The senses, their division and work : viewed physically and evolutionally / by Henry Muirhead.

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XXXII.—*The Senses—their Divisions and Work—viewed Physically and Evolutionally.** By Henry Muirhead, M.D., Cambuslang.

[Read before the Society, February 7, 1877.]

[After some introductory remarks the paper proceeded as follows :—]

Living material possesses inertia, that is, the disposition to persist, quite as much as non-live matter does; and this disposition, inclination, or property is, I do not much doubt, the operating agency in heredity, or persistence of type, whilst the never-ceasing incursions of the surroundants are the occasioning causes of all revolution, *i.e.* Evolution. Every biod is the battleground of these two contending forces :—the Ancestral or Conservative (instincts), and the Personal (experiences) or Reforming (tendencies), as I named them in a paper read before the Anthropological Society in 1870, where I pointed out, that as soon as reforming parties succeed in establishing themselves in power in the interior, they tend to become as conservative as those whose ancestors have been there for ages. To assist the inner powers in holding the reins of government in the besieged city of such a complex corporation as a mammalian organism exhibits, telegraphic communications between the internal factories have been established, and also between these and the outposts, to give immediate intelligence of danger, of supplies, of assistance, &c. These are in full communication with reacting centres, from the most primitive and direct reflex-reactors, to the most considerative of the cerebrum. It is to these outpost contrivances for intelligencing purposes, and their reports, that I chiefly intend to direct attention at present. For it is beyond the purport of this paper to narrate the various steps in differentiation of the nutritive, motor, and co-ordinating organs. Of the latter, the first distinctly visible are small ganglia, with nerves to the muscles, &c., to control these organs, but not to impart working power into them any more than

* In this paper I treat incidentally of Evolution and Continuity in live bodies, as in those of last session I did in reference to inorganic matter.

a coachman, through the reins, imparts power into his horses, or a corporal by his direction into his men. Then we have ganglia of a more generalised character, to sway some of the minor ones, as sergeants over corporals, lieutenants over sergeants, captains over lieutenants, up to the commander or syndicate, who may be represented by the cerebrum, controlling all more or less minutely as occasion requires; attending more to the fighting department than to the commissariat, except in taking care that proper supplies are provided and delivered. And I hold that the energies of the cerebrum are expended in receiving and digesting intelligence, holding councils, and in exciting, directing, and controlling the muscles—not in doing their work.

From the intelligence we receive through the outpost department, we all practically believe in the existence of something we call matter—something possessing possibilities of exciting sensation—inertia. This belief is a consequence of its acting on our organism. That is to say, what we believe of it are consequences of our brain-reactions to its action—our brain-reactions which I have endeavoured roughly to trace to the inertia of matter. We are conscious of this matter affecting us in at least six different classes of modes.

We are conscious of alterations of

Pressure,
Temperature,
Taste,

We are also conscious of alterations of

Sound,
Colour,
Odour.

The exciting causes of the first three modes of acting come to us through what I am led to consider the more primal, the more fundamental instrumentalities. I therefore call them *palaic*. And I conceive it is on the lines of these older ones that the instrumentalities of the latter three are developed—those capable of telegraphing to us of the physical excitors of sound, of colour, and of odour. I therefore, for distinction's sake, call these the *neoteric* sense-organs. These we do not find existing in the less differentiated types at present existing, so in all likelihood they were not developed in those first evolved at the dawn of life on earth. Again, holding matter to exist as ether, as molecules, and as masses, then, as a sort of cross-classification, it appears to me we may hold that we are acted on by matter moving

Ethereally, when conscious of effects of Heat or of Light,
Molecularly,* ,, Taste or of Odour,
Molarly, ,, Pressure or of Sound.†

I have long been in the habit of looking on ether as matter comparatively little, if at all aggregated; on simple molecules as aggregates of ether, and on masses as aggregates of molecules. For, pondering over matter in a fluid state, since we know it to shade off on the one side into the densest solid bodies, so we can conceive it shading off on the other side into ether, or, it may be, its constituent materials. And I ask, is it *prima facie* seemingly more improbable that oxygen gas is composed of ethereal particles, than that the enormously thick ice which extends for thousands of square miles around the poles, is all made up of oxygen and another gas? It would not have seemed so a hundred years ago or so. Since then, however, we have succeeded in separating and measuring the chemical elements of water, but not those of oxygen yet.

