By varying the temperature of the skin stimulated, it was found that with a sudden lowering of the temperature of the skin, the absolute increase of stimulus necessary to produce a heat sensation is lowered, whereas the relative rise of stimulus increases considerably. With a sudden raising of the temperature, the opposite effect is obtained. In this connection, it was also observed that the ability of the cold end-organs to perceive heat sensations increases in proportion to their own rise in temperature.

Furthermore, Alrutz concludes that heat sensation cannot be analyzed, but bears the same relation to warmth and cold sensations that the color orange bears to red and yellow, *i. e.*, a heat sensation is a fusion of both warmth and cold with the cold element affecting the intensity more than the warmth. The author varied the temperature of the stimulus on a certain spot and found that heat sensations of different intensities were obtained, the weak ones having an indifferent tone, but those of greater intensity a strong and uncomfortable tone.

In order to determine the effect of these principles on bathing, some experiments were made in warm baths. In general, the results obtained were the same as above: (1) The higher the skin temperature, the higher lies the absolute increase of stimulus necessary to produce a heat sensation, and conversely. (2) The higher the skin temperature, the lower the value of the relative increase of stimulus, and conversely. (3) The heat sensations, which are produced at a temperature of 35° C. or lower, are more or less temporary and are replaced by warmth sensations, which also shortly disappear. (4) The final conclusion is that baths in water whose temperature exceeds 36° can be regarded, according to the effect produced by them on the skin, as a combination of warm and cold baths.

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The Intermittence of Minimal Visual Sensations. I. The Fluctuation of the Negative After-Image. C. E. FERREE. Amer. Journal of Psychol., 1908, XIX., 58-129.

In a previous paper (*Am. Jour. of Psy.*, Jan., 1906) the author tried to show (1) that the intermittence of minimal visual stimuli is a phenomenon of adaptation; (2) that the intermittence is caused by involuntary eye movement; (3) that eye movement enables restoration to take place (*a*) by reducing the time of stimulation and (*b*) by shifting the area that is stimulated.

The object of the present paper is to show how eye movement can cause fluctuation of the negative after-image, and to point out the inadequacy of other theories. In succeeding papers the author will show the relation of the negative after-image to the intermittence of minimal visual stimuli and to adaptation.

The oscillatory theory represented by Plateau, Hering, and G. E. Müller disregards eye movement altogether; while the fatigue theory, represented by Fechner, Helmholtz, and Fick and Gürber, attributes direct influence to eye movement, but the causes are either unexplained or are untenable.

Hering's four arguments, based upon experiments, against eye movement Ferree shows to be untenable. Repeating the experiments under varying conditions he finds that eye movements *do* occur where Hering failed to find them, and that where Hering found no disappearance resulting from eye movement the image was at least *dimmed*, and disappeared when the intensity of the stimulus was lessened.

Exner agrees with Hering that eye movement does not cause the after-images to disappear by affecting the visual processes. Eye movement causes distraction of perception of the after-image, and hence the disappearance. Ferree finds, however, (1) that disappearance takes place only when the eye movement is rapid, and (2) that the after-image has permanently disappeared when the eye movement is stopped. Exner cannot explain why the after-image does not become visible again after the distraction has ceased. According to Exner, the more uniform the background the more distraction, and consequently the less fluctuation. But Ferree found the results the same experimentally whether a uniform or a mottled background was used.

The author then shows by experiments the causal connection between eye movement and fluctuation. In all cases where there was increased fluctuation there was increased eye movement. In particular: (1) Fluctuation does not occur when the after-image is too large or too small. Only with mean areas was there a tendency to move the eyes. (2) The steadier the fixation the less fluctuation, and conversely. (3) There were more fluctuations with a narrow strip as stimulus than with a square. (4) There were more fluctuations when the strip was turned vertically than horizontally. (5) The same results as in (1), (3) and (4) were obtained when voluntary eye movement was tried. (6) The longer the stimulus was fixated, the greater the number of fluctuations. (7) The more sensitive the individual to disturbances when fixating, the greater the fluctuations. (8) The more practiced the individual, the less fluctuation.

The author next shows the inadequacy of the fatigue theory. Helmholtz's view, that eye movement causes fluctuation by changing the illumination, does not account for the effects of varying the area of the after-image, nor for fluctuation in parts. Fechner's view, that eye movement causes vascular and nervous changes, does not explain the effects of variation in area, fluctuation in parts, nor the effects produced by varying the form and arrangement of stimulus.

Ferree explains the fluctuation and disappearance of after-image by what he calls 'streaming.' If in a bright diffuse light one close the eyes, not tightly, but so as to admit no light, and look deep into the field of vision, something like granules may be seen to flow across. There is apparently no order to the movement till the eyes are moved, when the direction of the streaming changes to that of the eye movement. The currents move with varying speed and in different directions. The streaming is narrower and heavier in the center of the field than elsewhere. The author thinks streaming is due to granules which flow over the retina. It is not due to entropy, circulation or a tear film, for (1) it is seen in the dark as well as in the light; (2) the streams have the same color as the background; (3) if the stream is weak the after-image is dimmed, if it is strong the after-image disappears.

The relation of streaming to fluctuation is as follows: (1) Only after-images of mean size fluctuate. This is because the streaming completely obscures a very small after-image and does not sufficiently obscure it when it is very large. (2) Greater fluctuation takes place when the stimulus is a narrow strip than when a square of the same area. The after-image due to the square obscures the whole area of streaming, while that resulting from the narrow strip does not. (3) There is more fluctuation when the strip is turned vertically than when placed horizontally. The heaviest streaming is in a horizontal direction (the direction of greatest eye movement); consequently, the vertical strip is more easily obscured. (4) Streaming explains how the results produced by involuntary eye movement can be duplicated by those obtained by voluntary. (5) When an after-image passes from one part of the field to another the increase and decrease of its fluctuation is what should be expected from its position with respect to the streams.

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