

Visualised numerals / by Francis Galton.

Contributors

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C. 5
VISUALISED NUMERALS.

19

BY

FRANCIS GALTON, F.R.S.

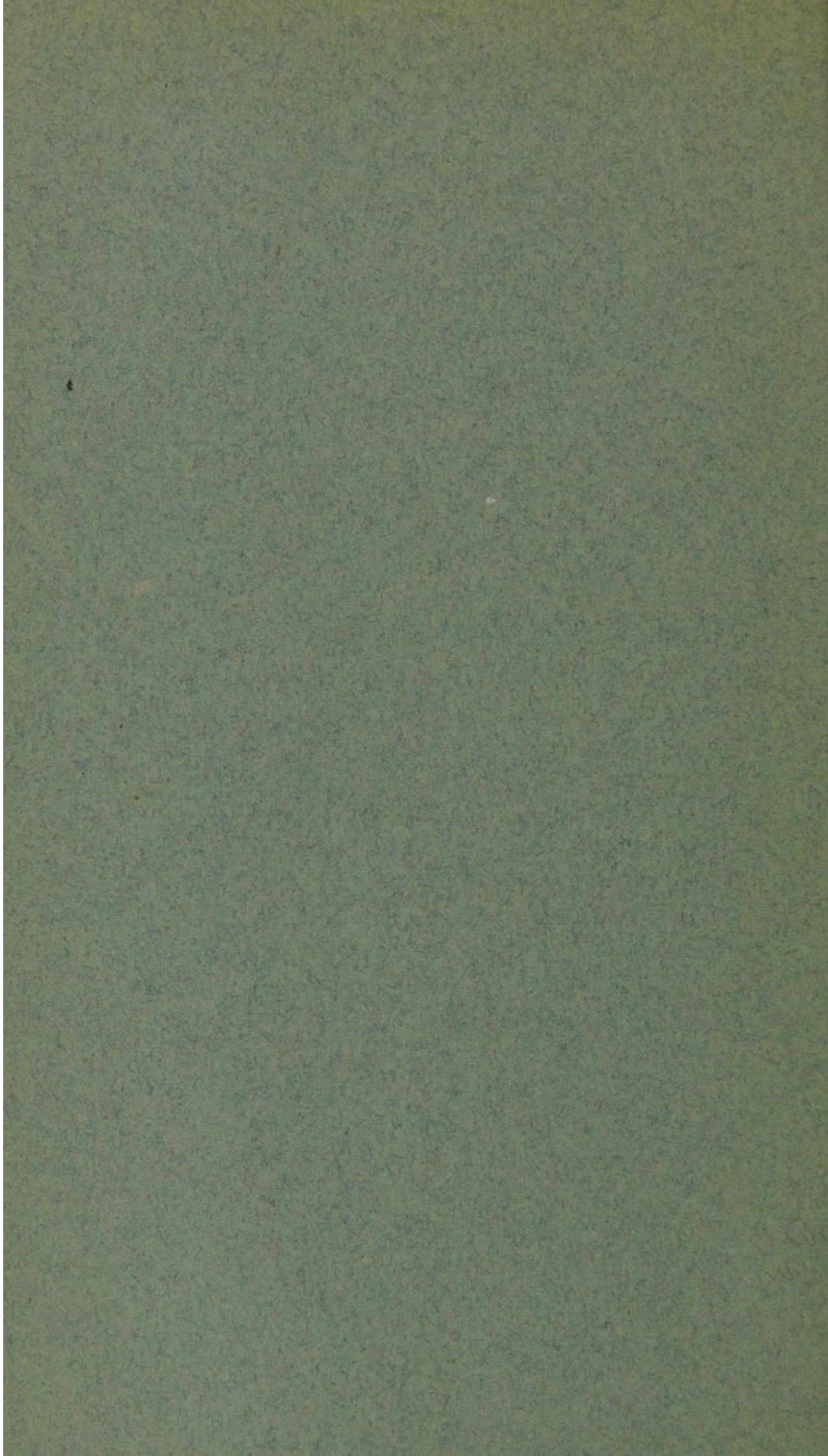
A MEMOIR READ BEFORE THE ANTHROPOLOGICAL INSTITUTE
ON MARCH 9, 1880, WITH THE REMARKS OF VARIOUS
SPEAKERS THEREON.

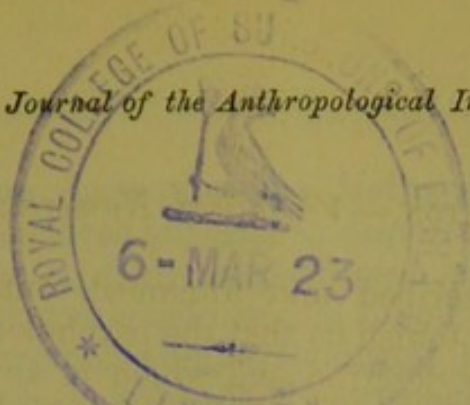
(Reprinted from the Journal of the Anthropological Institute.)



LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty.

1880.





VISUALISED NUMERALS. By FRANCIS GALTON, F.R.S.

I PROPOSE to describe a peculiar habit of mind which characterises, so far as I can judge, about one man in 30, and one woman in 15; but before doing so, I must say a word of warning against a too-frequent tendency to assume that the minds of every other sane and healthy person must be like one's own. The psychologist should inquire into the minds of others as he should into those of animals of different races, and be prepared to find instances of much to which his own experience can afford little, if any clue.

This is especially the case with psychologists who are not *imaginative* in the strict but unusual sense of that ambiguous word. I do not by imagination mean an uncontrolled fancy and inaccurate recollection. I apply the word imaginative to those who while they may be exceedingly matter-of-fact and precise, are apt to think in visual images; not in fancied words, nor in a more abstract manner. The mental state of imaginative persons is amidst a series of pictures, vivid in colour, and well defined in form, and it happens in many cases that what they mentally see appears external to themselves. There is no doubt that abstract thought is best carried on without the aid of this concrete imagery, and that a natural tendency to indulge in it is liable to be repressed by vigorous brain-workers. It is consequently uncommon among those scientific men whose attention I chiefly desire to gain. Every one, however, recognises the fact that some men of the highest order of genius and artistic temperament have had the gift of vivid mental presentation in a remarkable degree; they also know that chess-players exist, who have no mean capacity in other respects, who can play 10 or more games blindfold, having all the time a perfectly vivid picture of each board in succession before them, and seeing the chessmen on each, as made of wood or ivory, as the case may be. I therefore ask you all to take for granted the existence of imaginative persons, in the sense of the word in which I have used it, although many of yourselves may never have had the tendency to think in visual forms, or if you once had it, may have long since abandoned it.

Let me also remark, that if the existence of colour-blindness which affects about one man in 30 was unsuspected, or at all

events wholly undescribed and unnamed, until the time of Dalton, it need not astonish us that the psychological peculiarity which I am about to describe, and which is about equally rare (at least in adults), should hitherto have escaped notice.

Persons who are imaginative almost invariably think of *numerals* in visual imagery. If the idea of *six* occurs to them, the word "six," does not sound in their mental ear, but the figure 6 in a written or printed form rises before their mental eye. The clearness of the images of numerals, and the number of them that can be mentally viewed at the same time, differs greatly in different persons. The most common case is to see only two or three figures at once, and in a position too vague to admit of definition. There are a few persons in whom the visualising faculty is so low that they can mentally see neither numerals nor anything else; and again there are a few in whom it is so high as almost to give rise to hallucinations. The images of these persons, whether of numerals or not, are so vivid as to be undistinguishable from reality, except by the aid of accidental circumstances; thus the images may be transparent, or apt to vary in brightness from moment to moment, and to change more or less in outline. They may appear in the air without support, or any other of the innumerable conditions of objective reality may be absent, the want of which will render the visionary character of the image immediately manifest to a sane mind. Those who are able to visualise a numeral with a distinctness comparable to reality, and to behold it as if it were before their eyes, and not in some sort of dreamland, will define the direction in which it seems to lie, and the distance at which it appears to be. If they were looking at a ship on the horizon at the moment that the figure 6 happened to present itself to their minds, they could say whether the image lay to the left or right of the ship, and whether it was above or below the line of the horizon; they could always point to a definite spot in space, and say with more or less precision that that was the direction in which the image of the figure they were thinking of, first appeared.

