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PSYCHOLOGY

Effects of Field Brightness on an Induced Negative After-image Phenomenon

If a coloured stimulus, a white stimulus, and relative absence of stimulus are repeatedly presented in that order for 0.017, 0.10 and 0.083 sec respectively, there are values of stimuli brightness at which only the complement of the coloured stimulus is perceived. This effect, first reported by Bidwell in 1897¹, has facilitated investigations of after-images; the decision as to which of two complementary colours is seen is more accurately made than are decisions as to the colour, intensity, or duration of after-images. The study of induced negative after-images is of interest, as these phenomena depend on the relation between excitatory and inhibitory retinal reaction and may be used in physiological and pharmacological studies.

In 1947 Lehmann² devised apparatus by means of which the brightness of the coloured stimulus was maintained at a fraction of that of the white stimulus and the effective illumination below which only the coloured stimulus and above which only its complement was seen. Both Lehmann² and Kaplan³, who used somewhat similar apparatus, determined that this threshold could be altered by pharmacological agents. The equipment used in these investigations permitted the definition of only one set of brightness values of coloured and white stimuli at which reversal of colour perception occurs. Keeler⁴ constructed apparatus that would permit independent control of the brightness of the coloured and white stimuli and determined the curve of brightness of coloured versus brightness of white stimuli at which colour reversal occurs. (A typical such curve is shown in Fig. 1 as 'brightness of field' = 1/2 white stimulus.)

In all of the apparatus in the investigations noted, the coloured-white-black stimuli cycle was presented on a field the brightness of which was a function of the brightness of the white stimulus. (As the white stimulus is presented half the time, effective field brightness is about half that of this stimulus.) In this circumstance, a change in brightness of the white stimulus changes field brightness which, in turn, alters the reactivity of that part of the retina receiving the image of the stimuli cycle. This might be empirically satisfactory for some purposes; but the presentation of the stimuli-cycle on a field of constant brightness would give additional information as to the relations between white and coloured stimulus required for reversal of colour perception.

The independent control of field brightness was also desirable, as this would make it possible to maintain the coloured stimulus at a constant value and determine any effects of field brightness on the brightness of the white stimulus necessary for reversal of colour perception.

The equipment which generates the stimulus sequence⁴ consists essentially of a whirling episcotister with a 180° white segment, a 130° black segment, and a 30° aperture through which an opal-glass target may be seen. The episcotister is illuminated from above; the intensity of this illumination determines the brightness of the white

Fig. 1. Effects of field brightness on the brightness of red and white stimuli at which, when the brightness of the red stimulus is held constant and that of the white stimulus increased, green rather than red is first perceived. Red (625 mμ), white (3,000° K) and black stimuli are repeatedly presented in that order for 0.017, 0.10 and 0.083 sec respectively to the central 1° of a 5° white (3,000° K) field. —, 50 m.lamberts; ····, half-white stimulus; ---, 25 m.lamberts; -·-·-, 0

stimulus. The coloured stimulus is produced by trans-illuminating the opal-glass target. The black segment provides relative absence of stimulus. An aperture smaller than the meiotic human pupil in the eyepiece prevents changes in the subject's pupillary diameter from affecting retinal illumination. This equipment was revised by interposing a white screen, illuminated from above, with a 1° central aperture between the eyepiece and the episcotister. A diaphragm, between the screen-illuminant and the screen, controls field brightness. The system, as seen from the eyepiece, consists of a 1° central area in which the coloured-white-black cycle is presented visualized on a 5° white field of independently controlled brightness.

Some results obtained are presented in Fig. 1; the curve generated when the brightness of the white stimulus determines that of the field is also included. An orderly array of curves of brightness of the coloured stimulus versus the brightness of the white stimulus necessary for reversal of colour perception is generated. With a coloured stimulus of constant brightness, an increase in field brightness requires an increase in the brightness of the white stimulus for reversal of colour perception. The slope of the curves with constant field brightness is less than that in the situation where the white stimulus also determines the field. This may be explained on the basis that, in this latter circumstance, an increase in the brightness of the coloured stimulus will necessitate an increase in the brightness of the white stimulus and, thus, in field brightness which will require a yet further increase in the brightness of the white stimulus.

The results shown are for one subject typical of six. All determinations were made with a red (625 mμ) stimulus; the brightness of the white stimulus was increased until green rather than red was perceived. Absolute values vary among observers and in the same observer over time, but the relations among stimuli and field brightness noted are consistent.

Most significantly, these data indicate that the device may be quite responsive to changes in the sensitivity of the part of the retina which receives the image of the field; such changes would be equivalent to changes in field illumination. This is crucial in the interpretation of drug-induced changes in the colour reversal threshold. Even when the stimuli cycle is presented to the fovea (and thus to the cone-based systems) changes in the reactivity of the peri-foveal region (and thus rod-based systems) may alter the endpoint.

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