Art. LXXIII.—*After-images.*

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The phenomena to which I wish to draw your attention to-night are so common that my only excuses in bringing them before your notice are—firstly, the great interest I have always taken in the subject; and, secondly, the hope that if, after hearing the notes, you say to yourselves, "We knew all that before," some other member will take up the theme and tell us a little about his experiences, or throw some further light on the question.

Every one has noticed after-images, but few realise what an important bearing they have on the discussion of memory, for, unless percepts persisted for a time, we should be unable to grasp the idea that separate perceptions—say *a*, *b*, *c*, *d*, *e*—form one whole. After-images form a connecting-link between percepts and revived mental images, and they probably underlie many of the lesser acts of remembering, as Sully has well pointed out. Revived mental images are more important, because they lead to greater knowledge; but a clear understanding of after-images forms a good introduction to the subject of reproductive imagination.

It will be well at the beginning of this paper to define clearly what is meant by an image in psychology. James Sully, in his Outlines, distinguishes an "image" from a "percept" by saying that a "percept" is largely *presentative*, while an "image" is *re*presentative.

On the other hand, considering "images" under the heading of "ideas," an "image" differs from a "concept" or "general notion," for the latter deals with a class, while the former represents a concrete object or mental picture.

But the after-images I wish to speak of to-night are physiological rather than psychological phenomena; and it would have been better to have called them "after-percepts" had not the name "after-image" been better known. After-percepts of sight are the most frequent, although I have heard or read of after-percepts derived from all the organs of sense and movement. But to-night I shall deal only with the images of the organs of sight.

These images are divided into two classes—positive and negative. By a positive image we mean that colours in the representative image are of the same kind as in the presented object, while in a negative after-image the light colours become

dark and the dark light. The bright spot seen after looking at the setting sun is a good example of the first class; and I have obtained a very perfect negative image by looking at a dark photograph in a white mount. After-images are sensations, the positive being due to the continuation of the excitement of the nerve-centres, and the negative to the reaction of the nerves after excitation. Later on I shall deal with the changes of the positive into negative images.

Fechner, who was one of the great authorities on this subject, drew attention to many points of interest; but, unfortunately, he lost his sight, and was unable to complete his researches. It will be well to mention here that experiments with after-images are very trying to the eyes, and should be carried on with moderation. Many of Fechner's observations were taken in bed, and he describes how he found out that memory and knowledge play a very important part in perception. Lying in bed with his eyes open, he was under the impression that he could see the whole length of the bed, and in the memory-image he perceived the bed as he believed he had seen it. But the negative after-image showed clearly that the bed was foreshortened in the retina. Again, in the after-image the objects all appeared in one plane, while in the perception one object seemed to be further away than another.

Another peculiarity of after-images is that we cannot escape from them. Most people have noticed how painfully persistent is the after-percept of the sun or any bright light. This is due to the fact that after-images are caused by the action of the nerve-centres after excitement, and are not dependent on external objects. To obtain a good after-image, look steadily at a bright object, and then shut the eyes. The light will be distinctly visible for some time—indeed, the degree of success in obtaining a good image is largely dependent on the luminosity of the object. I have been unable to keep an after-image longer than a quarter of an hour. I was in London, and the afternoon sun was shining brightly on a polished shield, forming a brilliant point of light. I looked steadily at this object, and then shut my eyes, and covered them so that no light could interfere with the result. I then noted the various changes, and remained with my eyes covered until I could no longer perceive either a positive or negative image, even by pressing my eyeball. I looked at my watch, and found that nearly a quarter of an hour had elapsed. A lady to whom I had been talking on this subject told me that she had had a very remarkable revived after-image. She had been picking violets during the day, and in the evening she *saw distinctly* the bank where she had found the flowers.

The colours seen in these after-percepts are wonderfully pure and bright, and it has been observed that one colour may

be recalled after it has given place to another by pressure on the eyeball, either by blinking the eyes, or by touching with the hand.

The image also seems to wax and wane. This is probably due to the pulsation of blood in the arteries, for I have noticed that by moving my head I could change to some extent the colours of the image. When the eyes are shut and exposed to the light the colours of the image are, as a rule, brighter than when the eyelids are covered.

By observing the after-image my attention has frequently been called to some detail which I had not noticed in looking at the concrete object.

I will now give the results of a few experiments I have made for the purpose of noting the change of colour in after-images.

(1.) I was in a room with the window nearly covered with a dark-green blind, which did not quite reach to the top. The sun was shining brightly through this exposed part. Avoiding the glare, I looked for a second at the blue sky, which through the glass appeared almost white, then shut my eyes. Immediately I got a beautiful image—bright blue, with a dark stripe marking the wooden frame dividing the panes (which, by the way, I had not noticed with my eyes open). The blue changed into a bright violet, with a dark stripe, then to a rich yellow, which turned quickly into a deep brown with a light-grey or steel-coloured stripe down the centre. This negative image faded gradually into the surrounding dark background.

This experiment I repeated several times, with the same general results, but I found that every change in my position, by facing the light or turning my back to it, produced a different sensation.

So persistent was this after-image that I could open my eyes, look around the room without seeing the image, and shut my eyes again, when the image immediately reappeared.

(2.) I looked at the sun shining in the blue sky. The changes in colour were so rapid that I could with difficulty take note of them as they passed. But the general results were as follows: A white spot with a bright purple halo appeared in a darker purple background. The halo quickly disappeared, and the white spot changed to blue, still with a purple background; then the purple gave place to yellow, turning to orange, while the spot became yellow with a reddish background. I here pressed my eyeballs, with the result that the blue returned for an instant, but was followed immediately by orange. For a short time a green tint covered both spot and background, and after this had passed the red

and yellow tints changed places quickly; finally a yellow spot was left in a yellow background; and, when I had apparently lost sight of the image, I opened my eyes and found it again on the page of the book I had been reading.

It was curious and interesting to note how the colours would change places for a moment—an orange sun would appear on a yellow background, and suddenly give place to a yellow sun on an orange background. These changes lasting only for a moment, made the taking of accurate notes almost impossible.

(3.) I looked at the bright streak of light of a kerosene-stove, shut my eyes, but allowed the light to fall on the lids. First a yellow streak with a green halo appeared on a purple background; the halo disappeared, leaving yellow on purple; then a blue streak on a purple background, the blue gradually darkening till it appeared black, on a purple-grey background. This gave a negative image.

(4.) On trying the same experiment, but covering my eyelids, I found the image did not last as long. The yellow streak turned to orange, then to green with yellow halo, changing into dark-green, and then into a dark streak, the background being purple, varying in shade.

(5.) One evening I was walking up the Coote Road, when the presence of a persistent *after-image* showed me that I must have been looking unconsciously at a bright light. On recalling the circumstances I came to the conclusion that the light might have been that of a candle in the room I had just left, or that of the lamp at the corner opposite Russell's store. I walked quickly up Shakespeare Road and Clyde Road, but the image would not leave me until I reached the turning to Brewster Lane.

Examples and illustrations might be continued indefinitely, but I think I have said enough to prove that positive images change into negative, and it would be interesting if it could be shown that the changes of colour followed a fixed rule, as I am inclined to think. But, as I said before, experiments are trying to the eyes, and I found I could not continue my observations for long at one time.

I have been unable to obtain access to the latest researches on this subject, which is an interesting one, as it forms an introduction to the great subject of mental reproduction.