It is somewhat curious that the authors of the "Unseen Universe" should have chosen and used negatively that sense through whose instrumentality we chiefly have intercourse with that portion of our cosmos they denominate "unseen." Had they chosen intangible, inaudible, untastable, or inodorous, I should not have been led to advert to the title.

It may be objected to the foregoing cross-classification, that in hearing we are acted on chiefly by air and other gases, which may be looked on as unaggregated molecules. True, but it is not in consequence of their intermolecular—that is, their chemical action—on each other or on us, that they excite to consciousness of sound. On the contrary, it is in consequence of these gases moving in molar waves that they act on our organs of hearing—waves that are as really mass-waves as liquid waves are, or the teeth of a rotating toothed wheel appreciable through the finger. For we know that when air or other gas is blown with sufficient intensity against the baral‡ nerves, the latter telegraph inwards intimations thereanent. Another proof of the intimate relationship existing between the baral and audible excitors. In worms and more lowly organised biods the more neoteric of these two, that is the audible sense apparatus, is but little differentiated out of the palaic; whereas

* By chemical, *i. e.*, intermolecular action.

† More properly its physical excitant; but both in sound and taste, the excitants, telegrams, and brain-responses have not clearly distinguishing terms.

‡ Those nerves that telegraph of pressure, ambiguously named tactile or organs of touch.

In bats the neoteric-sense instrumentalities seem so highly evolved, that hearing is very likely of more service to these animals for hunting in the dark than sight is. In cats, again, the optic apparatus is so developed that they can hunt in the dark where nothing is visible to us.

It will have been observed that I make no mention of "muscular sense" in the foregoing enumeration. And I omit the instrumentality so called, for the simple reason that I do not believe in the existence of any such sense. My notion regarding it is, that it is merely some muscular actions, together with some mental operations, mixed up and confounded with separate intensities of pressure or baral-sense work. To illustrate my position, let us suppose a longish bar of silver to be suspended by a chain, and its upper end very hot, while its lower end is very cold. When I raise my *gloved* finger-tip so as to come very slightly in contact with the under surface of the bar, I get from my finger indications induced by mass pressure, and very soon after telegrams of alterations of temperature from the same region. The latter are in consequence of the cold end of the bar not dealing on terms of equality with my finger. In fact, giving back fewer thermal units than the many it receives from the finger. But in a short time I become conscious of another change in the character of the thermal telegrams. They are now indicative of a much higher degree of temperature. This is a consequence of the warmth travelling down the bar; so that now, instead of sending less heat to the finger-end than is received from it, there is a reversal of the rate of exchange, and the nervuli, true to their occupation, telegraph of the altered conditionment (of the finger-tip). If I now slowly raise my finger a little, there are altered intimations sent of sensal pressure. The same intimations would have been telegraphed from my finger-point, if, instead of my moving my finger, the bar had been lowered a little. Now please observe very particularly that sensal *feeling is reaction* to any change in kind or in degree of intensity of any stimulus telegraphed by any sensal nerve; and is neither the remembrance of a former feeling, nor the comparison of one feeling with another. Such operations are quite different from pure sensal feeling—conscious reaction to simple telegrams from the world outside the cerebrum or encephalon. Baral telegram No. 1 and baral telegram No. 2 when elected into feeling or consciousness, have *qua* feeling nothing whatever to do with the further conscious operation of finding out that one is more or less heavy than the other. Just as feeling of a high temperature has *qua* feeling nothing to do with the consciousness that a lower tem-

perature is lower. We might quite as reasonably postulate the existence of a distinct meta-thermal sense-organ to telegraph of greater intensities of temperature, as of a distinct meta-baral sense-organ to telegraph of greater intensities of pressure;—indeed, supplementary sense-organs for greater intensities of colour, of odour, of taste, and of sound. But the crowning absurdity of the notion lies in supposing, or at least implying, that there is in each muscle an organ of consciousness, which compares the different intensities of pressures, discriminates between them, and then telegraphs intimations of these discriminations or judgments,—a set of mental operations which never occurred in the biodal world till man invented symbols, or rather, employed arbitrary symbols to indicate measurements. A mode of operating which mathematicians may claim as still distinguishing the human from the infra-human individual.

