Notes and Comment

On selecting between theories of selective attention

GIDEON KEREN and JAMES SKELTON
University of Illinois, Champaign, Illinois 61820

In a recent paper, Shiffrin, McKay, and Shaffer (1976) claimed they had shown strong evidence to support the view that "... perceptual processing is automatic, not under subject control, and that selective attention is the result of subsequent processes in short-term memory" (p. 21). We argue that, in order for such a strong claim to be accepted, more compelling evidence must be presented. In fact, we feel that the current experiments reported by Shiffrin et al. (1976) were designed not to allow selection between competing theories so much as to provide data consistent with their own theory. This is not a trivial or meaningless distinction. Our argument is that advancement in science is more likely to come from evidence capable of rejecting theories than from evidence which merely supports one theory (Platt, 1964; Popper, 1963).

More specifically, we argue that any theory should be formulated so as to be testable under the most severe tests. Following Popper (1963), any conjecture or theory should be boldly put forward for trial, to be eliminated if it clashes with observations. These observations should as a rule be undertaken "with the definite intention of testing a theory by obtaining, if possible, a decisive refutation." The experiments reported by Shiffrin et al. fall far short of meeting these requirements. We now proceed to a close examination of the experimental manipulations and data interpretations reported by Shiffrin et al. (1976).

(1) All three experiments reported by Shiffrin et al. (1976) have demand characteristics which are so biased as to reduce or eliminate the demonstration of attentional effects. Rather than conducting a test capable of refuting their theory, if it were in fact incorrect, they virtually insured the survival of their theory. Their C1 condition is supposed to represent position certainty, hence concentrated attention, while the C9 and C49 conditions are supposed to produce distributed attention through positional uncertainty. For the experiments to be meaningful, we must of course assume that subjects are indeed trying to maximize their correct detections. We argue that, in all three experiments, the subject's best strategy in this effort would be to fixate both his eyeball and his "internal eyeball," or attentional focus, always on the center position *under all three conditions*.

First, consider an attentional model in which the subject can vary at will his distribution of attention so that a few positions receive extensive processing while the remaining positions receive only a small amount of processing. In the C1 condition, the optimal strategy would clearly be to focus attention on the center. This condition represents positional certainty or concentrated attention in the Shiffrin et al. (1976) experiment. Positional uncertainty and distributed attention are supposed to be represented by the C9 and C49 conditions, where the target may be in any of the central nine positions or anywhere in the 7 by 7 array, respectively. In Experiments 1 and 2 reported by Shiffrin et al., this is not a fair test of distributed attention, since the subject has probably learned during the practice sessions that the target was four times as likely to appear in one of the 9 central positions than to appear in one of the 40 peripheral positions. The odds of the target's appearing in the central 9 positions were 36/76. In a similar manner, the odds of the target's appearing in the center position in Experiment 3 were 25/73 compared with 6/73 for each of the other eight positions. It is therefore not surprising that the probability of a correct detection of the *center dot* (Experiment 1, Table 1a) or the center letter (Experiment 3, Table 3) varied but little for the so-called different attentional conditions. By the same token, it is not surprising that performance varied only slightly for the eight display positions surrounding the center in the C9 and C49 conditions in Experiment 1 (Table 1b).¹ Hence, to the extent that a subject can concentrate his processing capacity on central positions, he should do so in order to maximize correct detections. Our conclusion, therefore, is that the design of Shiffrin et al. does not enable one to distinguish between different attentional models.

This is not to say that positional certainty vs. positional uncertainty is incapable of producing attentional effects. Indeed, Posner (Note 1) showed its efficacy. His data indicated a benefit for the attended position and a cost for the unattended position, compared to a condition of positional uncertainty, even when eye movements were excluded.

(2) In regard to Shiffrin et al.'s (1976) comment, "It would of course have been desirable to have been able to devise a condition in which the subject was told in advance which of the outer positions would contain a target. However, such information, by inducing the subject to shift his fixation point to the known target position..." (p. 21), their argument is incorrect. Had the positions been indicated, say, 100 msec before the target presentation, with target durations actually used by Shiffrin et al.

(1976) of 10 to 40 msec, there would have been insufficient time for a voluntary saccade to be initiated but perhaps sufficient time to shift attention to the indicated position. This manipulation has, in fact, been used repeatedly (Eriksen & Hoffman, 1973, 1974), producing results consistent with attentional facilitation at a level prior to memory or decision processes, even when eye movements, masking by the indicator, and warning effects were controlled for. They showed that when the position in which a target letter would appear was indicated in advance of target onset, subjects responded faster in naming the letter than when there was uncertainty as to where the target would appear.

(3) We are not irrevocably prejudiced against the null hypothesis (cf. Greenwald, 1975). When a researcher reports, as the principle support for his theory, a failure to reject the null hypothesis, he should at least report the power ($1 - \beta$) of the test used. For the data of Shiffrin et al. (1976), we suspect the power is low. Unfortunately, Shiffrin and his associates have consistently failed to report the power of their tests, or to provide sufficient data for others to calculate it. This is particularly a problem when each of the three experiments (Shiffrin et al., 1976) showed a trend which was in the direction of attentional facilitation but which failed to reach significance in Experiments 1 and 3 but was significant in Experiment 2. Again, the explanations for the significant effect obtained in Experiment 2 are speculative and far from convincing, and represent the general trend to fit the data with the theoretical framework.

In summary, the experiments reported by Shiffrin et al. (1976) were poorly designed and suffered from serious methodological problems, thus casting doubts on the conclusions reached by those authors. However, we argue that, even if the above-mentioned experiments had been conducted in a perfectly satisfactory way, there would still be insufficient evidence to conclude that there is no attention and no capacity limits at the perceptual stage. Again, following Popper (1963), we argue that any theory must be tested under the most severe tests, which will allow refutation of the theory if, indeed, it is incorrect. This is especially crucial with respect to the question at hand because of its extreme importance for the study of attention. Indeed, Shiffrin et al. (1976) avoided a broader discussion of the issue. They failed to mention results by Beck and Ambler (1972), Eriksen and Hoffman (1973, 1974), and Posner

(Note 1) which are contrary to their own results and which clearly suggest a central selective attentional mechanism at an early stage of perceptual processing, at least under certain conditions.

Egeth (1967) provided an extensive review of the literature on selective attention. In his conclusions, Egeth argued that "unfortunately, it is not obvious what distinguished those situations in which subjects can filter readily from those in which they cannot. This is clearly going to be a fruitful subject for further study" (p. 56). Today, 9 years after the Egeth paper was published, we can confidently assert that the question still lacks an answer and that Egeth's final remark is still perfectly valid.

REFERENCE NOTE

1. Posner, M. I. *Attending to a location in space*. Paper presented at the meeting of The Psychonomic Society, Denver, November 1975.

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NOTE

1. Unfortunately, the authors did not provide us with the probability of correct reports for the points other than the one located in the center, although they have invested much effort to adjust the exposure duration for each point. If the data for all the points had been reported and the probabilities of detecting each point had been equal, then some of the arguments presented in the present paper would have been refuted.

(Received for publication April 26, 1976;
revision accepted June 18, 1976.)