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"Selective Visual Attention"

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EDITORIAL

SELECTIVE VISUAL ATTENTION

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THIS SPECIAL issue of Neuropsychologia deals with a restricted aspect of the more general problem of attention, a problem which in spite of the ambiguity of the term and the conspicuous lack of a generally accepted theory has always been central to both psychology and the neurosciences. While in the past the "intensive" aspects of attention and the related concepts of arousal, vigilance and alertness have usually been regarded as more suitable for scientific enquiry by neurobehavioral investigators, especially by neurophysiologists, clinical neurologists and psychiatrists, and motivational psychologists, more recently the focus of interest has shifted to the realm of the "selective" phenomena of attention, particularly in the visual modality. Generally speaking, selective visual attention is one of the main determinants of the multifarious pattern of differential reactivity of the animal or human organism to parts or aspects of its visual environment. Within this differential reactivity it is necessary to separate those "preattentive" reaction tendencies, which are built into the visual system (see e.g. [4]), from the variable and truly attentional predispositions which at any given instant influence the coupling between visual inputs and behavioral outputs.

One of the most convincing experimental demonstrations of the validity of the concept of selective visual attention has been obtained by applying an old experimental method, the reaction time method, to the reinvestigation of an effect described by Helmholtz in the 19th-century [2]. Helmholtz looked at a pair of stereoscopic pictures in a stereoscope which were made visible only occasionally, and for a very brief time, by a recurring spark. Although during the dark intervals he kept fixating steadily at the fused images of two pinholes pricked through the center of each picture and traversed by the faint room light, he found that before the spark came he could keep his attention voluntarily turned to any particular region of the extrafoveal dark field, so as to see, when the spark occurred, only those parts of the picture that lay in that region. On these grounds he argued that attention is quite independent of the position of the eyes and free to direct itself by a conscious and voluntary effort upon any selected portion of a dark and undifferentiated field of view.

Several modern experiments have confirmed that attention can indeed be turned to selected positions in the visual field unaccompanied by eye movements [1, 3, 6], and the use of the reaction-time method has allowed a quantitative analysis of the effects of this allotment of attention in terms of costs and benefits. Detection or discrimination reaction-time is shorter at attended positions, and longer at unattended positions, compared with a baseline condition in which attention is not directed to any specific position in the visual field. Seen from a neuropsychological perspective the studies by POSNER *et al.* [7] on the influence of directed attention on the speed of detection of simple light increments have proven particularly appealing because their simple experimental conditions are easy to utilize in neurophysiological studies, and thus their results can be meaningfully related, for example, to those obtained in investigations on attentional effects on the activity of single neurons in freely behaving animals [9]. Further, the cognitively undemanding character of the tasks employed in these studies makes them applicable even to those brain damaged patients who may have comprehension deficits or other impairments of higher-order neural functions.

In view of such actual or potential connections with the neurosciences, this special issue concentrates on attentionally induced changes in the speed of detection of simple, unpatterned light stimuli presented in different points in visual space. It brings together behavioral studies in normal (Fischer and Breitmeier, Gawriszewski *et al.*; Hughes and Zimba; Maylor and Hockey; Rizzolatti *et al.*; Tassinari *et al.*) and brain-damaged humans (Gazzaniga; Posner *et al.*) with direct investigations of nervous sytem activities performed, under similar experimental conditions, with the evoked potentials technique in normal man (Rugg *et al.*) and with single-neuron recordings in monkeys (Robinson; Goldberg and Seagraves).

An important question concerns the spatial distribution of the effects of directing attention without moving the eyes, and this question is specifically addressed in the papers by Gawriszewski *et al.*, Hughes and Zimba, Rizzolatti *et al.*, and Tassinari *et al.* The first paper demonstrates that attention can be specifically allocated to portions of the visual space not only in the frontal plane, but also along the third dimension. Although differing on several procedural and conceptual aspects, the other three papers concur in proving that the main meridians of the visual field have a powerful role in the spatial partitioning of the RT effects of selective visual attention, thus inviting speculations and investigations on the putative neural substrate of this spatial organization of attentional phenomena. At any rate, in order to be satisfactory any attentional theory must account for the striking changes in attentional effects at the vertical and horizontal meridians. Hughes and Zimba stress the difficulty to reconcile these changes with the hypothesis of positional expectancy as an internal beam of light which scans the visual field in a continuous fashion, while Rizzolatti *et al.* and Tassinari *et al.* relate the meridional effects to theories of attention as premotor organization or motor preparation.

In the paper by Tassinari *et al.*, the importance of the main meridians in the spatial organization of the attentional field is shown to apply also to the inhibitory after-effects of a previous stimulation, an after-effect which several experiments reported in the paper by Maylor and Hockey attribute conclusively to a previous covert orienting toward the initial stimulus. In all of the above papers visual stimuli were detected by making manual responses while the eyes were kept steady; the paper by Fischer and Breitmeier describes how positional expectancy influences saccadic (foveating) eye movements, and the results suggest that contrary to manual responses, ocular responses may be subject to constraints imposed by fixation and engagement.

Gazzaniga reviews experiments in split-brain patients which indicate that although the commissural section disconnects the perceptual systems of the two hemispheres, attentional control remains largely unitary, pointing to an as yet unidentified undivided neural substrate. [illegible]

attention in a contralesional direction, not only in the visual hemifield contralateral to the lesion, but also in the ipsilateral visual field.

The report by Rugg *et al.* shows how the evoked potentials method can be used for monitoring the activity of attentional mechanisms involved in the selection of stimuli on the basis of spatial cues and for analyzing the early modulation of stimulus processing by attention. The papers of Robinson and Petersen, and Goldberg and Segraves present instructive examples of how attentional phenomena similar to those described in normal humans can be studied at both the organismic and the single-neuron level in monkeys, thus arriving at important correlations between brain activities and attentional modulation of behavioral responsiveness. The first of these papers points to the participation of the pulvinar nucleus of the thalamus in selective attention, while the second emphasizes the need for neural theories of attention to account not only for the selection of stimuli, but also for the selection of motor responses.

As made clear by the above summary, the content of this special issue can hardly claim to present a comprehensive view of theoretical and experimental work in the field of selective visual attention. For example, studies of the way in which selective attention can help in integrating or separating the distinguishing features of a complex target [8] have not been included because the analysis of the underlying neural mechanisms has barely begun [5]. However, we are confident that in spite of this limitation the selection of papers presented here can provide the reader with abundant new information about some aspects of current work on this subject which are likely to be of immediate interest to neuropsychology and related fields, as well as with some recent theoretical developments which may contribute not only to a fresher look at the problem of attention, but also, in a more general sense, to the understanding of the relationships between brain and behavior.

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