At the same time, however, I am not prepared to assert that we are totally unconscious of the brain-work employed in telegraphing to the motor instrumentalities of the organism, when and how they are to act or refrain from acting. For we are, indeed, conscious of *willing* towards the performance of non-habitual muscular operations. The more habitual the operation, the less are we conscious of it, for reasons to be assigned afterwards. Well, we *will* the operation; but we never know how the command is obeyed, except through means of the return telegrams by the sensal nerves. A blind man, conscious of throwing a stone, does not perceive how far it has gone, or what it has hit, except indistinctly through hearing, until he carries his baral nerves up to where they can give him more definite information. A skilled fencer, on the other hand, urges and controls his sword-work under instant and accurate intelligence, being kept fully informed of all that is going on by means of his eyes chiefly. But further, although he appears to use *effort*—nay, does do so by means of his muscles—I hold it absurd to suppose that much physical effort—equal to mass motion—can be effected through invisible tubes filled with imperceptible fluid. We telegraph orders —the muscles do the work, just as we can fire an explosive mile off through means of a telegraph wire; but it is the explosive substance which does the damage. In fact, we deal with our muscle force as an engine-driver on a locomotive does with the steam (of the boiler) when he turns it on or off. If he had no sensal nerves or if they were all out of order, he would not know how the machinery of the engine operated.

I have said that I look upon the neoteric sense-organs as developed on the lines of the palaic. In addition to the reasons already

adduced, we may further consider that in so far as the external agencies are concerned, that light is nearly allied to heat, odours to tastes, and sound-waves to molar pressures. Then the neoteric instrumentalities are very locally developed, whereas the palaic are to be found everywhere. It may be argued that taste is quite localised in the mouth. This is, no doubt, the case in highly differentiated animals, but it is very far from being so in the more lowly and far more numerous individuals which, while they assimilate food and continue their species, are never endowed with neoteric sense-organs; not to speak of the myriads which flourished and died ere an eye or an ear was developed. In those biods whose body is all foot, and also all mouth, that mouth tastes, swallows, and assimilates food by any part of itself which happens to come into contiguity with an edible substance. Indeed, I am inclined to look on taste as the most palaic and also the most important of the senses in primal times. The one from whose information the retention or rejection of captured booty was determined on by the protozoa of primordial ages—in times when the taste-organism was little more differentiated than it is in a crystal, which we know retains the appropriate and rejects the inappropriate. A mode of acting still in vogue in those portions of our own food-canal which have their mode of taste still but little differentiated, or interfered with by cerebral influences, and which reject up or down the inappropriate with characteristic energy, seeming "survivals" of the palaic modes of operating of more primal times.

In this connection I may note briefly, that I hold that all forms of jugal Reproduction are differentiated processes of Assimilation essentially; and that, in like manner as assimilation, reproduction is disgusted, and the operations of its products are cramped, by paucity of proper variety in the materials assimilated. Variety in materials leads to variety in modes of operating; and the greater the variety in the modes of operating, the greater the enjoyment of life. For life, physically, is essentially connected with powers of moving unpossessed by inorganic bodies. In fact, each individual, when he excepts that which he evolves from the depth of his own consciousness, knows no other distinction.

Further, it appears to me that in the advantages derivable from variety of operations we may find the reason for the origination of jugal reproduction, and also the sources of the beneficial effects of kinless-jugation—cross-fertilisation as compared with kin-jugation—in-and-in-breeding. Advantages, we know, do accrue, except seemingly where the non-kinship—differentiation in operations—is such

as to get beyond the easily-assimilable, and to trench on the antagonistic—acting as poisons do on the individual biod, by putting the machinery of life out of gear; so that, even in the origination and differentiations of Reproduction, Continuity seems unbroken. The Fit + Fortunate = the Survivors. This does not necessarily imply the "survival of the Fittest."