Now the strange psychological fact to which I desire to draw attention, is that among persons who visualise figures clearly, there are many who notice that the image of the same figure invariably makes its first appearance in the same direction, and at the same distance. Such a person would always see the figure when it first appeared to him at (we may suppose) one point of the compass to the left of the ship at which he was looking, and upon the line of the horizon, and at 20 feet distance. Similarly, we may suppose that he would see the figure 7 invariably half a point to the left of the ship and at an altitude equal to the sun's

diameter above the horizon, and at 30 feet distance; similarly for all the other figures. Consequently, when he thinks of the series of numerals 1, 2, 3, 4, &c., they show themselves in a definite pattern that always occupies an identical position in respect to the direction in which he is looking.

Those who do not see figures with the same objectivity, use nevertheless the same expressions with reference to their *mental* field of view. They can draw what they see in a manner fairly satisfactory to themselves, but they cannot locate it in reference to their axis of sight and to the horizontal plane that passes through it. It is with them as it is with all of us in dreams, the imagery is before and around, but our eyes during sleep are turned inwards and upwards.

The pattern or "Form" in which the numerals are seen is by no means the same in different persons, but assumes the most grotesque variety of shapes. I have placed on the table or suspended against the walls copies of nearly sixty of them, which will be seen to run in all sorts of angles, bends, curves and zigzags. They have however for the most part certain characteristics in common. They are stated in all cases to have been in existence, at least so far as the earlier numbers in the Form are concerned, as long back as the memory extends; they come into view quite independently of the will, and their shape and position, at all events in the *mental* field of view, is nearly invariable. They have other points in common to which I shall shortly draw attention, but first I will endeavour to remove all shadow of doubt as to the authenticity of these statements.

I see no "Form" myself, and first ascertained that such a thing existed through a letter from Mr. Bidder, in which he described his own case as a very curious peculiarity. I was at the time making inquiries about the strength of the visualising faculty in different persons, and among the numerous replies that reached me I soon collected ten or twelve other cases in which the writers spoke of their seeing numerals in definite forms and in much the same terms that Mr. Bidder had used. Though the information came from independent sources, the expressions used were so closely alike that they strongly corroborated one another. Of course I eagerly followed up the inquiry and when I had collected enough material to justify publication, I wrote an account which appeared in "Nature" on January 15th, with several illustrations. This has led to a wide correspondence and to a much increased store of information, which enables me to arrive at the conclusions I shall lay before you. The answers I received whenever I have pushed my questions have been straightforward and precise. I have not unfrequently procured a second sketch of the Form and found it to agree closely with

the first one. I have also questioned many of my own friends in general terms as to whether they visualise numbers in any particular way. The large majority are unable to do so. But every now and then I meet with persons who possess the faculty, and I have become familiar with the quick look of intelligence with which they receive my question. It is as though some chord had been struck which had not been struck before, and the verbal answers they give me are precisely of the same type as those written ones of which I have now so many. I cannot doubt of the authenticity of independent statements which closely confirm one another, nor of the general accuracy of the accompanying sketches, because I find now that my collection is large enough for classification, that they tend to form a continuous series. I am often told that the peculiarity is common to the speaker and to some near relative, and that they had found such to be the case by accident. I have the strongest evidence of its hereditary character after allowing, and over allowing, for all conceivable influences of education and family tradition.

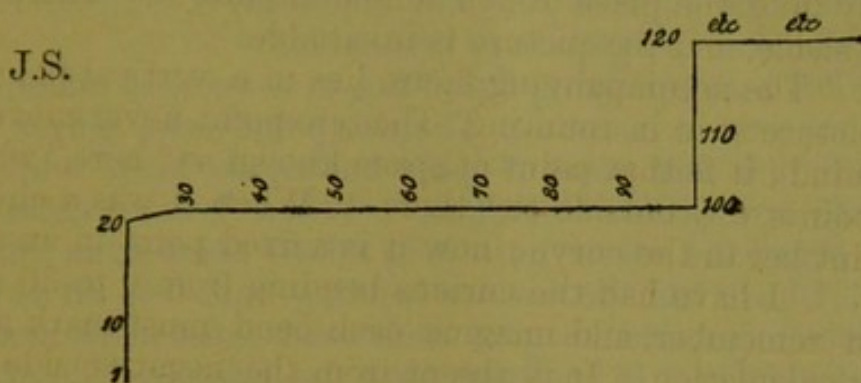
Last of all, I have taken advantage of the opportunity afforded by a meeting of this Society, to bring with me many gentlemen well known in the scientific world, who have this habit of seeing numerals in Forms, and whose diagrams are in the collection before you. Amongst them are Mr. G. Bidder, Q.C., the Rev. Mr. G. Henslow, the botanist, Mr. Schuster, F.R.S., the physicist, Mr. Roget, Mr. Woodd Smith, and Colonel Yule, C.B., the geographer. I wish that some of my foreign correspondents could also have been present, such as M. Antoine d'Abbadie the well-known French traveller and Membre de l'Institut, and Baron v. Osten Sacken, the Russian diplomatist and entomologist, for they have given and procured me much information.

I feel sure that I have now said enough to authenticate my data; it remains to treat them in the same way as any other scientific facts and to extract as much meaning from them as possible.

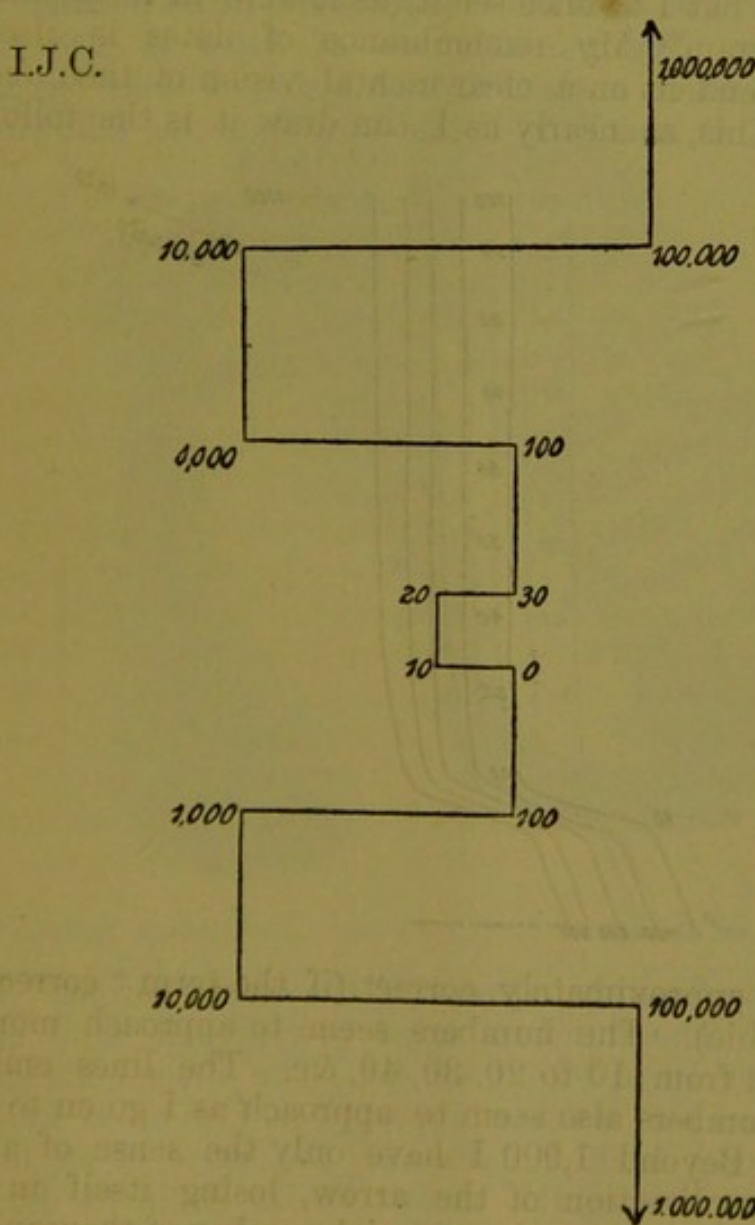
To repeat in part what has already been said, this peculiarity is found so far as my observations have extended, in about 1 out of every 30 adult males or 15 females. It consists in the sudden and automatic appearance of a vivid and invariable "Form" in the mental field of view, whenever a numeral is thought of, and in which each numeral has its own definite place. This Form may consist of a mere line of any shape, of a peculiarly arranged row or rows of figures, or of a shaded space.

