The electroretinogram (ERG) has frequently been considered as a possible research tool for use in the study of human color vision. The ERG offers several advantages: it is an objective measure, and thereby avoids the rather complex experimental designs which psychophysical studies sometimes entail. It presumably reflects activity in the visual system at a level close to the receptors, and thus may more nearly represent the "fundamental" color receptor systems. Perhaps most important, it is the only electrical response which may normally be recorded from the human retina. In practice, however, the use of the ERG to study color vision has proceeded slowly. The greatest deterrent to its use has been the fact that those conditions under which the ERG may be most easily recorded, i.e., when discrete stimuli are presented during dark adaptation or moderate light adaptation, yield a response which is primarily scotopic in origin (Riggs, Berry & Wayner, 1949). Even high levels of light adaptation, which sharply reduce overall response amplitude, fail to entirely suppress this rod originated activity (Armington, 1953). The rather surprising predominance of scotopic activity is now generally attributed to the vast numerical superiority of rods in the human retina, and to the fact that scattered light is demonstrably effective in stimulating peripheral rods which are not directly illuminated by the stimulus (Boynton & Riggs, 1951).

An effective technique for obtaining a pure photopic response is that of presenting stimuli at a flicker rate above that at which scotopic responses fuse. Piper (1902) distinguished between rod and cone retinas in several species on the basis of the frequency at which their ERGs fuse,
and noted the correspondence between these results and von Kries' psychophysical observations on normal and cone-free human subjects. Bernhard (1940) and Adrian (1944) showed that either the photopic or scotopic components of the human ERG could be selectively emphasized through proper selection of stimulus frequency. Dodt (1951) recommended rapid flicker as a technique for studying pure photopic responses and later (Dodt, 1954) presented data from several species with mixed retinas, in which a clear shift from rod to cone dominance occurred at stimulus frequencies between 20 and 30 flashes per second.

The ability of this technique to eliminate scotopic activity in the human ERG is demonstrated by the fact that the spectral sensitivity functions derived from ERG responses to stimuli flickered at 20 per second or faster resemble the photopic psychophysical sensitivity function (Johnson & Cornsweet, 1954; Armington & Biersdorf, 1956), whereas lower flicker rates result in a predominantly scotopic spectral sensitivity function (Riggs, Berry & Wayner, 1949). Further support may be derived from the fact that rod monochromats show no measurable ERG response to stimuli flickered at above 25 flashes per second (Wadensten, 1956; Heck & Rendahl, 1957).

A sensitive test for residual scotopic activity in the predominantly photopic ERG elicited by fast flicker from a normal eye was made at our laboratory in the following manner: stimuli at 480, 560 and 640 millimicrons were adjusted in intensity so as to elicit responses of equal amplitude when rapidly flickered at a brightness level equivalent to approximately 14 ft-L. and presented in a 60-degree Maxwellian view. Neutral filters were then introduced so as to reduce the intensity of each stimulus to a level equivalent to a directly viewed field of about 0.003 ft-L., which was approximately the subjects' photopic threshold. After the subject had dark adapted for 30 minutes, each of these weak stimuli was again presented at a flicker rate of 25 per second. The response was of course extremely small. 2000 individual responses to each stimulus were averaged with a Computer of Average Transients (Mnemotron, Technical Measurements Corporation). It was found that despite dark adaptation and the uniform reduction in intensity, the responses elicited by each of the three stimuli were still of essentially equal amplitude although much reduced (0.75 microvolt). Essentially the same results were obtained after one hour of dark adaptation. In other words, rapidly flickering stimuli of different wavelengths which have been adjusted in intensity so as to produce equal amplitude responses in the light adapted eye, elicit smaller but approximately equal responses when uniformly reduced in intensity.

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