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Unblocking in a runway discrimination problem produced by a surprising reduction in S– reward magnitude: The role of generalization decrement

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Blocking and unblocking groups were trained in Phase 1 on an instrumental discrimination task in which internal cues were relevant and brightness cues were irrelevant. The blocking group received large reward (L) in S+ and nonreward (N) in S– in both Phase 1 and Phase 2 and failed to learn about brightness when brightness cues were added as relevant, but redundant, discriminanda in Phase 2. Groups Unblocking:S and Unblocking:S+N received small reward (S) or a mixture of S and N trials, respectively, in S– in Phase 1, but otherwise were trained in the same manner as the blocking group. Both unblocking groups experienced a shift to all N trials in S– coincident with the addition of brightness as a relevant cue at the beginning of Phase 2. Brightness cues acquired very substantial, and equal, discriminative control in both unblocking groups and a control group trained only in Phase 2 with internal cues and brightness cues simultaneously relevant.

Rats trained on an instrumental, go/no-go discrimination problem on which internal, for example, reward-produced, cues are the relevant positive (S+) and negative (S–) discriminanda in Phase 1 fail to learn about brightness cues that are added in Phase 2 as relevant, but redundant, discriminanda (Capaldi, Verry, Nawrocki, 1982; Haggbloom, 1981, 1984). That is, prior acquisition of behavioral control by internal cues blocks (cf. Kamin, 1969) the acquisition of control by subsequently introduced brightness cues. This blocking effect is attenuated by a surprising reduction in S– reward magnitude coincident with the introduction of brightness as a relevant cue (Haggbloom, 1984), an effect called unblocking, which appears to be analogous to unblocking produced in classical conditioning by a surprising increase in unconditioned stimulus intensity (e.g., Kamin, 1969).

Neely and Wagner (1974) reported that some instances of unblocking due to a shift in reward conditions could be a consequence of generalization decrement due to a change in reward-produced cues accompanying the reward shift. This possibility is of special concern in the instrumental conditioning situations employed by Haggbloom (1984) and Neely and Wagner (1974), because of the very substantial behavioral control exercised by reward-produced cues in instrumental conditioning (see, e.g., Capaldi, 1966, and Haggbloom & Tillman, 1980). At present, the only evidence for unblocking in instrumental conditioning is the experiment reported by Haggbloom (1984), and that experiment did not control for the contribution of generalization decrement to the unblocking effect. The purpose of the present experiment was to investigate whether generalization decrement contributed to the unblocking effect reported by Haggbloom (1984).

Three groups—Groups Blocking, Unblocking:S, and Unblocking:S+N—were trained in Phase 1 on a discrimination problem on which reward-produced cues and certain intertrial-interval(ITI)-related cues were relevant discriminanda. Those cues are identified collectively as internal cues to distinguish them from brightness cues. Brightness cues were constant across trials in Phase 1, and thus were irrelevant. All three groups received large reward (L) on S+ trials. On S– trials, Group Blocking received no reward (N), Group Unblocking:S received small reward (S), and Group Unblocking:S+N received S on two-thirds and N on one-third of its S– trials.

In Phase 2, internal cues remained relevant, and brightness cues were added as relevant discriminanda for all groups. Group Control began training in Phase 2 and was treated the same as the three experimental groups. All groups received L on S+ trials and N on S– trials, Groups Unblocking:S and Unblocking:S+N having experienced a reduction in S– reward from S (or a mixture of S and N) to N on all S– trials.

The intermixture of S and N trials in S– during Phase 1 for Group Unblocking:S+N was the treatment of major interest in this experiment. Its purpose was to provide that group with experience responding to internal cues produced by N trials and thereby preclude the occurrence of generalization decrement due to a change in reward-produced cues when, in Phase 2, S– reward magnitude was shifted from S to N in the unblocking groups.

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The acquisition of stimulus control by brightness cues was assessed, as in the experiments reported by Haggbloom (1981, 1984), by an opposed-cue test involving the reversal of brightness cues.

METHOD

Subjects

The subjects were 40 male rats, approximately 90 days old at the beginning of training, bred in the laboratory from Holtzman stock.