It may be asked, since you object to the term "muscular sense," what machinery do you suppose does the work attributed to the so-called sense? The work is somewhat complex, and requires various instrumentalities. When a touch excites a baral sense-nerve to telegraph pressure intimations, a small group of reactive brain movements occur. These movements constitute the physical work of conscious feeling; in consequence of which we often proceed to make some estimation between said pressure feeling and some allied feelings. In order to effect this we recal into faint operation some former pressure-feeling work of the brain (or consciousness of it). This is termed recollecting it. Again, some muscles may be employed to bring the baral nerves into position to be stimulated by other pressures, or to repeat the set under discussion. In addition to these doings, another set of brain-movements—which we call Comparing—come into operation to enable us to estimate the differences between the different sensal stimulations,—the Estimations themselves being conclusions rejected or adopted. Now, not one of all these doings is sense-nerve work, except the work of the baral nerves when employed in transmitting baral telegrams—that is to say, telegraphing to the brain intimations of the disturbances excited in said nerves by anything which may press on them or their connections. I may here note that the term "touch" is very liable to be used ambiguously, and generally means muscle-work rather than sense-nerve-work; and "muscular sense" is the natural child of this amphibological parentage. And not only has this amphibious mongrel misled us into this mess about "muscular sense," but it is also chargeable with being the occasioning cause of our taking up the notion that to it (touch) belongs the credit of teaching sight and the other senses (so far as they are teachable) to acquire for us a knowledge of size, form, and impenetrability or resistance of bodies; whereas the eyes, with all their motor appliances—natural and artificial—are infinitely better *touching* instrumentalities than the fingers, lips, and tongue taken together. Touching is in reality the making the distal ends of the sensal nerves travel over stimuli, of which they telegraph. What we subsequently are *sensible* of are tremors from the central ends of the sensal nerves: nothing else. But this is antici-

pating. In the meantime, I may say that I hold that the baral sense organs are those palaic apparatuses which are excited by the impacts of sensibly ponderable masses; while the thermal sense organs are the palaic instrumentalities which are excited by the impacts of the almost imponderable particles or grouplets of ether. In thus attempting to raise into greater prominence the thermal sense, whose nerves have not yet been anatomically traced, may I hope that I make some compensation for depressing the muscular. That is, supposing both changes to come to be accepted—a state of opinion not likely to eventuate for some time to come.

We all know that some sensal telegrams are of themselves sometimes agreeable to us, while some, on the other hand, are disagreeable. I mean that they are so simply of themselves, and not apparently dependent merely on the greater or less intensity or repetition of the sensal telegrams. This class of facts likely depends on the constitution — evolution of the individual for the time being, since our appreciation of many of them may be altered by age and habit. Disagreeables in this class seem to be such, from the modes of motion induced, not according with the normal modes of motion of the organs affected. In the same way, the introduction of a new belief opposed to, or contradictory of, some old established belief of a race or caste, is found to be most repugnant to the theological, the moral, or the scientific modes of thought of that race or caste; just as a poison may be looked on as a substance which induces modes of motion in the organism incompatible with the normal modes. But besides the foregoing class of agreeables and disagreeables, there are many sensal telegrams which are pleasurable or painful (physically), in consequence of the amount of intensity or of repetition. The sensal telegrams may be so slight or so evanescent as to be barely perceptible, or so habitual as to be almost unheeded. In this stage they may be classed as indifferent in character. But an increase in intensity or repetition may cause them to be esteemed pleasurable for a time. Further, the increase may be so great as to merge into the disagreeable, passing on to tiring and painful, and still further on, till the normal information of the telegrams is almost or wholly lost in telegrams of nerve disorder or nerve destruction, which seem always painful, until from thorough disorganisation telegrams cease altogether. All our perceptions of desirables or undesirables, whether viewed in connection with spatial and chronal associations or not, must have some brain operation—must have this, whether induced primarily or associationally. While alive this is indispensable.

But, further, some will be inclined to say, in reference to sensal telegraphing, that I ought to include the conscious reaction of the brain—to the telegrams—that occurs in sensation work. Now, intimations sent through a telegraph wire, and consciousness of them by a telegraph clerk, are different doings, and require different instrumentalities. As they have different names in the telegraphic department, I think they ought to have distinguishing names in the human mechanism. I am not aware, however, that they have acquired distinguishing appellations in psychology or mental science. If they have not, the more is the pity. Not only does there seem a want of distinctiveness here, but also that there is a lack of clear appreciation as to the distinctive natures of Sensation and Perception; and I venture to postulate as a finger-post, to help us in our travail towards greater lucidity, that sensation is usually restricted to the consciousness of sensal intimations, and does not include consciousness of their apparitions when merely remembered again; whereas perception is a more generic term, including not only consciousness of sensal telegrams, but also consciousness of Recollections, Comparisons, Cognitions, Conceptions, Desires, and other Emotions. Moreover, surely for the sake of greater clearness the term Feeling ought to be restricted to simple reaction to sensal telegrams, so as to have nothing to do with the work of the sensal nerves telegraphing, on the one side, nor with the operation of conscious grouping of the feelings on the other side, when the latter come to persist in consciousness. For brevity's sake I must leave aside Emotions, which are feelings excited by some stirring action of the organism, intense enough to force itself into conscious notice, and impelling to organic action, although brain-work may have more or less power of restraining the tendencies. Emotions are less strong organic actings than those we call instinctive, reflex, or excito-motor—viz., coughing, sneezing, winking, swallowing, breathing, and other more palaic operations of the organism. Without further notice of this division of the feelings, and to aid in disentangling and delineating the various steps in the process of becoming conscious of the qualities and relationships of external objects, let us note down sensation work in the order of its procedure, jotting down telegraphing work alongside as analogous doings, to help towards a clearer apprehension of the physiological and psychological operations.