I give wood-cuts of some of these forms, and very brief descriptions of them, extracted from the letters of my correspon-

dents. (The wood-cuts have already appeared in "Nature."* Many other drawings on a smaller scale on two lithographed



plates will be found at the end of these pages, and brief descriptions of some of them are given partly in an appendix, and partly by the sides of the figures themselves.)

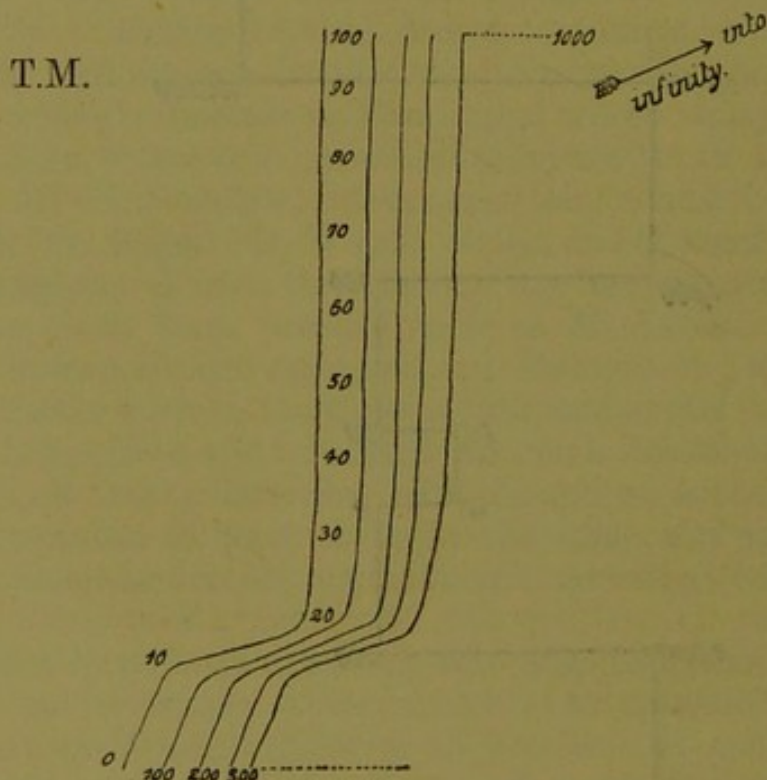


* I am indebted to the courtesy of the publishers of "Nature" for the use of these woodcuts.

I.S. "The figures are about a quarter of an inch in length, and in ordinary type. They are black on a white ground. 200 generally take the place of 100 and obliterate it. There is no light or shade, and the picture is invariable."

I.J.C. "The accompanying figure lies in a vertical plane, and is the picture seen in counting. The zero point never moves, it is *in my mind*; it is that point of space known as "here," while all other points are outside or "there." When I was a child the zero point began the curve; now it is a fixed point in an infinite circle . . . I have had the curious bending from 0 to 30 as long as I can remember, and imagine each bend must mark a stage in early calculation. It is absent from the negative side of the scale, which has been added since childhood."

T.M. "The representation I carry in my mind of the numerical series is quite distinct to me, so much so that I cannot think of any number but I at once see it (as it were) in its peculiar place in the diagram. My remembrance of dates is also nearly entirely dependent on a clear mental vision of their *loci* in the diagram. This, as nearly as I can draw it, is the following:—

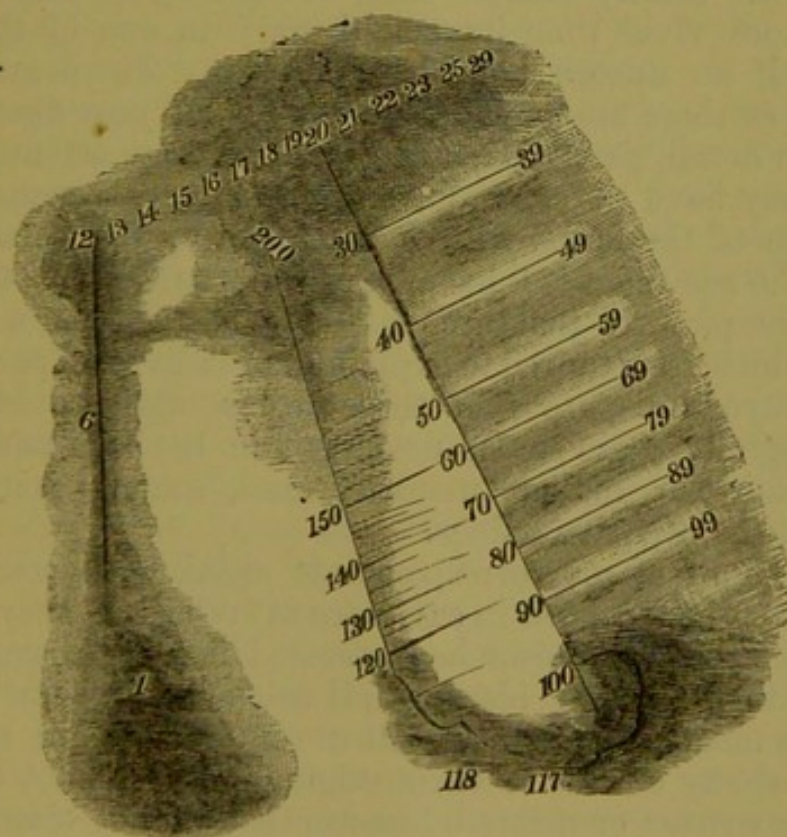


It is only approximately correct (if the term "correct" be at all applicable). The numbers seem to approach more closely as I ascend from 10 to 20, 30, 40, &c. The lines embracing a hundred numbers also seem to approach as I go on to 400, 500, to 1,000. Beyond 1,000 I have only the sense of an infinite line in the direction of the arrow, losing itself in darkness towards the millions. Any special number of thousands returns

in my mind to its position in the parallel lines from 1 to 1,000. The diagram was present in my mind from early childhood; I remember that I learnt the multiplication table by reference to it, at the age of seven or eight. I need hardly say that the impression is not that of perfectly straight lines, I have therefore used no ruler in drawing it."

D.A. "From the very first I have seen numerals up to nearly 200, range themselves always in a particular manner, and in thinking of a number it always takes its place in the figure. The more attention I give to the properties of numbers and their interpretations, the less I am troubled with this clumsy framework for them, but it is indelible in my mind's eye even when for a long time less consciously so. The higher numbers are to me quite abstract and unconnected with a shape. This rough and untidy production is the best I can do towards representing what I see. There was a little difficulty in the performance, because it is only

D.A.



by catching oneself at unawares, so to speak, that one is quite sure that what one sees is not affected by temporary imagination. But it does not seem much like, chiefly because the mental picture never seems *on* the flat but *in* a thick, dark grey atmosphere deepening in certain parts, especially where 1 emerges, and about 20. How I get from 100 to 120 I hardly know, though if I could require these figures a few times without thinking of them on purpose, I should soon notice. About 200 I lose all framework. I do not see the actual figures very distinctly, but what

there is of them is distinguished from the dark by a thin whitish tracing. It is the place they take and the shape they make collectively which is invariable. Nothing more definitely takes its place than a person's age. The person is usually there so long as his age is in mind."

