LECTURE NOTES ON ATTENTION.

AN ILLUSTRATION OF THE EMPLOYMENT OF NEUROLOGICAL ANALOGIES FOR PSYCHICAL PROBLEMS.

C. L. HERRICK.

At once a most difficult and a most important group of problems is offered in the study of attention. The importance grows, on one hand, out of the close connection of attention and its cultivation with the practical obligations of pedagogy, and, on the other, out of the theoretical relations of attention with fundamental mental endowments like volition and apperception.

The source of the difficulty is also two-fold; first, the attempts at experimental study of attention suffer from the ambiguity that, when all is done, the results are all apparently physiological rather than psychological. But this is only a conspicuous instance of what is true of experimental psychology as a whole. Care is necessary to discriminate the content in the mind from the physical accompaniments unless one is prepared to ignore that distinction entirely. The second difficulty is that different observers have different theoretical points of view and an unbiased stand-point is as impossible as it would be unproductive. The purposeless and indiscriminate collection of facts rarely furthers science. Working hypotheses and a willingness to reject them when evidence requires are the theoretically desirable conditions, though in practice the willingness to reject is on the part of some other observer or critic (none the less salutary in the result).

It seems proper to divide attention into (A) external or sensory and (B) internal or cognitional. This is merely a working division corresponding to the common experience that something may "catch the eye," on one hand, and that we "concentrate our thought" on a problem, on the other. It would

seem that popular language has crystallized an opinion that in one case the process is passive and in the other active. We are slow to reject the calm and impartial dicta of common sense—in fact, in some sense, this dictum is likely to be found correct, though the meaning of active and passive in such connections may suffer a good deal as the result of analysis.

External Attention.—One of the first evidences of awakening psychical life in the child is seen in the motions of the eye-balls as he attempts to follow moving objects, and one of the last evidences that is given that the departing spirit still hovers over the threshold is the same seeking motion of the eyes. As the most direct and unbiased avenue to consciousness, vision is the best sense from which to study the phenomena of external attention. Now if the eye be fixed upon a given field of view coinciding with the visual field of the retina it is evident that all parts of the field are capable of producing an impression on the retina and so on the nerve fibres and brain; in fact, each such spot does stimulate a point in the brain corresponding to the spot in the retina on which it falls. This neural irritation is not yet in consciousness but is a part of the “content of sense,” or sensory material for consciousness. Returning to the retina, if the field of view be uniform and uniformly illuminated and the gaze be fixed upon it under circumstances excluding other visual distractions a small disc will appear in the centre of the field of view which is somewhat more bright than the surrounding portions.¹

This little experiment is the physiological aspect of the fact that there is in the axial pole of the retina a spot in which only the cones are present and consequently the intensities of light and shade are more vivid than elsewhere in the retina. This relation would lose most of its significance were it not for another relation connected with it.

¹The descriptions of most of the experiments accompanying the lecture are omitted as they are of such a nature as will readily suggest themselves to the experienced reader.

Experiment.—Fix the single eye upon a faintly illuminated screen with perforations near the margin of the field and a shutter behind in such a way that a ray of strong light may be revealed at will. Note that the axis of the eye involuntarily turns toward the illuminated spot. Vary the experiment by using small colored images painted with transparent color and projected upon a transparent part of the screen, etc. Now determine to resist this tendency and keep the eyes immovably fixed on the original spot. Observe whether there is a feeling of tension in the eye, a strain on antagonistic muscles of the neck or in the scalp or even a sense of tension in the brain. Interpret the results. Observe what happens when the subject is encouraged to expect the new impression on the right and then unexpectedly it appears on the left. A wider angle than the actual retinal one may profitably be used in these experiments while in other cases a diaphragm will be needed. In some it is an advantage to have the head fixed while it might be instructive in the deviation experiments in some cases to have the weight of the head counterpoised by braces under chin and occiput suspended to a swivel in the ceiling.

What is the result if the eye is centred on a bright, a varying, or a barely legible object? Is there a conflict of interest?

