Inhibition and behavioral contrast¹

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Abstract

In one experiment, pigeons' pecks were reinforced during successive presentations of one stimulus (RFT) and not during successive presentations of a second stimulus (EXT). The highest rate of pecking occurred during the presentation of RFT stimuli that immediately followed EXT stimuli. In a second experiment, pecks were reinforced during the presentation of any of the top 8 of a column of 16 stimuli (RFT) and not during the presentation of any of the bottom 8 of these stimuli (EXT). The highest rate of pecking occurred during the presentation of the RFT stimulus that was closest to the EXT stimuli.

Problem

In one example of behavioral contrast (Catania, 1961; Reynolds, 1961a), extinction of responding in the presence of one of two alternating stimuli produced an increase in responding that was reinforced in the presence of the second of the two stimuli. This increase in responding has been attributed to an "excitatory effect" (Reynolds, 1961b) of extinction. An alternative interpretation, however, is that reinforcement ordinarily has inhibitory effects, and that extinction, the discontinuation of reinforcement, releases behavior from these effects. Two behavioral interactions that are consistent with this interpretation are illustrated in the present experiments.

Method

Subjects and apparatus. Three adult, male, White Carneaux pigeons, experimentally naive at the beginning of these procedures, were maintained at about 80% of their free-feeding body weights. Daily sessions were programmed in an experimental chamber the main panel of which is illustrated in Fig. 1. Reinforcement duration (grain in the feeder) was 3.5 seconds. Operation of the key produced a feedback click. Dim general illumination was provided, through the slot in the panel, by a 6-watt lamp behind the key. Stimulus lamps were blue 6-volt subminiature Dialights (#162-8430-934). The panel was enclosed in a sound-attenuating, ventilated housing, and was wired to automatic recording and controlling equipment (Ferster & Skinner, 1957).

Procedure. After preliminary training on a 1-minute fixed-interval schedule of reinforcement (FI 1-minute), discrimination

Fig. 1. Experimental panel. Stimulus lamps from the top to the bottom of the panel are designated by number (1 to 16) in the text. The panel served as one wall of a 10.5 by 13.5 by 13 inch experimental space.

Table 1. Sequence of Stimuli in Two Experiments. Numbers represent stimulus lamps in Fig. 1, "+" represents RFT, "o" represents EXT.

Experiment 1: Temporal Effects

Stimulus	3	6	6	6	6	6	3	3	3	6	6	6	6	6
Consequence	o	+	+	+	+	+	o	o	o	+	+	+	+	+

Experiment 2: Spatial Effects

Stimulus	1	9	5	10	3	14	7	12	8	16	4	15	6	11	2	13
Consequence	+	o	+	o	+	o	+	o	+	o	+	o	+	o	+	o

training was instituted: some stimulus lights were correlated with reinforcement (RFT) and others were correlated with extinction (EXT). During each stimulus presentation, one of the stimulus lamps and the lamp behind the key were lit. If the stimulus lamp was one correlated with RFT, the first peck that occurred after 1 minute had elapsed was reinforced. If the stimulus lamp was one correlated with EXT, the lights turned off after 1 minute, but no sooner than 5 seconds after the last peck (Morse, 1955). The next stimulus presentation was preceded by 5 seconds of darkness, during which pecks had no effect.

Two experiments, described in Table 1, have been selected to illustrate two major effects obtained with this procedure. The first experiment illustrates effects of the temporal ordering of RFT and EXT stimuli: stimulus 3 was correlated with EXT, and stimulus 6 was correlated with RFT. The sequence was repeated 6 times daily. The second experiment illustrates effects of the spatial ordering of RFT and EXT stimuli: stimuli 1 to 8 were correlated with RFT and stimuli 9 to 16 with EXT. This sequence was repeated 8 times daily, beginning at a different place in the sequence each day. In each experiment, no responses were recorded during the first 16 stimulus presentations of any session.