[The engraver took much pains to interpret the meaning of the rather faint but carefully made drawing, by strengthening some of the shades. The result was very very satisfactory, judging from the author's own view of it, which is as follows:—"Certainly if the engraver has been as successful with all the other representations as with that of my shape and its accompaniments, your article must be entirely correct."]

In some cases, the mental eye has to travel along the faintly-marked and blank paths of a form, to the place where the numeral that is wanted is known to reside, and then the figure starts into sight. In other cases, all the numerals as far as 100 or more, are faintly seen at once, but the figure that is wanted grows more vivid than its neighbours; in one of the cases it rises as if an unseen hand had lifted it. There are as many varieties as there are persons, but I will not now describe their shapes in detail, partly because I want to draw attention to the points they have in common, and principally because I hope that some of the forms will be explained by the persons themselves who see them. I have, however, written at the side of each of the pictures that are suspended against the walls, those details which are required to explain their individual peculiarities.

It is beyond dispute that these forms originate at an early age, though they are so far developed in boyhood and youth as to include the higher numbers, and, among mathematical students, the negative values.

Nearly all of my correspondents speak with confidence of their forms having been in existence as far back as they recollect. One states that he knows he possessed it at the age of four; another, that he learnt his multiplication table by the aid of the elaborate mental diagram he still uses. Not one in ten is able to suggest any clue as to their origin. They cannot be due to anything written or printed, because they do not simulate what is found in ordinary writings or books.

The figures run frequently to the left, and more often upwards than downwards. They do not even lie in the same plane. Sometimes a form has twists as well as bends, sometimes it is turned upside down, sometimes it plunges into an abyss of immeasurable depth, or it rises and disappears in the sky. In one case it proceeds, at first straightforward, then it makes a backward sweep high above head, and finally recurves into the pocket, of all places! It is often sloped upwards at a slight

inclination from a little below the level of the eye, just as objects on a table would appear to a child whose chin was barely above it.

All this contrasts strongly with the character of the Forms under which historical dates are visualised by the same persons. These are sometimes copied from the numerical ones, but they are more commonly based both clearly and consciously on the diagrams used in the school-room.

The same may be said of the imaged letters of the alphabet; therefore the numerical Form is the oldest of all. I suppose that it first came into existence when the child was learning to count, and was used by him as a natural mnemonic diagram, to which he referred the spoken words "one," "two," "three," &c. Also, that as soon as he began to read figures, their visual symbols supplanted the verbal sounds, and permanently established themselves on the Form.

Hence the Form is of an older date than that at which the child began to learn to read, it represents his mental processes at a time of which no other record remains. It persists in vigorous activity, and offers itself freely to our examination.

The teachers of some schools have kindly questioned their pupils for me, and I find that the proportion of young people who see numerals in Forms is much greater than that of adults. But for the most part their forms are neither well defined nor complicated. I conclude that when they are too faint to be of service they are gradually neglected, and become wholly forgotten, while if they are vivid and useful they increase in vividness and definition by the effect of habitual use. Hence, in adults, the two classes of seers and non-seers are rather sharply defined, the connecting link of intermediate cases which is observable in childhood having disappeared.

These Forms are the most remarkable existing instances of what is called "topical" memory, the essence of which appears to lie in the establishment of a more exact system of division of labour in the different parts of the brain than is usually carried on. Topical aids to memory are of the greatest service to many persons, and teachers of mnemonics make large use of them, as by advising a speaker to mentally associate the corners &c. of a room with the chief divisions of the speech he is about to deliver. Those who feel the advantage of these aids most strongly are the most likely to cultivate the use of numerical forms.

The question remains, why do the lines of the Forms run in such strange and peculiar ways? the reply is, that different persons have natural fancies for different lines and curves. Their handwriting shows this, for handwriting is by no means

solely dependent on the balance of the muscles of the hand, causing such and such strokes to be made with greater facility than others. Handwriting is greatly modified by the fashion of the time. It is in reality a compromise between what the writer most likes to produce, and what he can produce with the greatest ease to himself. I am sure too, that I can trace a connection between the general look of the handwritings of my various correspondents and the lines of their Forms. If a spider were to visualise numerals, we might expect he would do so in some web-shaped fashion, and a bee in hexagons. The definite domestic architecture of all animals as seen in their nests and holes, shows the universal tendency of each species to work according to definite lines. The same is seen in the groups and formations of flocks of gregarious animals, and in the wedge-shaped or other flights of gregarious birds.

The rambling character of the lines that characterise the majority of the Forms are natural to the taste of a child. They may be recognised in their drawings, in the castles they construct on the sand, and in the outlines of the borders of their flower-gardens. The appreciation of firm curves can hardly co-exist with the imperfectly developed physique of the child; it is related to the accurate hand, the steady tread, and the generally well-adjusted muscles of manhood. A natural instinct in favour of those rigidly straight lines in which printed matter is disposed in schedules, or of the circular outlines of many diagrams, can hardly as yet have become frequent in our race. No savage possesses it. Our habitual use of the straight line and circle has grown up as it were yesterday, under the requirements of manufactures based on careful measurements with a rule, and carried out by the plane and the turning lathe, which instruments make it now much more easy to work in accordance with these lines than any other. The rambling numerical Forms being based on the instinctive preferences of childhood, show the solidity of their foundation by persisting in defiance of subsequently acquired tastes.

Children learn their figures to some extent by those on the clock. I cannot, however, trace the influence of the clock on the numerical Forms in more than three cases out of all my collection, which amounts to nearly 80 pictures of one kind or another. In one of them, the clock-face actually appears, in another it has evidently had a strong influence, and in the third, its influence is indicated, but nothing more. I suppose the Roman numerals in the clock do not fit in sufficiently well with ideas based upon the Arabic ones.

The paramount influence proceeds from the names of the numerals. Our nomenclature is perfectly barbarous, and that of other civilised nations is not better than ours and frequently

worse, as the French "quatre-vingt dix-huit." We speak of ten, eleven, twelve, thirteen, etc., in defiance of the beautiful system of decimal notation in which we write those numbers. What we see is one-nought, one-one, one-two, etc., and we should pronounce on that principle, with this proviso, that the word for the one having to show both the place and the value, should have a sound suggestive of "one" but not identical with it. Let us suppose it to be the letter *o* pronounced short as in "on," then instead of ten, eleven, twelve, thirteen, etc., we might say *on-one, on-two, on-three, etc.*

The conflict between the two systems creates a perplexity, to which conclusive testimony is borne by these numerical forms. In almost all of them there is a marked hitch at the 12, and this repeats itself at the 120. The run of the lines between 1 and 20 is rarely analogous to that between 20 and 100, where it usually first becomes regular. The teens frequently occupy a larger space than their due. It is not easy to define in words the variety of traces of the difficulty and annoyance caused by our unscientific nomenclature, that are portrayed vividly, and so to speak painfully in these pictures. They testify by the evidence of indelible scars to the effort and ingenuity with which a sort of compromise is struggled for and has finally been effected between the verbal and decimal systems. I am sure that this difficulty is more serious and abiding than has been suspected, not only from the persistency of these twists which would have long since been smoothed away if they did not continue to subserve some useful purpose, but from the results of experiments on my own mind. I find I can deal mentally with simple sums with much less strain if I audibly conceive the figures as one-nought, one-one, etc., and I can both dictate and write from dictation with much less trouble when that system or some similar one is adopted. I have little doubt that our nomenclature is a serious though unsuspected hindrance to the ready adoption by the public of a decimal system of weights and measures.

