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Capturing attention

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The first chapter of Wilhelm Wundt's text, *An Introduction to Psychology*, is devoted to the topic of attention. This reflects attention's prominent role in the history of investigations of cognition and perception. And deservedly so. Humans and other animals are limited processors of information. Because of this, a proper understanding of the inner workings of mental mechanisms that transform and digest information must include a description of the processes by which certain sources of input are selected for further analysis while others are ignored.

Although research on the topic of selective attention has been fairly eclectic in its choice of paradigms and specific phenomena, recent research has concentrated especially on two issues. The first concerns spatial allocation of processing resources, and the second focusses on details of processing when there is little limit on our capacity to engage in mental activity. Below we briefly review developments in each of these areas and tentatively offer some prognoses for the near future.

Spatial selectivity

In 1912, Wundt commented: 'If ...we practice letting our attention wander over ...different parts of the field of vision while keeping the same fixation-point, it will soon be clear to us that the fixation-point of attention and the fixation-point of the field of vision are by no means identical' (p. 20).

This early work coupled with the research of Purkinje and Helmholtz on related issues has, from time to time in the history of perceptual research, spurred psychologists to inquire about the processes involved in attending to spatial locations. Sperling's (1960) research with the partial report technique and Cherry's (1953) studies of dichotic listening can, perhaps, be pinpointed as the developments that have renewed concern with this problem.

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In the ensuing years, research by various investigators has uncovered some of the details of the processes involved in selectively attending to spatially defined stimuli (e.g., Eriksen and Hoffman, 1973; Hoffman, 1979; Jonides, in press; Posner, 1980). One of the most important findings is that spatial selectivity for visual as well as auditory stimuli can be accomplished without any overt change in the peripheral sense organs (Eriksen and Hoffman, 1973; Jonides, 1980; Posner, Nissen and Ogden, 1978). This fact has led to a debate about the locus of selectivity in the processing stream, a debate that in many ways mimics the debate concerning the adequacy of selective attention models that have been developed since Broadbent's (1958) seminal work in this area. For example, Shiffrin and his colleagues (Shiffrin and Gardner, 1972; Shiffrin, McKay and Shaffer, 1976) have argued that selection occurs in short-term memory after early perceptual analysis has been completed. The experiments of others, however, indicate a selectivity that is difficult to reconcile with a memory interpretation, since the tasks in which the selectivity occurs place only trivial memory demands on subjects (e.g., Bashinki and Bacharach, 1980; Jonides and Somers, Reference note 1; Posner *et al.*, 1978; Shaw and Shaw, 1977). Resolution of this conflict requires further investigation, and a coherent synthesis of a growing body of research.

One essential component of a theory of selectivity will be a model of the actual mechanism of selection, regardless of its locus in the processing stream. While some of the papers cited above allude to such a mechanism, to date there has been insufficient attention to this problem. Shaw and Shaw (1977) proposed a general model of selectivity that has the important feature of being general across specific tasks. Jonides (1980) has tested specific versions of this model that seem to narrow the space of remaining alternatives to an interesting subset—namely, those in which processing occurs in parallel over a variety of spatial loci and can be focussed on one of these loci by internal guidance or by external stimulus control (Jonides, in press). But it is clear that more specific models need to be proposed and tested before progress can be made on this problem.

Once we have a better understanding of the mechanics underlying spatial selectivity in vision, the relationship between shifts of attention to local spatial regions and shifts of the eyes to spatial locations may be uncovered. Interesting parallels between these phenomena suggest that they may share some fundamental mechanisms in common (see e.g., Jonides, in press, and Todd and Van Gelder, 1979, for discussions of internal *versus* external control over the body's and the mind's eye movements). Although eye movements seem to be neither necessary (Eriksen and Hoffman, 1973; Jonides, 1980; Posner *et al.*, 1978) nor sufficient (Klein, 1980; Remington, 1980) conditions for attention movements, the question of whether movements of attention can facilitate the programming or execution of subsequent eye movements has received less study (Todd and Van Gelder, 1979).

Neurophysiological research by Wurtz and colleagues (Goldberg and Wurtz, 1972; Mohler and Wurtz, 1976; Wurtz and Mohler, 1976) suggests a further basis for pursuing the connection between attention shifts and eye movements. Their work has suggested that cells in the superficial layers of the superior colliculus are involved in the control of both eye and attention movements. Several other investigators, however, have found evidence that cells in the parietal lobe are involved in shifts of spatial attention, independent of eye movements (e.g., Robinson, Goldberg and Stanton, 1978). Further research in this area has important implications for models of selective attention and saccade guidance and control (e.g., Mays and Sparks, 1980).