1. External object excites stimulating work in the distal ends of the sensal nerves.	1. As the battery does in the extremity of the telegraph wire.

2. There follows tremor-travelling along the sensal nerve.	2. As along the telegraph wire.
3. Response work by the brain moving.	3. As by the needle moving.
4. Attention to trains of sensal telegrams—feeling work.	4. Equal to telegraph spelling work.
5. Grouping work to get at relationships less or more complex.	5. Equal to word-forming and sentence-forming.

In reference to our acquiring notions of Relationships, I beg attention for a few moments to our mode of procedure.

The sensible qualities of an object—*i.e.*, its modes of operating on us—are *to us* merely sensal feelings evolved and noted—the simplest *conscious* results of brain-work. For there are vital results of sensal stimulation which may not rise into consciousness. And each sense organ telegraphs to the brain nothing but its own peculiar class of modes of stimulating, as induced in and through it by the external motant. Therefore the conscious feelings of sensible qualities which we have in consequence of messages transmitted through one sense-organ, do not add to nor corroborate the testimony of any of the others in reference to space-occupancy, or the relative position of the object in any great degree. In other words, we are affected by organic actions which we have learned to call feelings ; but these, in their character of simple feelings, give us no further information regarding objects. Feelings, as such, do not go any way in enabling us to determine where they are, or where they come from ; whether they are in anything anywhere, or if more than one set of them inhere in the same reality (*ding-an-sich*) ; or if *its* properties, *its* modes of acting, have any resemblance to the conscious brain movements we call sensible qualities of objects. But although they cannot corroborate one another in respect to testifying to each other's modes of inducing sensible qualities, through being able to repeat one another's telegrams, they one and all of them, without exception, testify each with more or less minuteness according to the relative abilities of the accompanying motor instrumentalities, in regard to the truth of the measurements estimated from the testimony of any one of them, in reference to the relative Position, Size, and Form of any sensible object. I say, that they each and all of them agree whenever and wherever we make use of our motor instrumentalities (natural and artificial), to carry these sensible-qualities-indicating instruments towards, up, over, or round any object concerning which we wish to get information, to enable us to

make estimates in reference to its relative position (locality), size, and form. The latter two being estimates of the relative positions of the *parts* of the object. The former of these having reference to the *distances*—the latter having regard to the *directions*—in space of the parts concerned. All these relative measurements we are enabled to estimate, through Time-estimates, by making the muscles, and other analogous organs, move to and fro the distal ends of the sensal nerves. Then, according to their positive or negative telegrams, we are enabled to judge regarding the relative positions of the objects and parts of objects inducing the messages. When we move about certain nerve-ends, and sensal telegrams are sent in, we assume that there is then present outside something which excites them to telegraph. If, however, no telegram be transmitted, we assume that it is because there is then no object present capable of exciting to telegraph. I repeat—because I am not aware that any one has pointed out the fact, or called attention to its importance in reference to the evidence of the reality of an external world—I say, that all these six witnesses agree in their testimony to the apparent truth of the relative measurements of objects and distances, as far as they, by means of our motor appliances, are brought to examine and bear witness to the relative position, size, and form of any object.