These Forms are no doubt of some convenience for mnemonic purposes and it is worth considering what shape is most likely to suit the majority of those who wish for the first time to make one for their use. It ought of course to be based on the decimal system and judging from the majority of the Forms it need not go higher than 100. I am sure that symmetrical divisions at each ten would be too elaborate and uniform for general convenience, and that a system of scores and half scores would be the best. In short a pentagon, with a mark in the middle of each side, seems most likely to fulfil the conditions; it certainly suits me well. In that figure the angle at the bottom would stand indifferently for 0 or 100, and the other angles for 20, 40, 60

and 80; the place of 50 being in the middle of the horizontal top line. I find that my own mind has a decided left-handed twist, so that I cannot without an effort reckon the divisions in this imaginary pentagon in the direction in which the hands of a clock would move, but I must proceed reverse ways.

This concludes what I desired to say and I trust that the gentlemen whose names I have mentioned will kindly explain their own Forms and favour us with any remarks that may help to throw light on this curious subject. The lithographed page with 8 drawings, contains copies of their Forms (made by a camera lucida) from those they were so good as to send me and the following are brief explanatory extracts from their letters. The other lithograph contains 24 forms of other persons; they will sufficiently explain themselves.

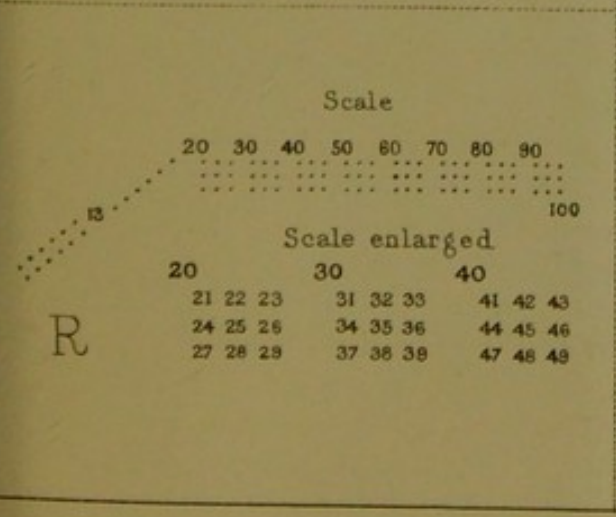
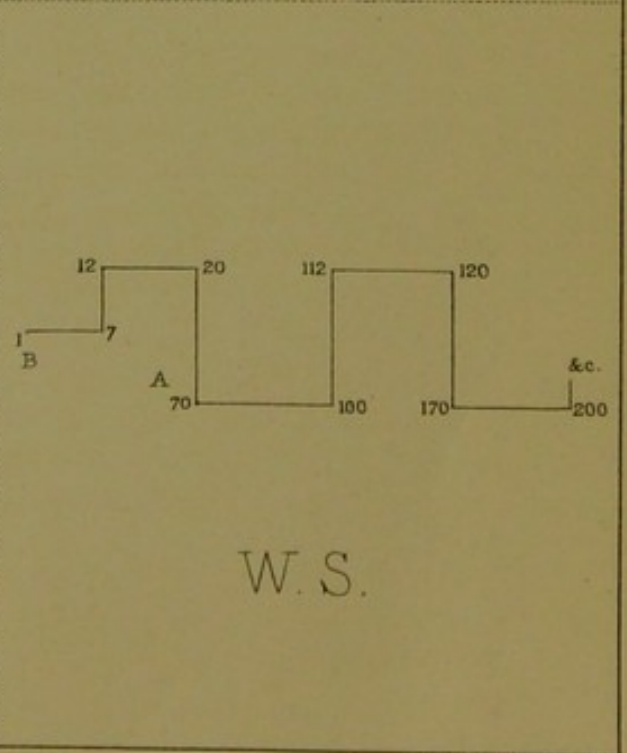
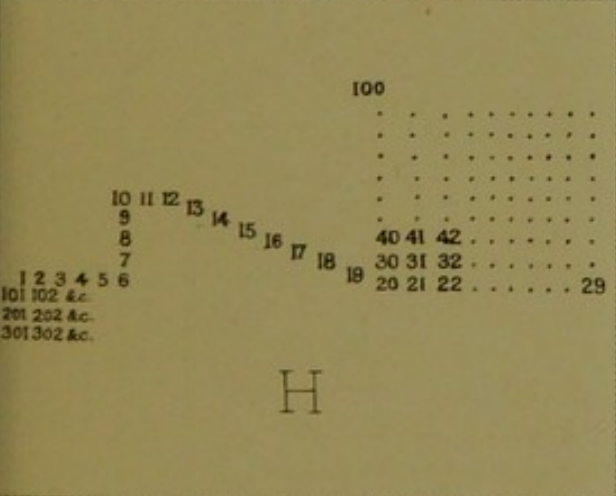
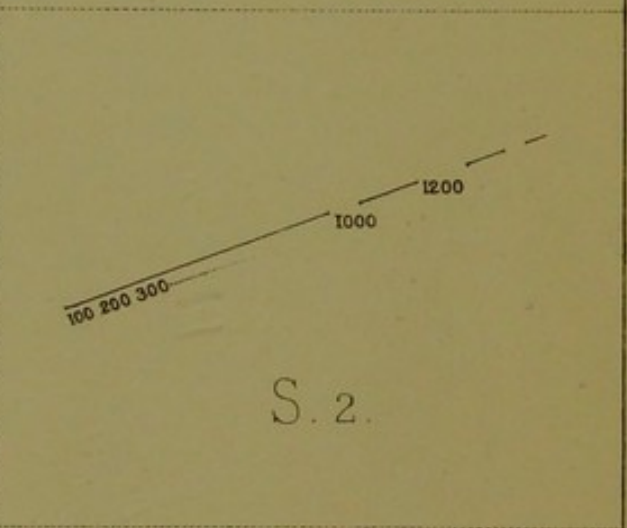
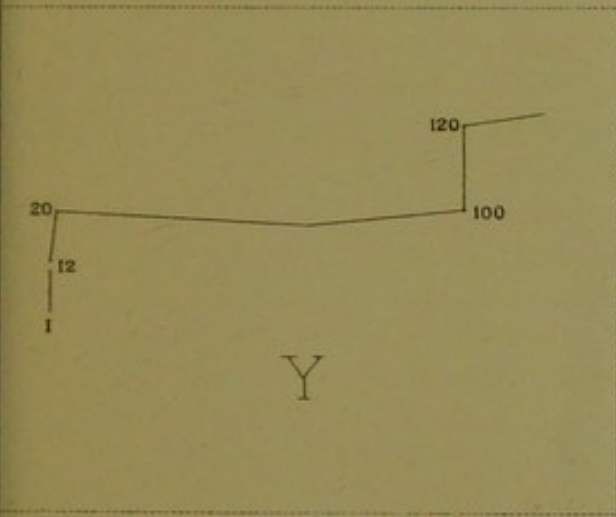
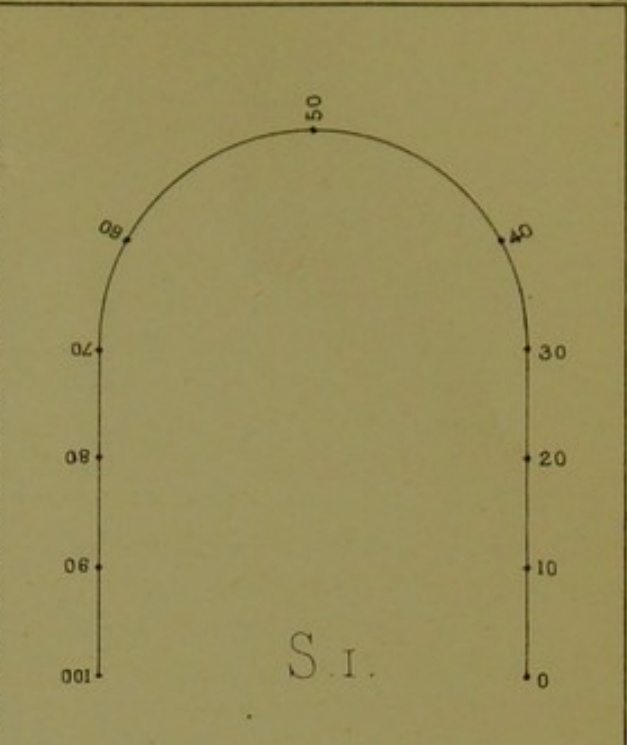
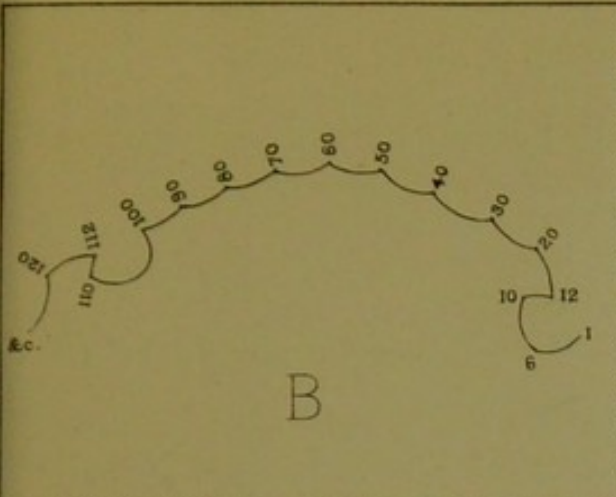
APPENDIX.