Automaticity

In a sense, a second recent focus of attention research has not been on attention at all, but rather its absence. The topic is nicely introduced by a quote from William James' *Principles of Psychology*:

> 'If an act became no easier after being done several times, if the careful direction of consciousness were necessary to its accomplishment on each occasion, it is evident that the whole activity of a lifetime might be confined to one or two deeds —that no progress could take place in development. A person might be occupied all day in dressing and undressing himself; the attitude of his body would absorb all his attention and energy; the washing of his hands or the fastening of a button would be as difficult to him on each occasion as to the child on its first trial; and he would, furthermore, be completely exhausted by his exertions. For while automatic acts are accomplished with comparatively little weariness, the conscious effort of the will soon produces exhaustion.'

During the past several years, psychologists have rediscovered this distinction between processes that are under strategic control and those that are automatic, especially in the domain of perceptual and cognitive tasks. One might argue that strategically controlled processes typically constitute our most impressive armament against complex problems, and that they stand in contrast to the more stereotyped activities that have been identified as automatic. Even in their relative stereotypy, however, automatic processes are not a mere cedilla in our mental lives, as James indicated: They form a crucial part of our processing repertoire because they require little effort and attention to execute. Consequently, we are left free to devote our sophisticated mental machinery to the tasks that require it.

These considerations have led psychologists in recent years to concentrate on the development of automaticity in processing. The highlights of this work can be found in LaBerge (1975), Logan (1978), Schneider and Shiffrin (1977), and Shiffrin and Schneider (1977) among other places. The empirical work in these papers tries to identify the learning regimens that are necessary and/or sufficient for automaticity to develop.

This is obviously one of the crucial issues that must be addressed in research on automaticity, and so it is not surprising that the vast majority of work on this topic since Bryan and Harter's (1899) early study has concentrated on development. But some might argue that this emphasis has been premature because the successful study of automaticity first requires a well-specified, theoretically-motivated set of criteria that can be used to identify when a process has become automated. Only a few investigators have tried to establish such criteria with any empirical tests of their adequacy (see Jonides, in press; Jonides, note 2; Logan, 1978; Regan, 1981). Consequently, it seems reasonable to prescribe a substantial emphasis on this problem before further work on the development of automaticity proceeds apace.

The benefit of a well-defined set of empirical criteria will extend beyond the study of development to another important aspect of automaticity, its generality. As is reasonable, most of the available research on automatic processing has demonstrated its development within a single task context, or at best within the context of two tasks that are very closely related (e.g., Schneider and Shiffrin, 1977). While this is an important first step, it leads one to ask about the extent to which an automatic process once developed will transfer to a new task situation. Clearly, automaticity would lose much of its current play if there were convincing evidence that automatic processes are completely task specific. Of course, it will not be straightforward to test the generality of automatic processes since cognitive psychology does not yet have a taxonomy of processes that participate in various task performances. Nevertheless, this problem should attract some empirical attention over the coming years, as it has already begun to do (Benjamin and Jonides, Reference note 3).

We can identify one final theoretical issue about automaticity that is worth noting as well. There seems to be an undercurrent of belief in the literature that automatic and non-automatic processes are not merely ends of a continuum, but are qualitatively different from one another. The case for this belief has not been made, however. Indeed, judging from the course of previous theoretical arguments about incremental *versus* all-or-none learning, it will not be a case that is easy to make. Nevertheless, it is a fundamental question whose answer will help determine the form of specific models of automatic processes that are proposed.

Summary

The topics of spatial selectivity and automaticity have formed the focus of much recent research on attention, both in our laboratory and elsewhere. They do not, of course, nearly exhaust the possible areas for further research. For example, Triesman's (Triesman and Gelade, 1980) research on the application of 'focal attention' to encoding is certain to excite interest, especially because it seems to contradict much of the recent work on automaticity in encoding (e.g., Egeth, 1977). Also, there is a growing concern that phenomena investigated in the experimental laboratory have direct application in the 'real world'. This suggests that advances in attention research may lead to advances in the diagnosis and treatment of a range of pathological conditions that may be due in part to attentional deficits, including autism, schizophrenia, and various kinds of brain trauma. Whatever these additional developments, to reach an understanding of the mechanisms underlying spatial selectivity and automaticity would be an important theoretical breakthrough in the decade ahead.

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