Novelty and attention: Controls for retinal adaptation and for stimulus-response specificity*

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Three experiments used a free-choice technique to investigate effects of novelty on selective attention. Ss underwent a habituation phase, during which combinations of spots of one color were presented, and then a test phase, during which spots of the familiar color and a novel color were presented together. Experiment 1 showed that, during the test phase, Ss were more likely to respond to novel stimuli whether manual or verbal responses were performed in both phases. Experiment 2 produced the same effect with different distances between stimuli and the fixation point for the two phases, ruling out retinal adaptation as an explanation. Experiment 3 showed the effect to occur when different responses were performed in the two phases, indicating that it is stimulus-specific.

The term "attention" has been used through the years, and is still used, to denote several distinct phenomena and variables (Berlyne, 1969, 1970, in press). Among other usages, it is applied to processes that determine which of several competing stimuli, each associated with a corresponding response, will gain control over behavior.

Selective visual attention in this sense can be studied by means of a free-choice technique (Berlyne, 1950, 1951). Two or more visual stimuli, corresponding to distinct manual responses, appear simultaneously, and S has to respond to any one of them. With this technique, it has been found that novel stimuli are more likely than others to capture attention. If S goes through a habituation phase, during which stimuli of a particular shape and color are used, and then a test phase, in which such stimuli are paired with stimuli of a different shape or color, he will make significantly more responses to the latter during the test phase.

McDonnell (1968) introduced some improvements into the procedure, the principal one being tachistoscopic exposure of stimuli for .1 sec. The effect of novelty on attention was confirmed once again. The brevity of exposure excluded the possibility that Ss shifted their gaze from the fixation point to one of the stimuli (Dodge, 1899; Miles, 1939; Bartz, 1962) and that the direction of eye movement determined which stimulus was responded to. Consequently, one can assume that the response depended on some kind of filtering process that comes into play after light has entered the eye. There was, however, one possible explanation that might have accounted for McDonnell's finding and perhaps also for the findings of the earlier experiments. During the habituation phase, half the Ss saw green and the other half red spots which could appear at any of four locations equidistant from a central fixation point. During the subsequent test phase, red and green spots appeared at these same locations and thus stimulated the same areas of the retina as the habituation stimuli. Exposure to spots of one color during the habituation phase might have induced chromatic adaptation in the stimulated areas of the retina. Consequently, the novel color, being complementary to the familiar color, might have appeared more intense or vivid, which could conceivably account for S's tendency to respond more often to it.

The experiments to be reported were concerned with this question, as well as with another on which further evidence is needed. In some of the earlier experiments (Berlyne, 1957; McDonnell, 1968), stimuli of novel and familiar colors appeared, on different trials, at the same locations and therefore evoked the same responses. This rules out the possibility that the effect represents a response-specific decrement, like Hull's (1943) "reactive inhibition (I_R)," i.e., a diminished tendency for a particular response to be evoked by any stimulus. However, it could be either stimulus-specific, i.e., a diminished tendency to make any response to a particular kind of stimulus (cf. Glanzer's, 1953, "stimulus satiation"), or stimulus-response specific, i.e., a diminished tendency to perform a particular response to a particular kind of stimulus. Since the effect failed to appear when 24 h intervened between habituation and test phases (Berlyne, 1957), it cannot be identified with Hull's "conditioned inhibition ($_SI_R$)," which was conceived as a lasting stimulus-response-specific decrement. But short-term stimulus-response-specific decrements are well documented with reference to both unlearned and learned behavior (Thompson & Spencer, 1966; Hinde, 1970; Razran, 1971). McDonnell (1968) found the attention-to-novelty effect even when S's task during the habituation phase called for quite different responses (counting the stimuli) from the manual choice responses performed during the test phase. This favors stimulus specificity rather than stimulus-response specificity. On the other hand, Berlyne (1957) did not find the effect in similar conditions. So further investigation of this issue is called for.

EXPERIMENT 1

The main purpose of the first experiment was to provide a baseline with which the data of the next two experiments could be compared. It was necessary to ascertain if the effect would appear not only when manual responses were performed in both habituation and test phases, as in previous experiments, but also when verbal responses were performed in both phases.

Subjects

Twenty-four summer-school undergraduates taking psychology courses were divided into four groups. Groups MR and VG consisted of three males and three females, while Groups MG and VR consisted of two males and four females.

Apparatus

The apparatus was the same as that McDonnell (1968) used. A Gerbrands Harvard-type two-channel tachistoscope was set to expose each stimulus card for .1 sec when manually triggered. S's eyes were 565 mm from the center of either field. Beneath the tachistoscope was a horizontal response panel with a square key in the middle on which S's fingers had to be placed between trials and four circular response keys occupying locations corresponding to the corners of a diamond centered on the square key.