To illustrate my position by what Herbert Spencer calls a concrete example, suppose a hot plum-pudding before us. We can, of course, from the photal telegrams, through means of the optic organs, moved by their appropriate motor instrumentalities, estimate the relative position, size, and form of the plum-pudding. A blind man can do the like by means of his baral telegrams, and also through thermal intimations, when he moves his fingers to and fro to gather their information. If he used his tongue, taste-nerves, independently of the other sense-organs, could transmit information also, though with more difficulty to him from its enclosed position. The telegrams of odour could be employed less minutely from the still more enclosed situation of the nerve ends, although a foxhound has little trouble in following a narrow trail for miles. Hearing-sense's nerves are still more enclosed; so the details we can arrive at by means of their telegrams are even less minute, yet if the object were a musical box, we could gather a knowledge of its locality and size. Moreover, it is also evident from the foregoing, that these sensal telegrams never oppose nor contradict—but as far as in them lies corroborate—each other's testimony in reference to any object, or any portion of an object *moving* from one place to another: that is to say, first as

to its being present in one locality during a given time, and then subsequently absent from said place, and present in another. For it is only by making our motor organs carry our sense instrumentalities to requisite places, as a dog does his nose, that we can get positive and negative information, from which we draw conclusions as to matter's motions. And the assistance we get from, and the use we make of, the instrumentalities connected with sight seem to me to be worth more than all those of all the others put together. Of course I include the limb muscles. Muscles are not telegraphers, but telegraph carriers or porters.

Physicists have puzzled much over the inverted image that we see in the eye after death, which has, in my opinion, as little to do with the brain-work of vision as with that of taste or smell. We no more really have objectively a *formed picture* of an object visible, than a man born blind has with the same picture in his eye. But just as a blind man moves his baral nerves over an object with his fingers and their papillæ, and according to hereditary constitution, personal practice, and memory arrives at a conclusion: so the motor instrumentalities of the eye (probably the fibres of Müller move the rods) carry the optic nerve-ends to and fro, so that they can telegraph inwards from the different disturbances they are carried over; and according to hereditary constitution, personal practice, and memory, we are enabled to arrive more or less quickly at estimations of the positions, sizes, forms, and motions of objects. Thus solely by manipulating (or papillating, if you please) over photal telegram-excitants, as a blind man does over baral, do we arrive at a knowledge of the relative positions of the head and feet, top and bottom, &c., of any object in reference to the ground, or anything else. Difference of colour being merely difference in the character of the motion* in the photo-telegraphic messages, which, therefore, induce difference in the brain-response necessary to consciousness. Sometimes the groupings of the telegraphic quiverings or pulsings are improperly arranged by us, so that our notions are incorrect, and we imagine objects to be that which they are not. Indeed, it not unfrequently happens that it is only after we come to hit on the proper cue, that we are enabled to arrive at a correct determination of what is truly telegraphed through the optic nerves: and still more is this the case in regard to other telegrams. For, observe, all our conscious operations, *qua* consciousness, are mental or brain

* Possibly arising from the difference in the size of the grouplets of ether, which the smaller they are, may rotate the more quickly, and travel farther in the direction of the violet end of the spectrum.

operations. The fact is, we do not become conscious of one in a hundred of our sensal telegraphic messages. Only of those to which we elect to (?), or are compelled to, devote brain-work do we become conscious,* and even then, the brain-work must be strong enough, and long enough continued—must have sufficient intensity and sufficient repetition,† so as to invest the brain with mnemonic ability to re-enact the mental operation, ere we can become conscious of it one instant after, or any other succeeding instant. We are virtually unconscious of what is merely instantaneous brain-work. When the four cups of a Robison-anemometer revolve with great rapidity, we observe one at the right side and one at the left side, but nowhere between. This is in consequence of the cups remaining longer in the same line of sight at the sides. A Crookes' radiometer shews this easily. [Experiment shewn.] It is by taking advantage of this fact (as well as distracting our attention) that the juggler exhibits and performs before our eyes, things and processes of which we fail to become conscious—fail in consequence of the short-lived brain reaction never acting so again. It appears, therefore, that we are conscious only of what our brain can and does re-enact—that is, of what it can *remember*, and only during the

* Moreover, it sometimes happens that we do not become conscious of an object (do not notice and group its constituents) until the external reality ceases to have communication with the sensal nerve ends. For instance, in gazing intently through a window, some paces off, at a beautiful white cloud, we may fail to note the sash-bars, fail to be conscious of them, until we happen to shut our eyes, and further darken them by a handkerchief; when the window-bars then exhibit themselves quite distinctly in normal distance, size, and form, but in any direction towards which we turn our eyes. This occurs, we may suppose, in consequence of the affected nerve-ends continuing to quiver in the fashion induced by the reflected light from the bars for a few moments previous to our darkening our eyes. We being still stirred by their telegrams, note the latter, now that the intenser telegrams from the cloud do not distract our attention, note them whilst they are induced by the protracted quiverings of the nerve-ends, and group their intimations in their proper relative positions, according to methods and laws for which we have acquired proclivities and aptitudes through inheritance or long habituation personally.