Apparatus

The apparatus consisted of two parallel straight alleys 105 cm long x 9 cm high and wide. The walls and floor of one alley were painted black, and the walls and floor of the other alley were painted white. The last 25 cm of each alley constituted a goalbox separated from the rest of the alley by a manually operated guillotine door. The doors and goalboxes were painted the same color as the alley in which they were located. Each goalbox contained an unpainted wooden goal cup. A gray startbox, 9 cm high and wide x 25 cm long, could be aligned to permit entry into one alley or the other. The startbox had a gray, manually operated guillotine door.

The alleys were divided into three sections over which running times were recorded (respectively, start, run, and goal times). Start times were recorded from the opening of the startbox door, which triggered a .01-sec clock, to a point 30 cm into the alley. Run and goal times were recorded over the next 40 and 30 cm, respectively. The offset of the first clock and the operation of the remaining clocks were controlled by photoelectric circuitry.

Procedure

The rats were housed in individual cages and had free access to food and water for at least 2 weeks prior to the 1st day of food deprivation. The food-deprivation schedule consisted of 12 g of Wayne Lab Blox per day and was begun 14 days prior to the start of discrimination training. It continued throughout the experiment, with the amount of food consumed in the runway during training being subtracted from the 12-g daily ration. Water was always available.

On each of Days 12-14 of deprivation, rats were handled in squads of four for 4 min per squad. After being handled on each day, the rats received 10 45-mg Noyes pellets in their home cages. Discrimination training began on Day 15 of deprivation.

On all rewarded trials, the rats were removed from the goalbox after the times had been recorded (after approximately 10 sec) unless the reward had not yet been consumed. Reward consisted of 12 45-mg Noyes pellets on L trials and 2 pellets on S trials. On N trials, the rats were confined to the unbaited goalbox for 20 sec.

The rats were run in squads of three (Phase 1) or four (Phases 2 and Test), with each squad containing one rat from each group. Within each squad, the order of administering trials was randomized daily. The order of successive squads was held constant across days.

All trials were initiated by opening the startbox door approximately 3 sec after having placed the rat in the startbox and regardless of the rat's orientation. A maximum time of 30 sec was allowed in each section of the alley. If 30 sec was exceeded in any alley section, the additional time was added to the time score of the next section forward. If the animal did not enter the goalbox within 90 sec, it was placed in the goalbox.

Design

In Phase 1, which lasted 12 days, Group Blocking received two consecutive L trials separated by a 3-min ITI followed 20 min later by two consecutive N trials separated by a 3-min ITI (LL...NN schedule) daily. On this schedule, stimuli unique to Trial 1, and the memory of L (S^L) produced on that trial, function as S+ cues signaling L on trials 1 and 2, respectively. Similarly, stimuli unique to the relatively long within-day ITI, and the memory of N (S^N) produced on Trial 3, function as S– cues signaling N on Trials 3 and 4, respectively. The LL...NN schedule defines a situation in which internal cues are relevant discriminanda (Haggbloom, 1981, 1984). One-half of the rats in Group Blocking received all of their Phase 1 trials in the black runway, and the remaining rats were trained in the white runway. Thus, brightness was irrelevant in Phase 1.

Group Unblocking:S was treated exactly like Group Blocking in Phase 1 except for the occurrence of S on Trials 3 and 4 each day (LL...SS schedule). Group Unblocking:S+N received the LL...NN schedule on Days 3, 6, 9, and 12 and LL...SS on all other Phase 1 days. In these groups, then, internal S– cues signaled S rather than N (or, in the case of Group Unblocking:S+N, an average reward amount greater than N). Brightness cues were made irrelevant in Phase 1 for the two unblocking groups in the same manner as for Group Blocking.

In Phase 2, which lasted 10 days, Group Control began training, and all four groups were treated identically, receiving the LL...NN sequence daily. Brightness cues were made relevant by administering all L trials in one runway, for example, black, and all N trials in the other runway, for example, white. Appropriate counterbalancing of brightness was employed, with the newly added brightness cues becoming part of the S– stimulus compound for each rat.

A single, opposed-cue test day followed Phase 2. All procedures on the test day were identical to those in Phase 2, except that brightness cues were reversed for each group.

RESULTS

Start, run, and goal times were summed for each trial to obtain a total time, and all time scores were converted to speeds in centimeters per second. Only total speeds, which were representative of responding in each alley section, are reported here. Some analyses were performed on difference scores obtained by subtracting mean daily S– speeds from mean daily S+ speeds.