Stimulus Material

Two sets of 48 stimulus cards were prepared for the habituation phase, and one set of 36 cards was prepared for the test phase. Every card bore from one to four circular spots, each 25 mm in diam, occupying locations corresponding to the corners of a

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diamond centered on the fixation point. The center of each spot was 63.5 mm from the fixation point. One set of habituation cards had only green spots and the other set only red spots. Equal numbers of cards had one, two, three, and four spots, respectively, with each of the four locations occupied equally often within each subset. Of the 36 test cards, one-third had one, two, and four spots, respectively. When there were two or four spots, half of them were red and the other half green. All four locations were counterbalanced among all these conditions. The spots on the test cards were also 63.5 mm from the fixation point. The order of presentation for each set of cards was randomized, with the restriction that each half of each sequence contain equal numbers of cards bearing the different numbers of spots.

Procedure

Groups MG and VG had cards bearing green spots during the habituation phase and Groups MR and VR had cards bearing red spots. The same test cards were used for all groups.

Groups VG and VR had the correspondence between the circular response keys and the possible locations of colored spots on the stimulus cards pointed out to them. They were told that, whenever one spot appeared, the corresponding key was to be pressed as quickly as possible. When two or more spots appeared, any one of the keys corresponding to them was to be pressed. Groups VG and VR had similar instructions, except they were to say "Top," "Bottom," "Left," or "Right," instead of performing manual responses.

Results

In Experiment 1, as in Experiments 2 and 3, one-tailed significance levels were used to test the effect of novelty, since a unidirectional null hypothesis was being examined. Two-tailed significance levels were used for interactions.

The number of responses to red spots on test-phase trials with two or four stimuli was subjected to analysis of variance. As Table 1 shows, the mean was significantly larger in groups that had been exposed to green spots during the habituation phase than to groups that had seen red spots, confirming a tendency to attend more frequently to stimuli of a novel color. Neither the main effect of the response demanded (manual or verbal) nor the interaction between this variable and habituation color approached significance.

EXPERIMENT 2

The procedure and design of this experiment were identical with those of Experiment 1, except that the stimulus spots on the habituation cards were 38 mm from the fixation point, while those on the test cards remained at 63.5 mm. Consequently, the stimuli that were presented in the habituation phase stimulated different retinal areas from the test-phase stimuli, precluding the attribution of any novelty effect to local retinal adaptation.

Table 1
Test Phase: Mean Number of Responses to Red Stimuli (Out of 24)

	Group						
	Green Habituation		Red Habituation				
Experiment	MG	VG	MR	VR	F (G vs R)	df	p (One-Tailed)
1	15.0	14.7	10.5	11.5	11.13	1,20	< .005
2	12.8	15.2	11.3	11.8	5.77	1,20	< .025
	VMG	MVG	VMR	MVR			
3	13.8	14.8	12.5	12.7	3.05	1,20	< .05
2 and 3	14.2		12.1		7.96	1,40	< .005

Note—*G = green habituation color, R = red habituation color*

Subjects

The Ss consisted of 24 summer-school undergraduates taking psychology courses. The MG, MR, VG, and VR groups each consisted of three males and three females.

Results

As Table 1 shows, Ss who had green spots during the habituation phase once again performed significantly more test-phase responses to red spots than did those who had red spots during the habituation phase. Once again, the kind of response had no significant effect and did not interact significantly with the novelty-familiarity variable.

EXPERIMENT 3

The results of Experiments 1 and 2 are compatible with either stimulus specificity or stimulus-response specificity, since every S had to perform the same choice response, whether manual or verbal, in both habituation and test phases. In Experiment 3, half of the Ss had to make verbal responses in the habituation phase and manual responses in the test phase, and the other half had the contrary arrangement. Apart from this, the procedure was the same as in Experiments 1 and 2, and the stimulus cards were those used in Experiment 2.

Subjects

The Ss consisted of 24 more summer-school undergraduates taking psychology courses. They were divided into four groups, VMG (three males and three females), MVG (two males and four females), VMR (three males and three females), and MVR (two males and four females). The VM groups had to make verbal responses in the habituation phase and manual responses in the test phase, whereas the MV groups had to make manual responses in the habituation phase and verbal responses in the test phase. The G groups had green stimuli in the habituation phase, and the R groups had red stimuli.

Results

As Table 1 shows, Ss who had been exposed to green stimuli during the habituation phase chose to respond to red stimuli in the test phase significantly more often than did Ss who had been exposed to red stimuli, showing that the novelty effect was still present despite the change in responses from one phase to the other.

The results of Experiments 2 and 3 were subjected to a joint analysis of variance (see Table 1). The novelty effect was significant, but none of the other effects or interactions was. In other words, it made no significant difference whether Ss made similar or different responses in the two phases.

CONCLUSIONS

The results of Experiments 2 and 3 point to a filtering mechanism in the visual system, coming into play after information has left the retina, that favors response to stimuli possessing short-term novelty when these are in competition with others. The results of Experiments 1, 2, and 3 together indicate that the effect occurs regardless of whether the same responses or different responses are performed during habituation. Consequently, the effect appears to be stimulus specific rather than stimulus-response specific.

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