† Of course intensifying and repeating are here understood in synchronous as well as sequent order. If bodies be too minute, their qualities, *i. e.*, their molecular doings, are not able to stir to appreciable feeling reaction until a sufficient number of telegram exciting motants co-operate synchronously or sequently. Diligent practice, however, generates ability to discriminate better—to react consciously to the stimuli of more minute or fewer grouplets than was possible on first attempts; demonstrating that conscious noting and grouping of feelings are organic operations—are, in fact, analogous to what we call more or less artistic work, physical or mental.

moments or minutes that the brain does remember, does re-enact the processes with sufficient intensity. And, further, we may remember having had sensal telegrams without groupings of them, or remembering the groupings of them as objects and their doings. Moreover, the brain requires some teaching, some practice to commit to memory—*i.e.*, acquire ability to go over the groupings again in the absence of the primary stimulants. Just as all processes which require teaching—as walking, dancing, speaking, writing, &c.—must have some practising to get the facility of repetition into the memory of the organs taught. Even the physical operation of belief is nothing more than some mode of brain-acting become so habitual as always (when excited by circumstances) to reappear in accustomed fashion, in consequence of the absence of such disturbing influences as can compel action in any other fashion. Diseased (*i.e.*, abnormal) organic actings induce abnormal feelings, and also abnormal groupings of them and their relationships—insane notions. Our dreams shew that we believe as our brain acts. If asked, why I ignore spiritual influences? I reply, this paper is confined to physical operations. I have no physical evidence of a human belief in the absence of a human brain.

Our sensal feelings are the mental molecules which, noted as synchronous and persisting, make up our sensible and extended objects —*sensible as felt, extended as grouped*—with all their relationships in Space, as we guess and assume them and it to be. These mental molecules and their groupings as objects, together with recollectings of them—noted as occurring asynchronously and non-persistingly—compose our calendars of Time. Objects, Space, and Time are therefore to us, just as we have been compelled to group them, from our sensible telegrams. When we are grouping feelings or clusters of them, this nascent work of forming view or notion is the process termed Subjective, and its offspring Subject. When the grouping is arranged in conscious work, and so repeated as to be mnemonically recallable in due arrangement, in consequence of incitement thereof by feeling, cluster, or symbol, the grouping recalled is termed Objective or Object respectively, according as we refer to the operating or its fruit. To us the subjective operating is more obvious, from its unaccustomedness; while, on the other hand, the objective work is more overlooked (non-remembered) from its easy-going rapidity, as all habituated organic operations are prone to be. With this distinction the processes and proceeds are the same. For although we talk of subject as being that in which the subjective inheres, we are

conscious of its work only. When there is no working, there is no consciousness. And we may hold associations of ideas to arise from the stirring of some similarity—A, of sensible qualities merely; B, of said qualities' groupings in time; C, in space—less or more complexly; and, D, by aid of symbols.

To conclude, for I am afraid I have exhausted your patience. The six classes of sensible telegraphic messages, when *consciously* reacted to, are our sensal feelings, and are the physical fundamentals of all human knowledge. Our Guessings, Surmisings as to their and our relationships, constitute our Thinkings—our exercise of reason. Thus would I distinguish between Feeling and Thought. Even Descartes' axiomatic, "*Cogito ergo sum*," is slowly elaborated from guessings-over—arranging relationships of—these fundamentals. Human babies require years and thousands of these conscious feelings before arriving at Descartes' conclusion, or using the first personal pronoun in referring to themselves. Idiots never do so at all, and lunatics sometimes change the *ego*. It is through inducing and attending to the movements of ourselves and other things that we are enabled to test our surmises and assumptions,—the views we mentally, *i.e.*, meta-physically, arrive at in reference to the relationships of the things telegraphing to us, wittingly or unwittingly, through the sense organs. For I re-assert that all our views concerning the positions, sizes, forms, and motions of objects are metaphysical assumptions, however probable they may seem from the number and remarkable unanimity of the independent witnesses. To extend the empire of our sensal feelings, and to make assurance of our assumptions more sure than our natural instrumentalities enable us to do, we have invented and constructed numerous physical appliances to extend the range of the telegraphic apparatus, and our means of manipulating with them, so as to afford us a wider range, a greater number, a distincter vision, a broader basis of physically-excited data, from which we may mentally construct ideal representations, notions, views of the objects around us, of their various movements, processes, relations, and interactions; and, further, to test all for the purpose of verification or reconstruction.