We have then in the eye a device for differentiating a part of the field of vision by reason of which that portion is more vividly reproduced in the brain and we have an anatomical adjustment of the muscles of the eyeball to enable this sensitive point to be turned upon any object which, by reason of the inherent intensity, usurps the position. More than this, there is a very complicated system of nervous correlation reflexes which must have developed *pari passu* with the anatomical structure by which the visual coördinations are affected anatomically.¹

It is of fundamental importance to decide whether the turning of the eye upon the vivid point in the margin of the field is due to volition or is spontaneous and a pure reflex. It seems certainly to be the latter. It may be noticed that in the fixing of both eyes on any field there is a complicated coordination which has to be learned but passes out of voluntary control, so far as the details of the process are concerned, very early. When any particular object is to be “fixed” in vision the two maculæ luteæ must be properly adjusted as “identical” spots of the retina and when this is done all other parts of the two images will fall on “identical” spots. Now when a bright or vivid spot appears near the margin of the field we might

¹ The instructor will review the visual-motor coördinating systems.

assume that the effect is the same as that of a false accommodation of the maculæ and the instinct to correct it has potency to make the new accommodation before an act of judgment can adjudicate the question.¹ Whether this is an entirely satisfactory solution or not there is little doubt that external attention is of the nature of a reflex which may or may not retain a relation of subordinated connection with conscious processes. If careful attention is paid to what goes on during these involuntary acts of accommodation one may notice a certain sensation in the eyeball and muscles usually not felt at all. Now even where these sensational elements do not enter consciousness as such (or at all) they are stored up along with the retinal sensation and may be employed in the formation of a sense of position—a concept of a spatial nature. However obscure the mechanism of this process, there is no doubt that it takes place. When we exercise ourselves in the effort to mentally estimate the position of various objects in the field of vision seen by aid of momentary illumination and discover that this too is possible, it simply seems to mean that associations have been fixed between lateral cells in the retina and the muscle sensations produced in bringing an image on the macula lutea through the necessary arc to impose it on that spot.

Experiment.—Using a screen at a fixed distance from the eye the subject practices the estimation of distances until a degree of familiarity with the measures is obtained. Then in the dark try the same by instantaneous electric spark. Note accuracy. Tabulate results. Now try the same experiment varying the duration of the illumination and observe whether there is an optimum period and, if possible, whether the eye is moved. Compare the two methods of estimation, *i. e.*, that where the eye motions are used directly and those where they are used indirectly.

It is, then, obvious that the same class of sensations, *viz.* those derived from the act of accommodation, may be used in one case to produce a sense of effort or may become, in another, data for localization.

¹ Compare the labored attempt of ZIEHEN to explain this point. *Leitfaden*, p. 134 et seq.

Experiment.—Glance casually over a page of print and note whether some phrase or word catches the eye. (The experiment is much more conclusive when done unintentionally). What word emerged? On repeating this experiment and glancing casually down the columns of the "Times" the writer caught the word "college" and "university" many times also the word "association" several times and hardly another word. A house keeper looking at the page of the "Youth's Companion" saw "cooking" and "sweeping" first.

The experiment may be conducted under scientific control in various ways. Arrange groups of figures similar in size and body of shade, most of them unfamiliar, one or more familiar, and reveal them for a short period (not too short), or produce familiarity by exposing squares covered by some one or more of the symbols as preparatory to the experiment. Note the effect of "association."

The result of these experiments convinces that the selection of one out of many impressions to be placed in the favored attitude in the sense organ is largely influenced by *interest* and *habit*. The word "interest" is here used in a popular and perhaps misleading sense. Probably in the sphere of the external sense these effects are all the result of habit. For example, the reason that my eye caught the words "college," "university," and "association" out of their places among others was certainly not the superior interest which these words have for me, for they emerged before there was any consciousness of the interest. True, I had often associated in mind these very words in interesting connections and had consciously gone about to seek these words or passages containing them with the mind "loaded," so to speak, for this particular game. The result is a habit of selection which retains its unconscious power. The number of cotemporaneous sensations received by any sense is purely a matter of the structural adaptability of the organ or its natural field. All of the impressions of a given field of sense may become the content of that sense and so may exert their appropriate effects in infra-conscious spheres of association, etc., even though only part of them ever reach consciousness. The discussion as to the possible number of cotemporaneous sensations is based on a misconception. Though the content of sense may be diversified only one thing is ever in the focus of consciousness at a given time.