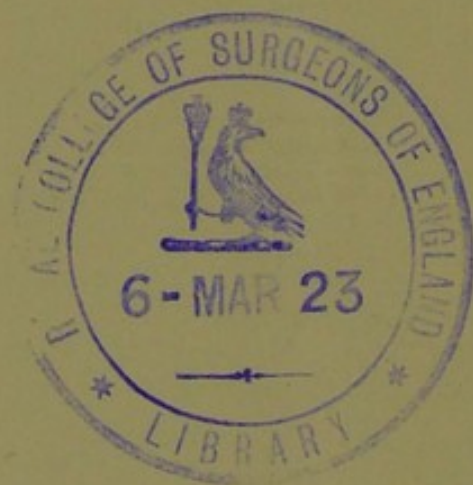
Brief Extracts from a few letters, with illustrations see Plate I (the letter accompanying each illustration is the initial of the Correspondent.)

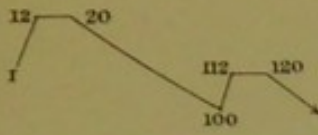
GEORGE BIDDER, Q.C.—One of the most curious peculiarities in my own case, is the arrangement of the arithmetical numerals. I have sketched this to the best of my ability, every number (at least within the first thousand, and afterwards thousands take the place of units) is always thought of by me in its own definite place in the series, where it has if I may say so, a home and an individuality. I should, however, qualify this by saying that when I am multiplying together two large numbers, my mind is engrossed in the operation, and the idea of locality in the series for the moment sinks out of prominence. You will observe that the first part of the diagram roughly follows the arrangement of figures on a clock-face, and I am inclined to think that may have been in part the unconscious source of it, but I have always been utterly at a loss to account for the abrupt change at 10 and again at 12.

Colonel YULE, C.B.—I am not sure that the angle at 20 is a right angle, nor the line from 20 to 100 straight. Neither do I (or *did* I perhaps more correctly) see them in type, or black on white ground. I used to see them in gradations of colour, but I cannot fix these now with truth. I can only remember that 30 and up to 40 were of a subdued sunny colour; a division of the shade took place at 12.

The Rev. G. HENSLOW.—I have always associated my numbers from childhood upwards as in the accompanying arrangement, but am quite at a loss to know how it arose. My alphabet corresponds with it.

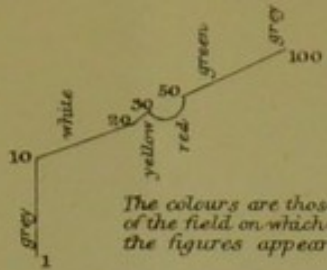






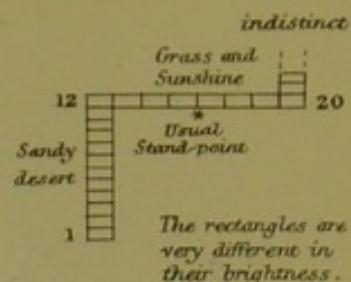
Every unit has its own tint
2 white, 4 orange, 7 blue.

C.



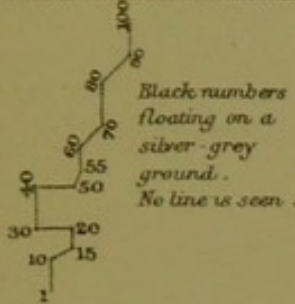
The colours are those of the field on which the figures appear.

G.E.



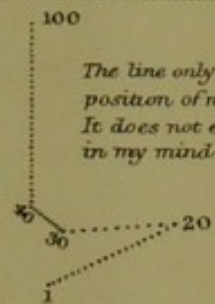
The rectangles are very different in their brightness.

G.S.



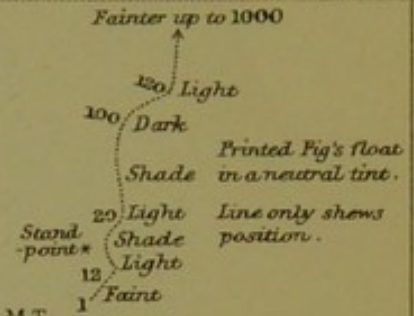
Black numbers floating on a silver-grey ground. No line is seen.

E.N.

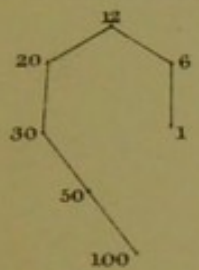


The line only shows position of numbers. It does not exist in my mind.

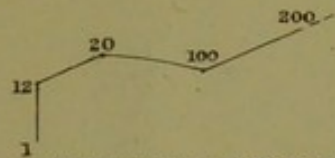
W.H.P.



M.T.

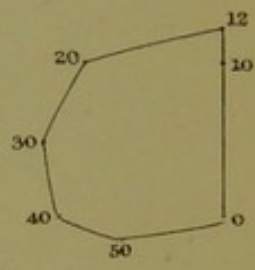


by G.H.

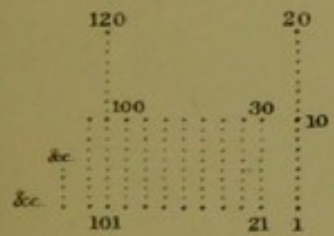


Some numbers, as 48, 96, 108, are brighter and more defined than the rest. 8 gives the idea of redness, 9 of blackish-blue.

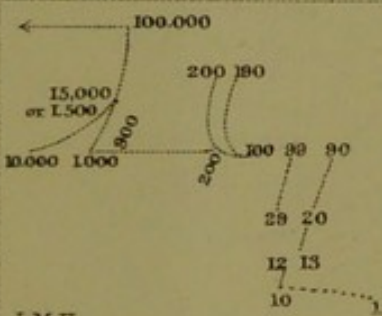
THW



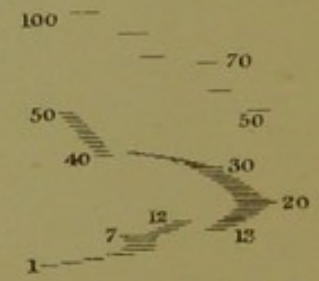
F.G.E.