[*Note.*—Since the reading of my paper, Professor M'Kendrick has called my attention to Kühne's researches (see *Nature*, vol. xv., p. 296), where it is shewn how Kühne fixes photographically in the retina the image there seen. This corroborates the Professor's statement (in the discussion) that chemical action occurs during vision, both going to confirm the general law, that every vital action is accompanied by chemical change. At the same time, it does not nullify the statement that we are acted on by matter moving ethereally (conditioned) when conscious of effects of heat or light, nor operate to contradict the notion that we

direct attention to feelings, to group spatial and chronal relationships of objects and processes. Moreover, although it shews what actinic rays seem to do, further investigations are yet required to find out the modes of operating of thermal and photal rays, which appear to be more immediately concerned in exciting to thermal and photal sensation.]

Discussion on Dr. Muirhead's Paper.

Professor M'Kendrick, M.D., said he had listened with great interest and pleasure to the paper read by Dr. Muirhead. He had certainly taken a wide view of a subject which would lead into very intricate and difficult questions. He was particularly interested in the purely physical way in which Dr. Muirhead had tried to examine sensory impressions. This was the true way to get at a thorough understanding of nervous mechanism. Quite recently there had been several attempts made to ascertain what really occurred in the terminal organs of sense under the action of particular stimuli. For instance, the question had often been suggested —what was the particular action of light upon the retina, and the action of sound upon the terminal organs in the intricate mechanism of the ear? For a long time this subject baffled investigation, but now it was known that by careful arrangements, and with proper instruments capable of delicate measurements, a change in its electrical condition could be made out in the optic nerve under the influence of light. Light produced a distinct and specific chemical change in the retina, which change might be manifested at once to the senses by an electric variation, which could be detected and measured by a galvanometer and other delicate apparatus. It had also been shewn that the action of light upon the retina was nearly similar, even in quantitative results, to the action of light upon a sensitive plate of chloride of silver, such as was used in certain photographic arrangements. Up to that time no one had succeeded in making out exactly what happened in the terminal apparatus of the ear, but quite recently he had satisfied himself that odours produced a specific change in the olfactory nerves,—a change similar in character, so far as could be measured by the galvanometer, to that which occurred in the retina and optic nerve with the stimulus of light. By investigating such problems, physiologists might help such thinkers as Dr. Muirhead in still further effecting a complete correlation between physical forces and agencies outside of themselves, acting on the terminal organs of sense, and those processes which take place in our nervous mechanism. He had listened to the paper with great pleasure, and hoped to read it in the printed *Proceedings.* Such investigations

as those Dr. Muirhead had made were of great value, and this was specially true of those into the mechanism of sensory impressions, and into the more obscure actions of the nervous system. Pondered over and studied in all their bearings by thinkers, these investigations would assist in laying the foundation of a sound psychology.

XXXIII.—*On New Chromium and Manganese Compounds.*

By J. B. Hannay, F.R.S.E.

[Read before the Chemical Section, March 26, 1877.]

While studying chemistry, and more especially when reading researches relating to the fundamental principles of the science, the fact has again and again been forced upon my notice, that the science of chemistry has been led along one particular line by the force of circumstances; and that of a great number of chemical systems that are possible, chemists have, as would be expected, fallen into that which was nearest to hand. As chemistry is a science which has sprung up naturally with the growth of the inquiring faculty in man, it was to be expected that the science would follow, in its principal lines, the state of things naturally existing. The chemist works in an atmosphere which contains moisture, and all the substances he finds on this earth have been subject to the action of water; in which compound he finds his most valuable ally in dissolving substances, in order that they may act intimately upon each other. Thus the chemist has, by force of circumstances, been compelled, or we may say led, to build up an elaborate system of bodies, either directly soluble in, or prepared from substances soluble in water; so that nearly every chemical compound we know of has been cast in this great water mould, or made from substances which have received this stamp. Thus we have an enormous system of water chemistry; and what wonder that chemists used water as a type on which to frame the decompositions and combinations of dynamical chemistry, by means of rational formulæ, when the whole system had been carefully modelled upon that compound?

Then, if we look over any general list of carbon compounds, we are at once struck with the fact that, however complicated the compound may be, it is, *not* as a rule, decomposed by water, but is in fact generally soluble in it; but if we take complicated compounds