So far we have been dealing with comparatively pure cases of external attention, but it is not to be denied that the con-

scious processes react on the sensory organs and modify their functions. It is a familiar commonplace that the degree of attention is very dependent on the feeling tone of a sensation. Two points are to be noted here: first, that the greater number of feelings associated with sense impressions have a practical value for the life of the individual and have so acquired an impulsive connection with external attention without calling consciousness into play; and, second, that the very nature of feelings involves intensity of the stimulus (summation, on one hand, and irradiation, on the other,) so that this comes under the head of intensity as above. But let us turn to another form of this activity. I resolve to attend to the excitations of some sense or, as we say, to keep eyes and ears open. This resolves itself into a more or less fruitless attempt to accommodate the organ voluntarily and results in for the most part ill-directed if not disturbing oscillations in the tension of the organ. Thus when in the night I strain the ear to catch a sound in no special locality I become conscious of the fact that the tensor tympani and stapedius muscles are making castanets of my ears and audition is impeded rather than facilitated; so when I strain if perhaps I can make out another star in a vacant space I lose more than one "dimension" before visible. One becomes conscious of a sense of effort in various organs, even in such as have no direct connection with vision and also of alterations in the somatic sensations. These sensations of effort, then, seem to us to prove the presence of attention, even voluntary attention, when there is absolutely no attention, for it is idle to speak of attention when nothing is attended to. It is only a cavil to say that in the case indicated there is attention to the sensations of effort. Such reasoning is an endless chain. When we really attend to something in the sensory sphere it is some specially selected anticipated thing. Even in the general case of listening for a noise we reproduce in thought one noise after another in advance. "It will prove to be a creak, or a scratch, or the like." Imagination meets the visual impression more than half way. "Is it a dagger that I see before me?" We are looking for something—our attention consists in the scrutiny of the content

of sense with a reproduced vestige as a guide. The reproduction may be of a very simple sort, as that of number—we may be repeating mentally, simply “how many?” as we scrutinize the sense content, but it is easy to see that the state of things here is very different from that in case of external attention—we are now dealing with a complicated central correlation across if not wholly within the field of consciousness.

Internal Attention.—We have seen that internal attention popularly lays claim to active and conscious effort, but we have learned that such sense of mental effort may be, and sometimes is, simply the association of muscular sensations and that internal attention implies a variety of coördinations in consciousness and we need not be blamed if we fall to doubting the validity of the sense of self-direction in internal attention. Internal attention is connected with the process of comparison either of the content of sense with some vestige or concept, or of two or more psychical elements along themselves. Thus we receive the advices from sense with a predetermined interrogatory, it may be, “Is the new impression the same as some other? Does it belong to the same class? Was it previously associated with A, B, or C? Is it as big, as loud, as persistent, etc?” In other words, we compare the new sensation with some standard in reproduction and form more or less implicate judgements as to identity, similarity, difference etc., so that we find ourselves projected into regions in the very penetralia of the psychical life far from the supposed boundaries of mere attention. This experience is enough to show that attention is not a faculty or independent activity of mind. Inner attention then may be but the measure of the vividness of consciousness under different conditions and attendant circumstances, whether of presentations of sense or central processes. But, it is proper to ask, what then becomes of the appearance of voluntary direction of attention? If it were true that we can force our minds to attend to any thing we choose, then this would become a matter of volition and need not require a separate treatment. Very brief reflection shows that we cannot attend to anything we please, for, in the first place, it is necessary that the thing