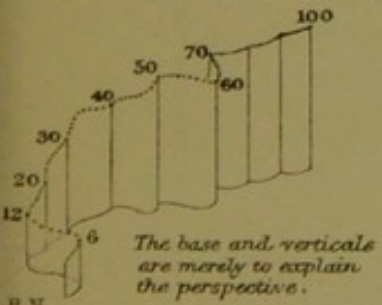
C.A.



L.M.H.

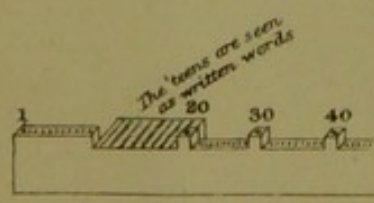


N.L.



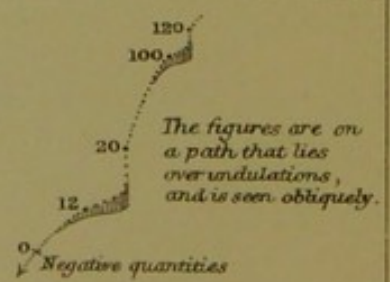
The base and verticals are merely to explain the perspective.

R.N.

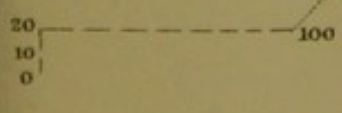


The frame is merely to explain the perspective.

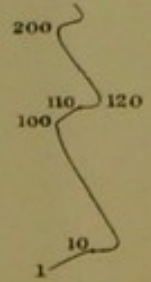
E.D.



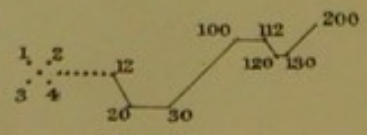
C.H.



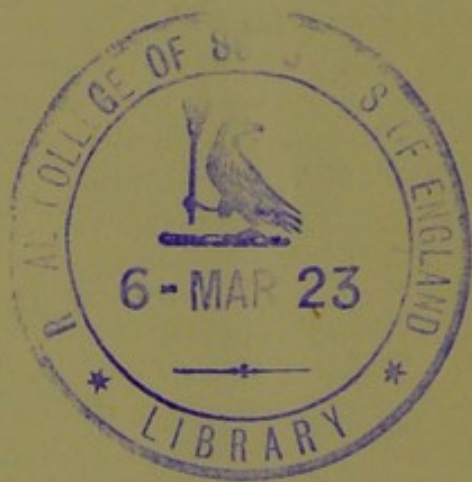
T.H.



M.E.H.



W.B.L.



ARTHUR SCHUSTER, F.R.S.—The first figure shows the appearance the diagram 0-100 would have if looked at perpendicularly. It recedes from the eye with a slight upward slope of about 1 in 12. I make extensive use of this diagram, it seems to me to act as a shelf on which I can put any number and take it out again when required. There is however, a good deal of elasticity in this (as well as in the second figure), when I am specially occupied with one part of it, say between 70 and 80, as in thinking over what has happened in the last 10 years, that part would seem to become larger and encroach on the territory of its neighbours. On certain occasions also, the diagram would become distorted so as to join the 100 to the 0.

This is not the only figure on which I visualise numbers; the hundreds seem to me to be arranged as in the second figure, in a line sloping upwards. Between 1200 and 1500 the diagram becomes confused; above 1500 I cannot visualise numbers. I have almost daily to deal with such up to four or five figures, but they are only figures to me, I cannot represent them in a diagram.

JOHN ROGET.—The first twelve are clearly derived from the spots on dominoes. After 100 there is nothing clear but 108 (*i.e.* 9×12), and then I begin with the units and tens only as above.

B. WOODD SMITH.—In my case the numerals follow the route shown in the accompanying figure. Above 200 it becomes vague and is soon lost, except that 999 is always in a corner like 99. The lines bear no reasonable proportion to the numbers they contain, my own position in regard to them is generally at A, nearly opposite my own age, 50, and has shifted as I have grown older, but it sometimes varies between A and B. When at B I always stand with 1-7 to my left, but when at A I can face either towards 7-12 or towards 12-20, or 20-70, but never (I think) with my back to 12-20.

DISCUSSION.

GEORGE BIDDER, Esq., observed that he had possessed the faculty of mental visualisation referred to in the paper, so long as he could remember. He imagined the mental pictures to be survivals of some early association of childhood, which however, in most cases, it is impossible to trace. In the mental picture or diagram that numerals appear to him to assume, the first twelve numbers are placed as if on a clock face, and probably the idea was originally derived from that source. In his diagram, there was an angle at 10, and again at 12. He could only account for this, by supposing it to be the result of a struggle between the decimal and duodecimal systems of notation. He explained also that not only numbers, but almost all subjects of thought and memory present themselves to his mind in a visualised form:—For example, the months of the year are arranged in a circle. The days of the week in a line from right to left. The dates and events of history have also a

definite local arrangement. As regards the latter, he believed that he could identify part of it with the arrangement in a certain historical puzzle-map, which he once, as a child, possessed.

He pointed out in connection with the subject, the curious value of *memoria technica* in assisting the memory, which usually consists of the arbitrary association of the fact to be remembered, with some totally incongruous, and perhaps ludicrous topic, and that apparently the very incongruity is an aid to memory; he also explained that the visualised pictures were not in his case to be confounded with impressions real or false of the organs of external sense, and did not seem to rank with them at all.

Dr. HACK TUKE: With reference to a question just put by Major-General Lane Fox, as to "Whether the cause of the difference between different people in the power to visualise mental impressions depends upon the perfection of the organs of sight? I see no reason to suppose such to be the case. I have no doubt the optic nerve is as well developed, and the sight as good in those who are destitute of this power as in the 1 in 30 who possess it. Dr. Ferrier and others, believe they have made out the visual centre in the grey matter of the cerebral convolutions; and it is probably here that this remarkable power resides. It is not in the peripheral expansion of the optic nerve. If we could examine, I hope it may be long hence, the grey matter of the visual centre of Mr. Bidder and others who have given us their experience to-night, we ought to find under the microscope a greater perfection of structure than in that of ordinary people. If our knowledge were sufficiently advanced, we ought to discover cells exquisitely adapted to their purpose; cells possessing a receptive and retentive power in a superlative degree. This visualising of forms might be called a faculty of physiological hallucination, as distinguished from what I am more familiar with—pathological hallucination. I have paid some attention to this among the insane, and have observed marked differences among them on careful inquiry into their sensations, although at first sight, they seemed identical. Thus, with auditory hallucinations, I find that when a man hears an imaginary voice, he sometimes hears it as clearly as he hears my own; while in other cases it is only heard internally. It is an inward voice. Corresponding conditions, I suspect, occur with those who visualise figures. In some, there is a distinct objective form; in others, the internal representation, however vivid, does not reach the point of objectivity. It would take too long to go into the physiological causes of these differences. There is no doubt that the researches of Mr. Galton in regard to these remarkable mental representations, which are consistent with perfect health, present great interest to those who study the hallucinations which result from disease. In both instances, they are alike purely subjective in their nature.

Mr. SCHUSTER: The diagram of numerals which I see, has roughly the shape of a horse-shoe, lying on a slightly inclined plane, with the open end towards me. It always first comes into

view, in front of me, a little to the left, so that the right-hand branch of the horseshoe, at the bottom of which I place 0, is in front of my left eye. The numbers then succeed each other, going upwards and to the left; 50 is placed at the highest point. When I move my eyes without moving my head, the diagram remains fixed in space, and does not follow the movement of my eye. When I move the head, the diagram unconsciously follows the movement, but I can, by an effort, have it fixed in space as before. I can also shift it from one part of the field of view to the other, and even turn it upside down. I use the diagram as a resting-place for the memory, placing a number on it, and finding it again when wanted. A remarkable property of the diagram is a sort of elasticity which enables me to join the two open ends of the horse-shoe together when I want to connect 100 with 0. The same elasticity causes me to see that part of the diagram on which I fix my attention larger than the rest.

