COOK, BARBARA ANN. Relationship of Visually Evoked Responses to Patterning of Stimuli and Nature of Perceptual Discrimination, as a Function of Degree of Dark Adaptation. (1974) Directed by: Dr. M. Russell Harter. Pp. 38.

The present study investigated the effects of stimulus-element size, dark-adaptation level, and the interaction of these variables on cortical evoked potentials and perceptual responses. Specifically, the study sought to define any systematic changes or relationships among these response measures as a function of the independent variables.

Five subjects' (Ss') cortical responses from three electrode placements, O_z, O_1, and O_2, were recorded. By means of a haploscope, S could view with each eye separately a like display of a blank or checkerboard (checks subtending 20 or 60 min of arc) stimulus transparency. The right and left eye were presented the stimulus alternately by illumination of the display with back flashes. During the experimental session, the right, experimental eye (E eye) became dark adapted, while the left, control eye (C eye) was maintained at a constant level of adaptation. Evoked cortical responses and perceptual measures of absolute threshold and brightness-/or sharpness-match discriminations at prescribed regular intervals during each 15.0-minute session were obtained.

Results of the experiment were analyzed in the context of a) patterned-stimulus research attesting to the significance of stimulus-element size in relation to evoked response amplitude, and b) electrophysiological, psychophysiological,

and dark-adaptation research implicating anatomical and functional changes in size of receptive field of visual neurons, and, hence, differential responding, neuronally and perceptually, under photopic and scotopic viewing conditions.

The response amplitude of a surface-negative component peaked about 100 msec. after stimulation by the 20-min stimulus; this response to the 20-min stimulus was notably different from that to the diffuse or the 60-min stimulus. An hypothesized degradation of 20-min response amplitudes as a function of dark-adaptation level (time) occurred most dramatically in a positive component, which peaked about 200 msec. after stimulation, although present also in the earlier component. Statistical analysis of the data support the significance of these observations. Hypothesized relationships between perceptual discriminations, VERs, and stimulus-element size as a function of dark adaptation were not consistently obtained, however. Although VER amplitude to the 20-min check was influenced by dark adaptation, as predicted, VER amplitude to the 60-min check and diffuse light was not influenced by dark adaptation. Rather, the psychophysical measures reflected increased sensitivity as a function of dark adaptation in response to both patterned and the diffuse stimuli. The effects of adaptation level on evoked responses support earlier researchers' findings that occipital responses are mainly photopic in origin.

RELATIONSHIP OF VISUALLY EVOKED RESPONSES TO PATTERNING OF STIMULI AND NATURE OF PERCEPTUAL DISCRIMINATION, AS A FUNCTION OF DEGREE OF DARK ADAPTATION

by

Barbara Ann Cook

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M. Russell Harter
Thesis Adviser

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of the Graduate School of The University of North Carolina at Greensboro.

Thesis Adviser ______________________

Committee Members ______________________

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Introduction

Evoked electrical cortical activity, made available through electronic averaging computers, can be graphically represented as positive and negative deflection patterns. As related to visual research specifically, such electrical activity, defined as visually evoked responses (VERs), as opposed to spontaneous activity, is the time-locked cortical responses to specific photic stimulation. By signal averaging, these evoked responses to successive stimulation are summated while spontaneous activity, which is not time-locked to the photic stimulus and might be considered a contaminating contributor, tends to average out.

Extant Literature and Its Significance to the Current Research

Since the development of refined sensing, recording, and averaging techniques, research in the area of visual physiology has burgeoned. A truly comprehensive review of the literature devoted to the investigation of VERs is a monolithic task, demonstrated by several reviews (Donchin & Lindsley, 1966; Regan, 1972); fortunately, the restrictions imposed by the variables to be explored in the proposed study, stimulus-element size, dark-adaptation level, and their possible interaction, narrow the review of appropriate and necessary research. Introductory to this restricted review, however, is the general recognition that VER literature abounds with studies employing diffuse visual stimulation in the evocation of cortical responses from which characteristic response latencies, waveforms, and most especially, amplitudes have been analyzed for systematic changes related to parameters of the physical stimulus and parameters of subjective perception (See Regan, 1972, for review). Studies employing diffuse light had explored and established that there existed definable relationships between VERs and parameters of the physical stimuli before investigation into such relationships for patterned stimuli was begun. Consideration of patterned stimuli was a logical step forward since man lives in a world of shapes, sizes, and colors, rather than diffuseness. Moreover, other areas of investigation, such as electrophysiology, had begun to support and continue to support the sensitivity of the primate visual system to contour, size, and wavelength (Wiesel, 1960; DeValois, Jacobs, & Jones, 1963; Wiesel & Hubel, 1966; Hubel & Wiesel, 1968).

Acceding the significance of the numerous diffuse-light studies as a foundation for investigation into responses to more complex visual stimuli, the present review incorporates results of only a limited number of these studies which assist explication of the purpose of the proposed study, and/or analysis of its results. The bulk of the review considers research concerned with patterned stimuli and/or dark adaptation.

Studies of Diffuse and Patterned Stimuli

Rietveld (1963) presented an early summary of the extant literature in VERs, studies utilizing diffuse light stimulation, noting particularly the contradictory nature of the resulting data when the complexities of the VERs were examined. In what appeared as an attempt at clarification, Rietveld investigated shape and time relations of the occipitocortical response to light flashes as related to stimulus parameters such as flash intensity and luminance. The results of that particular investigation have since been re-evaluated by other researchers and are of significantly less import relative to the proposed study than research later conducted with pattern stimuli.

Rietveld, Tordoir, Hagenouw, Lubbers, and Spoor (1967) conducted a study in which both blank and checkerboard patterned stimuli were employed. Generally, they reported changes in VERs for blank and patterned stimuli in amplitude, sign, and latency. Specifically, under blank stimulation, a large surface-negative (SN) component was observed at 60 msec., followed by a large surface-positive (SP) component at 100 msec.; viewing patterned stimuli, Ss generated a smaller SN component preceding a large SN at 100 msec. Comparisons of the responses to the two different types of stimuli demonstrated that there was an inversion of the positive trough at a latency of 100 msec. and a deepening of a SP component observed at 200-235 msec. in responses to a change from diffuse to patterned stimuli. More important, however, the authors, in examining specifically the effect of stimulus arc size on responses, observed and described an inverted U function in terms of response amplitude to the size of the elements within the stimulus--that is, intermediate stimulus-element sizes (e.g. 10 to 20 min of arc) produced maximal response amplitude. An equally important additional observation of the study was a relatively pronounced attenuation of response amplitude as the site of stimulation was varied from central to more peripheral retina; based on the observation that the response patterns were fully developed in response to a display size of 4^{o} visual subtense when presented to the central retina, the authors concluded that the fovea contributed the greatest part to the pattern response, a conclusion generally or conditionally supported by later researchers (Perry & Copenhaver, 1966; Harter, 1970). Cigánek (1970), using bright and dim flashes, observed differences in waveform of the VERs to stimulation of high and low intensity, interpreted as differences attributable to foveal-cone and peripheral-rod responses. He noted the response to dim flashes as typically an occipitally-negative wave, peak latency at about 250 msec., with a less reliable preceding positive wave.

Among others following Rietveld, et al. (1967), Harter and White (1968) made extensive excursions into the effects of check size on parameters of VERs. In observing the effects of contour sharpness and check size on VERs, a negative component at 90-100 msec., and a positive one at 180-200 msec., were observed, the latter being particularly sensitive to check size, the former to contour sharpness, with degradation of