should be presented to consciousness. We cannot attend to a sensation not already a content of sense nor to an unreproduced reproduction. We can not manufacture a sensation to "attend to," but can we perhaps reproduce a vestige not in consciousness? It is evidently absurd. In the case of the various sense contents we have seen that some have special attributes of intensity or special reinforcing collaterals to adapt them to affect the higher centres. May it not be true that the vestiges of conscious processes (memory material) may have similar differential powers and special vehicles? The familiar fact that repetition facilitates reproduction shows that these vestiges are capable of being differentiated in their power of appeal to consciousness. Now experimentally let us undertake to recall the name of the man we met yesterday. "Think" as I may, no trace appears. I wrinkle the brow and strain all sorts of antagonistic muscles and set up a great sense of effort in the attempt to induce cerebral innervation, in fact, I do succeed in forcing an unusual supply of blood into the head and quickening the play of images but none of them is the right one. Try a new tack! The presentations originally responsible for all the disturbance were of—a person—a man—met yesterday—and we have exhausted the associational images called up by "man"—"name"—"Jones, Jenkins, Jaynes, etc." let us dismiss them and see what "yesterday" has to offer. The vestiges are fresher—they rush upon me—more trouble to dismiss the undesired ones. Certainly here they are! "Broadway—hospital ambulance—Dr. B's clinic"—and, at last Dr. B. himself. What could be more simple, I have "recalled the name." No, but was not what I really did the inhibiting of the undesired reproduction in order to let the chain of association follow its own laws of appearance? Thus we seem to have reached Wundt's position that attention is essentially the results of inhibition. We cannot remain content with this conclusion for, first, practically, we are unable by introspection to find evidence of any such voluntary inhibition, second, theoretically, we seem to have gained nothing by such an assumption for the source and nature of the volition involved is as obscure as ever. What is certain is

that consciousness hovers from point to point in accordance with laws some of which we are able to formulate, if not to explain. Before leaving this point we meet the apparently legitimate criticism that what has been said applies rather to reproduction than to attention. Attention, it may be said, is not responsible for calling data to consciousness but for retaining them when there. However, observe that, if the conclusion that only one datum can be in consciousness at once be correct, experience shows that it is impossible to keep attention fixed for the fraction of a second on absolutely one presentation. There is a constant flux and alteration. Attention becomes then a set of rapidly repeated reproductions. In thinking intently of one thing we limit the field of oscillation and cut off distractions as much as possible, but the oscillations with the various resulting associations continue and give pregnancy to the meditation. Here again inhibition emerges as the agent of attention. Here too we are forced to reject the interpretation as above. The sense of voluntary effort in attention we may agree with Ziehen in ascribing to sensations of innervation, etc., that in no sense are a cause of the attention. But we would not stop there, but believe that the sense of personal participation in our activities is of a more complex character than that suggested by the Münsterberg-Ziehen school.

To understand attention then one must understand the nature of consciousness. From its psychological side this is confessedly insoluble and we must be content either to pursue our search no further or to accept such suggestions as may come from neurology and philosophy. In taking the latter course we are frankly entering a theoretical domain where only a balance of probabilities and reasoning from analogy can serve us.

The organ of consciousness is the cerebrum and the great and distinguishing character of the hemispheres is the unlimited associational mechanism. All sorts of lower neural processes which are to influence consciousness have their offices here but these stations are all connected with each other. From all that we know of the analogies of nerve force it does not seem inherently impossible that a current from an eye centre

might if permitted to reach an auditory cortical station, produce some sensation—perhaps of a new kind of sound. The anatomical relations prevent an interference of this kind but the results of the current's action on the eye station may meet and modify a similar product of an ear station in a centre of a higher order. In the frontal lobes, perhaps, is a projection system of the highest order where the last fine adjustments occur. There must be, it would seem, a constant balance or resolution of forces in such a system. The centre of tension, if it could be seen, would be found flitting with greater rapidity than the reflected disc of the electrometer of a testing outfit from one station to another in obedience to the various disturbances of equilibrium—due here to a new sense presentation, there to a nutritive adjustment removing a temporary inhibition. There is, to all appearance, only this sort of physiological unity possible. The only psychological unity is the unity of consciousness. Is there a connection between the two? We are inclined to answer in the affirmative. While it seems necessary from considerations not necessary to enter upon here to consider consciousness itself a spontaneity of a higher than nervous nature, it is apparent that it finds its physical condition in this vortex or nervous "centre of gravity." If this or something like this is the truth about consciousness, then attention is a name for the play of consciousness and a study of its laws reduces, on one hand, to the investigation of neural equilibrium and, on the other, to a natural history of consciousness. The conditions of inner attention are those of association and inhibition.