Visual adaptation in relation to brief conditioning stimuli

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ABSTRACT

Measurements are made of the changes in state of visual adaptation before and after a change in conditioning stimulus. Liminal test stimulus is taken as a measure of visual adaptation.

1. The liminal test stimulus starts to rise sharply about 0.1 sec. before the eye is exposed to the conditioning stimulus. There is also a corresponding, but less marked, rise before the conditioning stimulus is cut off. The remaining sections refer to recovery of dark adaptation after conditioning stimuli of brief duration.

2. The course of recovery of dark adaptation is the same for both positive and negative contrast of the test stimulus against the general background, the numerical values of the contrast being equal.

3. The effect on recovery of dark adaptation of a steady illumination of the field of view is found to be nil until the state of adaptation corresponding to the field illumination is reached, when recovery ceases.

4. The effect of area of test stimulus on the shape of curves of recovery of dark adaptation may be eliminated by the equivalent background brightness transformation: the curves of recovery of equivalent background brightness are coincident for all areas of test stimulus.

5. Recovery of dark adaptation was measured under standard conditions for twenty-six subjects. Personal variation was not reduced by making the equivalent background transformation, indicating that the variation is due to real differences in rate of recovery of the photochemical mechanism of the eye.

6. Recovery curves are given for two subjects for a wide range of intensities of initial conditioning stimulus.

7. A comparison of recovery curves after the two types of conditioning stimulus—a flash covering a large central area of the field of view; a flash covering a small excentric area of the field of view—shows that the equivalent background formula, \( \beta = 16E/\theta^2 \), already well established for static conditions, applies to this case also. (\( \beta \) is equivalent background brightness, \( E \) is illumination at the subject’s eye, \( \theta \) is the angle subtended at the eye between conditioning and test stimuli.)
8. The effect of a succession of conditioning stimuli has been reduced to a simple formula, at least up to a total duration of the succession of 5 sec. Up to 0·3 sec. the eye integrates perfectly the series of conditioning stimuli. Afterwards, integration becomes progressively less perfect according to the relation

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e = E \left( \frac{p_0}{p} \right)^{\frac{1}{2}},$$

where $\epsilon$ is the intensity of the equivalent single stimulus, $E$ is the total intensity of the multiple stimulus, $p_0$ is 0·3, and $p$ is the total duration in seconds of the multiple stimulus.

9. Experiments with conditioning stimuli of different colours show that, within the range of these experiments, it is the scotopic brightness of stimulus which is related to subsequent recovery of dark adaptation, not the photopic brightness.

10. Experiments in the laboratory with natural test objects (lantern slides of various scenes) show that, when an object is on the limit of visibility, the average background brightness in the immediate neighbourhood of the object may be taken as an equivalent background brightness for the calculation of recovery times: a detailed consideration of the pattern of the object itself is unnecessary.

11. The effect of the area of the conditioning stimulus, when this is neither very large nor very small, is investigated. It is found that, under given conditions of observation, each subject has a characteristic critical angle by which he can deflect his fixation from the test object and still perform the visual task required of him. In the experiments here described the visual task was to find the test object and re-align upon it some form of gun sight.