Results

Experiment 1. The average rate of responding of Pigeon 406 to stimuli at each position in the sequence is shown in Fig. 2. The data are similar to those obtained from the other two birds, and to those obtained from each bird in other similar sequences. The highest rate of responding (second and eleventh stimuli) occurred when a RFT stimulus followed an EXT stimulus, but did not depend on whether 1 or 3 EXT stimuli preceded the RFT stimulus. The lowest rate of responding (first and eighth stimuli) occurred when an EXT stimulus followed a RFT stimulus. After the initial decrease in the rate of responding to the RFT stimulus, following its initial presentation, the rate of responding remained fairly constant (third through seventh and twelfth through sixteenth stimuli).

The general findings illustrated in Fig. 2 were evident in cumulative records of a single sequence of presentations, and were repeatable throughout 52 successive daily sessions.

Experiment 2. In this experiment, all 16 stimuli were used, half correlated with RFT and half with EXT. The sequence was such that RFT and EXT alternated, so that effects of stimulus location were not confounded with temporal effects such as those illustrated in Fig. 2.

The average rate of pecking of Pigeon 406 to each of the 16 stimuli is shown in Fig. 3. The highest rate of pecking occurred to stimulus 8, the RFT stimulus that was closest to the EXT stimuli. The rate of responding to RFT stimuli decreased with increasing distance from the EXT stimuli, except near the end of the column (stimuli 1, 2, and 3). The rate of responding was lower to stimulus 9, the EXT stimulus that was closest to the RFT stimuli, than to stimuli 10, 11, and 12. The lowest rate of pecking occurred to the EXT stimuli that were farthest from the RFT stimuli (stimuli 13 through 16).

The effects illustrated in Fig. 3 typically occurred after about one week of the procedure. Within two or three weeks of continued training, the gradient of response rates within RFT stimuli and within EXT stimuli disappeared. In various experiments, however, similar gradients were obtained from each pigeon, and were recoverable in several ways: by changing the position in the column of lamps at which the transition from RFT to EXT occurred; by reversing the RFT and EXT stimuli; by varying the RFT and EXT sequence and counterbalancing or correcting for sequential effects; and by covering the lamps with a translucent plastic strip (Fig. 1), which temporarily made the several positions along the column less discriminable.

Discussion

The present findings bear a striking resemblance to effects in sensory systems. Reinforced responding was maximal when no reinforcement immediately preceded the responding (Fig. 2). This effect is analogous to temporal effects in the visual system (e. g., Ratliff et al., 1963, Fig. 16). The spatial effects suggest that reinforcement in the presence of one stimulus inhibits responding in the presence of other nearby stimuli (Fig. 3). These effects are analogous to spatial effects in the visual system (e. g., Ratliff & Hartline, 1959, Fig. 4).

This analogy suggests that it may not be necessary to assume that extinction has excitatory effects on reinforced responses to account for behavioral contrast. The major behavioral interactions may be decrements, relative to the maximal responding that is maintained by the isolated reinforcement of a response, produced by

Fig. 2. Average rate of responding during 1-minute presentations of stimuli correlated with RFT or EXT as a function of the position of the stimuli in a sequence of presentations. The sequence was repeated, so that the sixteenth stimulus was followed by the first stimulus. Average data over three daily sessions for a single pigeon.

Fig. 3. Average rate of responding during 1-minute presentations of each of 16 stimuli. Stimuli 1 to 8 were correlated with RFT, and stimuli 9 to 16 were correlated with EXT. The order of presentation was such that RFT and EXT alternated. Average data over three daily sessions for a single pigeon.

preceding reinforcement of the response or by reinforcement of other responses.

The present data were obtained with successive presentations of stimuli. Similar interactions also occur when two or more responses are reinforced concurrently. For example, an increase in reinforcement for one of two concurrent responses produces a decrease in the rate of occurrence of the second of these responses (Catania, 1963).

The notion that reinforcement of different responses, or of responses to different stimuli, produces inhibitory interactions analogous to those in physiological systems has application to a variety of experimental situations. For example, the temporal interaction accounts for the finding that rats reinforced with food in two successive goalboxes at the end of two successive runways run faster to the second goalbox on those trials in which reinforcement has been omitted in the first goalbox (Amsel & Roussel, 1952), and the spatial interaction accounts for the peaks that may be obtained when maintained generalization gradients are used to compare reinforcement and extinction gradients (Reynolds, 1961b).

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Note

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