

## DISCUSSION

### THE FUNCTION OF INCIPIENT MOTOR PROCESSES<sup>1</sup>

There is no doubt that such a theory as the author discusses is of important advantage, yielding a base for a fair understanding of nervous functions. In regard to the assumption that the discharge of a motor center may induce the discharge of a cortical center that is tributary to it, there is evidently something left to the imagination of the reader. It is possible that from the point of view of practical or quantitative science, so to speak, some other hypothesis may be found more defensible.

With this in mind the writer will venture to describe the nervous mechanisms that produce the image, holding to the author's first assumptions but departing from the induced discharge assumption. To bring out the point quickly, let us begin by considering the following case that is easy of explanation, and lead up gradually to the functions under controversy.

If a child sees a red ball and utters the word ball, and then makes a forward movement, certain associations will be formed. At a later time the child is prompted to utter the word ball but the movement is only partially carried out and the word is inaudible. An image of the red ball appears in the child's mind. Now in the first occurrence which we may term the experience, we may say that there are afferent impulses due to the sight of red, to the shape of the ball and to the sound of the uttered word. These go to the cortex, or at least a part of each kind does so. There are also kinæsthetic impulses from the eye muscles and from the throat and lips, and a part of these causes excitation in the cortex.

In the second occurrence, which we may term the recall, there are kinæsthetic impulses from the muscles used for the word and no doubt some of these will be just the same as if the word had not been suppressed but uttered aloud. Now if conditions are right, these latter excitations will reach the cortical centers which were excited in the experience. The author's first assumptions and theory of association are the explanation. Take the color red for example. In the experience, the excitation starts in the retina,

<sup>1</sup> M. F. Washburn, *Psych. Rev.*, Vol. XXI., No. 5.

thence goes to the cortical center for red, thence it flows to the motor centers in activity. Within a moment the excitations from the speech muscles pass through the cortex and perhaps follow the identical neurons just stimulated by the color. By the rules, the common pathway will have its conductivity increased by the experience.

When the recall comes, the flow from the receptors in the muscles will follow this line of increased conductivity, pass through the cortical center for red and hence an image of red will arise. The flow will proceed from the cortical center by the pathways that are open to some motor center or centers. Thus we see that the suppressed utterance of the word ball has brought up an image of the color red and yet there has been no induced discharge such as the author describes. For the above demonstration, it is essential that in the recall some of the muscles be partially contracted so as to cause the kinæsthetic excitations which we assume to follow from muscular contractions.

Let us now go a step further and suppose that some time later there is an occurrence we will term the secondary recall. The child is prompted to utter the word but there is no movement and no real contraction nor even a noticeable change of tone in any muscle. Again an image of the red ball appears. It is probably fainter than in the previous case but it is still clear.

To explain the secondary recall, we will advance the *theory of strain signals*.

Beginning with the motor discharge which prompts the utterance but is not of sufficient intensity to cause muscular contraction, we are brought to the motor terminal in the muscle. Let us here make the following assumption:

When a nervous discharge to a motor terminal is too weak to cause contraction it will produce a chemical or molecular change in the muscle substance which spreads to the sensory terminals, causing an excitation of certain neurons, which we will term a strain signal. This change in the muscle substance requires about the same time as a muscular contraction.

With the aid of this assumption our explanation of the secondary recall will follow the same course as for the other recall. The strain signal acts upon the cortex just as a kinæsthetic excitation would and stimulates those very sensitive cortical neurons which give rise to the image. Thus we see again that the incipient utterance of the word ball has brought up an image of the color red. It is

worth noting that between the two types of recall that we have discussed, there are possible stages where kinæsthetic impulses from some muscles are joined by strain signals from others to arouse the image.

We find that the theory of strain signals is in some conformity with the good old rule that what is true approaching a limit is true at the limit, for the image arises from a discharge coming from the muscle to the cortex, both when there is some contraction occurring and when the contraction is incipient only. Moreover the theory appears to be borne out by introspection as when you recall a song, the words seem to sound in your ears at about the same rate of succession as if you were singing them. Again, the intimate relation of nerve to muscle would indicate that a disturbance of the motor nerve, however faint, would cause a change of some kind in the muscle as the theory requires. It may be only a sort of ripple like a sound wave that traverses the muscle. If the reader has given much thought to such matters, he will be able to find other arguments in favor of the theory of strain signals.

It would take too long to discuss fairly the matter of "imageless" conscious processes or degrees of clearness or faintness of images. We may briefly note, however, that in considering these matters, one should keep in mind the rules for the formation of associations and the changes that occur during the development of a movement system or performance. As the performance is being perfected by practice, unnecessary movements are dropped. But the dropping of movements means the elimination of kinæsthetic impulses and also certain changes in the excitations due to the reaction of the environment. These eliminations and changes will naturally result in the fading and disappearance of images and in the formations of new associations. By way of illustration, remember that the images of Tuesday reflect the movements of Monday and prevail over the faded images that reflect the movements of Sunday. In the final stage when the performance has become automatic, the only paths of high conductivity will be those connecting the movements or essential to the performance.

Finally it is submitted that the considerations brought out by the author regarding attention would be met by the theory of strain signals equally well as by the author's theory of incipient motor processes involving induced discharge.

Comparing the two theories, we observe that the author's theory assumes that a motor discharge that is too faint to cause

contraction of the muscle is strong enough to induce a discharge in the extremely sensitive tributary cortical center. The theory of strain signals assumes that a motor discharge that is too faint to cause contraction is strong enough to excite certain sensory terminals in the muscle which have communication with cortical centers.

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