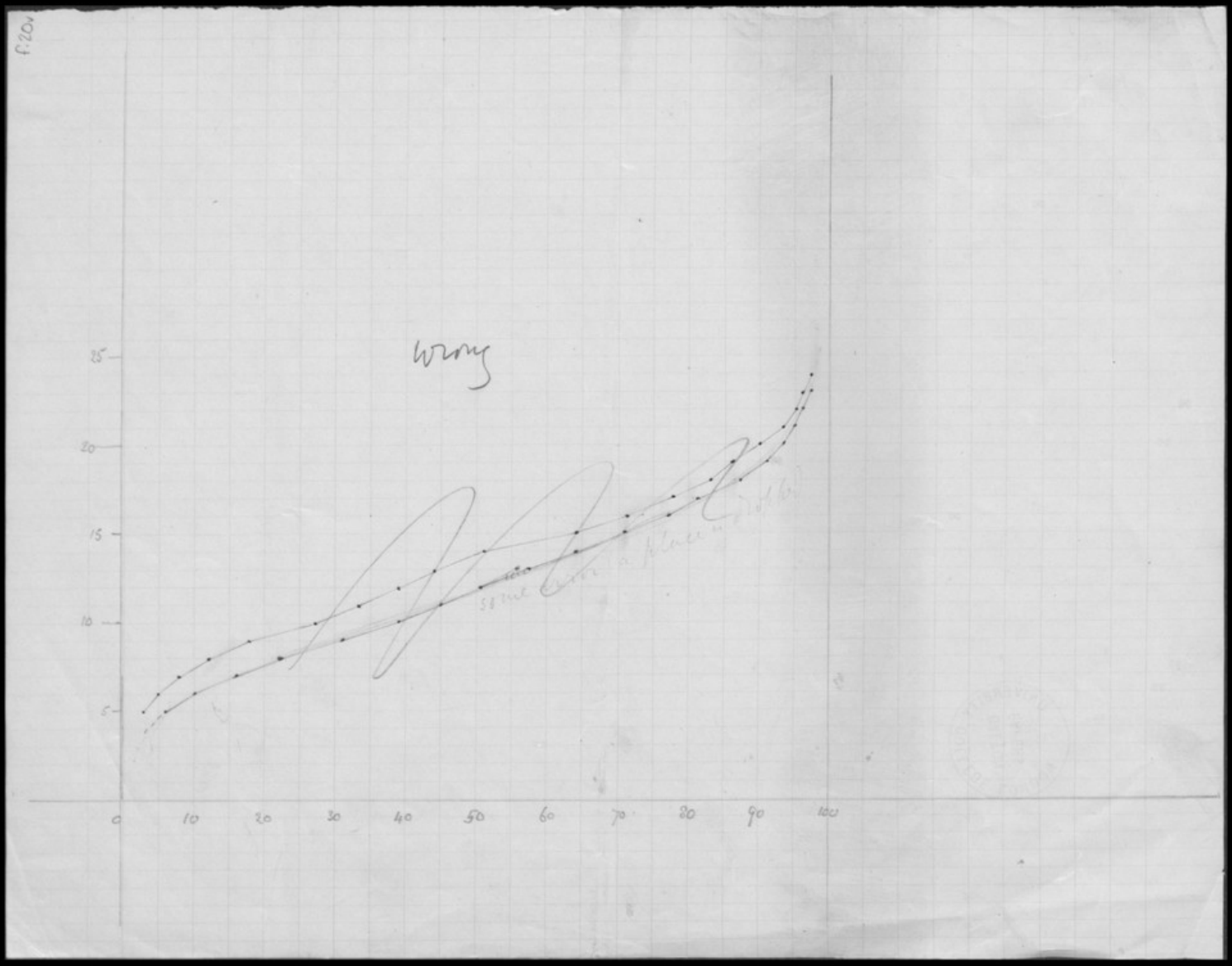
11.85

16.8
7.6
24.4
12.2

Obs smoothed

Obs smoothed

	Males	Females
1–5	3	6
6	5	10
7	8	16
8	12	22
9	18	31
10	27	39
11	33	45
12	39	51
13	44	56
14	57	63
15	64	71
16	71	77
17	78	81
18	82	82
19	87	87
20	90	91
21	93	93
22	95	95
23	96	96
24	97	98
above	100	100


f.20
wrong
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100