I also have a diagram on which I place the months of the year. The diagram is an oval curve. The months follow each other in the direction of motion of the hands of a watch. The summer months take up a much larger space than the winter months.

I see the days of the week arranged in a straight line from right to left.

Although both the numerals and the days of the week succeed each other from right to left, I am not left-handed.

MR. A. TYLOR: Mr. Bidder in his remarkable and most valuable account of the workings of his own mind, and of the hereditary power which he possesses of visualising, has stated: First, That the face of the clock itself (but with the figures XI and XII deficient) from which as a child he had learnt to tell the time, recurs to his mind when he visualises. Second, That the picture of a certain number of the kings of England following William the Conqueror, appears still in his mind in the same row that he first saw them in the child's pictorial history book from which he learnt their names, dates, and order. From the statement made by Mr. Galton on the authority of most of the visualists, the impressions of this kind made in childhood are the most permanent, brightest and clearest. The events happening since childhood are more difficult to visualise than the earlier periods of history.

This statement refers us to the importance of object lessons for children, the Kinder Garten system, and explains why children should be taught by objects. A block, with three dimensions, faced with a picture of an object used to illustrate a letter or word, seem to enable any child to visualise and make the first great abstract step in education.

I may mention my own experience on a subject not touched on by Mr. Galton: viz., the manner of learning to distinguish the right hand from the left.

I found that difficult, and when a young child invented for myself a plan, of overcoming that difficulty, I pictured, or as it will now be called (after the valuable discovery of Mr. Galton),

visualised myself always in the same position in the same room riding on a rocking-horse, with a whip in my right hand; as I knew that the hand with the whip must be always between the horse and the wall, I could determine which was my right hand in whatever position I actually was, by placing myself visually in the proper position on the horse. No doubt most children do something of this kind in learning lessons, music, or ciphering.

Had I known how to interpret what had happened to myself and to Mr. Galton's other observers—when I read before the Institute, my paper on the "Object-Origin of Pre-historic Thoughts and Ideas,"* I should have strengthened my argument on Thought. Mr. Galton's researches extend the principle I thus advocated very much. I believe now, that the only thoughts that young children can attain to, have a distinct object-origin, and on this point children resemble the whole animal world. Not only has Mr. Galton's inquiry a local value, but his investigation will probably affect the theory of the working of the human mind, and have an important application on other questions of biology.

Mr. ROGET on being called upon, stated that the form which the numbers from 1 to 100 instinctively assumed in his imagination, did not seem to exhibit any remarkable peculiarities as compared with those of other persons who saw such forms. It was, however, so deeply engraven in his mind, that a strong effort of the will was required to substitute for it any artificial arrangement. This he had found to be the case in the endeavour to fix dates in his memory. He had, in childhood, been trained by his father (the late Dr. Roget), to the use of a well-known system of *memoria technica* advocated by Feinaigle, in which each year has its special place on the walls of a particular room, and the rooms of a house represent successive centuries. This plan his father had made great use of, and it had always served the speaker well for the chronology of earlier ages; but, for that in which we live, particularly for events during his own life, he had, in spite of various attempts, never succeeded in fairly locating the dates in the room assigned to them. They *would* go to what seemed to be their natural homes in the arrangement above referred to, which had come to him from some other, probably prior, but unknown source. The numbers from 1 to 12, taken separately, usually appeared to him in symmetrical forms, chiefly learnt, he had little doubt, from the spots on dominoes.

Mr. RICHARD B. MARTIN: I should like to ask Mr. Galton if he has observed the singular power which is the subject of his paper to exist in any particular class of persons, or to be associated with any special pursuits, artistic, mathematical, or otherwise.

The Rev. G. HENSLOW described his own scheme of visualised numerals, which, like several others, had an angular bend at 10, and another at 12. The figures 1-6 being horizontal, fig. 6 was in the usual point of sight, 7 to 10 being vertically arranged. The

* "Trans. Anthropological Institute," vol. vi, p. 125.

whole range from 1 to 100 (101 recommencing at 1) was in sight at once, and any figure could be observed in its normal place; but if the head was turned, the whole scheme moved accordingly. By an effort of the will, if the eyes were *alone* turned and not the head, the scheme could be shifted also, so that the fig. 6 would still retain its position in the line of sight.

His mental alphabet was described as partially coloured; several of the letters being the initial letters of colours, partake of the same hues. Thus, B, G, R, P, are blue, green, red, purple, respectively. I is black, being the initial letter of Ink, while C and O are white, apparently due to the white space included within the circle of black; that others are coloured, such as A being yellow, and several grey. He could not account for these facts.

Mr. Henslow also described his experience of *Visual Objects*. On shutting the eyes and waiting for a minute or so, some object, real or nondescript, is sure to appear. Something in its form appears to be suggestive of some other object, into which it spontaneously turns, the latter resolving itself into a third, and so on till the series vanishes. The visual objects are thus purely automatic creations of the brain. Sometimes an object will appear which had been previously seen, but entirely forgotten, showing that unconscious or automatic memory was at work. The objects often seen are elaborately cut glass bowls, etc., highly ornamental; embossed, chased or frosted or filigreed gold and silver ornaments, flower-stands, etc., of exquisite beauty; as well as common objects, fruit, flowers, jugs, sofas, etc. Brilliant and elaborate patterns of textile fabrics are not unfrequent. Choice bits of scenery, such as a narrow gorge, covered with ferns and mosses, with cascades, etc., or again, well-remembered scenes of childhood, will spontaneously appear.

If an attempt be made to foist some object into the dioramic series, a great effort of the will is required. The first attempt may either fail entirely or some nondescript hybrid structure, part automatic and part volitional, will appear. By a continued and determined effort to see the object thought of, the will or volitional effort may overcome the automatic action of the brain, so that the object determined upon will at last appear distinct and sharply defined.

Every object is generally very distinct, though if of some length, the whole of it cannot always be seen at once, thus the stock of a gun was only visible, not the barrel. They are at focal distance, excepting scenery, which appears as in nature. The objects are of small size, 1 to 2 or 3 inches in diameter or length.

Several water-colour illustrations of visual objects were exhibited by Mr. Henslow.

Colonel YULE, C.B. : I am afraid my experiences in this way are less striking and vivid than those described by the gentlemen who have spoken. The diagram representing the form in which I see the series of numbers is on the wall, and will be seen to be of a very simple kind compared with theirs. With me, too, the impressions have become sensibly weaker of late years, and in describing them

it is not always quite easy to say how far I am speaking from surviving impressions, and how far from memories of the past. I must say, too, that I have found that under the effort to fix and describe these impressions in writing for Mr. Galton, they have become, as it were, thinner, and hard to catch; and in this experience I do not stand alone.

Though I could respond to much that was said of their own impressions by Mr. Bidder and Mr. Henslow, there is one point in which their experiences raise in me strong dissent. They actually describe not only the procession of numbers as seen by them, but that of the days of the week and the months of the year as advancing from *right to left!* Now, so strong with me is the opposite impression that their description seems to me quite anomalous, and in fact if I said all I felt I should say—"Why, everybody *knows* that they go the other way."

I may mention that the procession of numbers as I see them, rising vertically from 1 to 20, and from 20 going off to the right in a tolerably straight line up to 100, applies strictly also to my retrospect of the history of the centuries. Every event in the first 20 years of a century (*e.g.*, the Union with Scotland, the Rebellion of 1715 in the last century; or the Regency, the battle of Waterloo, etc., in the present century), I see as in the vertical part of the series, every event in the remaining decades of the century falls into the horizontal procession.

Colonel Yule then spoke of the form and different colours of the days of the week as they appeared to him; and in conclusion said that in being called up to speak on this subject, he could not but feel a good deal like M. Jourdain, who was so astonished at learning that he had been speaking prose for 40 years without knowing it. So he (the speaker) had been *visualising* for a good deal more than 40 years, and but for their friend Mr. Galton he should never have become aware of the fact.