Phase 1

Group Blocking ran substantially slower in S– than in S+ by the last day of Phase 1 (mean difference score = 60.03). Groups Unblocking:S and Unblocking:S+N also ran slower in S– than in S+, but discriminative responding was not as pronounced in those groups as in Group Blocking (mean difference scores of 12.62 and 9.48, respectively). An analysis of variance (ANOVA) with groups (3) and brightness (2) as between-subjects variables and discriminanda (2) and trials (2) as within-subjects variables was applied to speeds on the last day of Phase 1. Simple effects of discriminanda at groups showed that S– speeds were reliably slower than S+ speeds for each group [smallest $F(1,24) = 4.73$, $p < .05$, for Group Unblocking:S+N].

Phase 2 and Test Day

Figure 1 shows the mean difference between speeds in S+ and S– on the last day of Phase 2 and on the test day for each of the four groups. As can be seen in Figure 1, all four groups ran substantially faster in S+ than in S– by the end of Phase 2. Discriminative responding at the end of Phase 2 was best in Group Blocking, worst in Group Unblocking:S+N, and intermediate in Groups

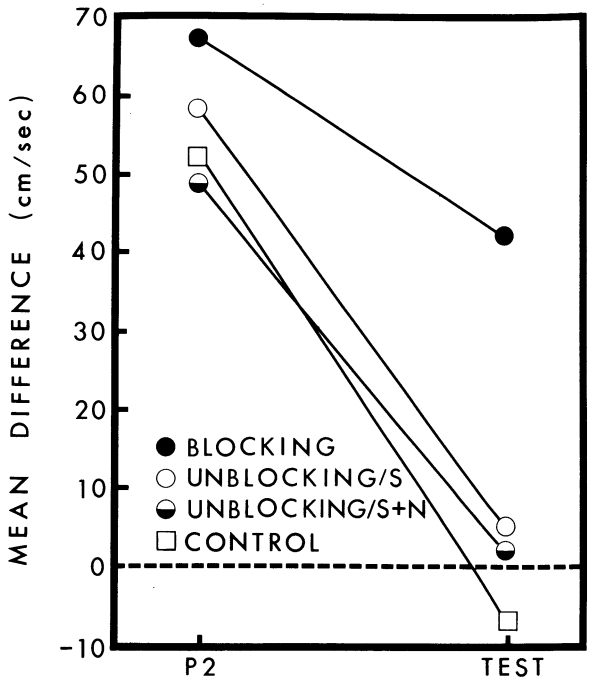

Figure 1. Mean difference between speeds in S+ and S– on the last day of Phase 2 (P2) and on the test day (test) for each of the four groups.

Unblocking:S and Control. Looking at the test day, it can be seen that the reversal of brightness cues virtually eliminated discriminative responding in Groups Control, Unblocking:S, and Unblocking:S+N. There was also some disruption in discriminative responding in Group Blocking, but not nearly as much as that in Group Control or the unblocking groups. Thus, the acquisition of stimulus control by brightness was substantially blocked in Group Blocking. On the other hand, brightness acquired nearly as much control in the unblocking groups as it did in Group Control.

An ANOVA identical to that applied to speeds on the last day of Phase 1, but this time with four levels of groups, was applied to speeds on the last day of Phase 2. Simple effects of discriminanda at each group showed that S+ speeds were reliably faster than S– speeds in each case [smallest $F(1,32) = 59.69$, $p < .001$, for Group Unblocking:S+N]. An identical ANOVA and simple effects applied to speeds on the test day showed that Group Blocking continued to run faster in S+ than in S– [$F(1,32) = 33.58$, $p < .001$] but that Groups Unblocking:S and Unblocking:S+N did not (Fs < 1). Group Control ran faster in S– than in S+ on the test day, but not significantly so [$F(1,32) = 2.61$].

An ANOVA applied to the difference between mean S+ and S– speeds on the last day of Phase 2 and the test day with groups (4) as a between-subjects variable and phase (2) as a within-subjects variable yielded a reliable groups x phase interaction [$F(3,32) = 3.07$, $p < .05$]. Simple effects of groups at both days showed that the differences among groups on the last day of Phase 2 (see Figure 1) were not reliable [$F(3,32) = 2.49$] but that those on the test day were [$F(3,32) = 11.66$, $p < .01$]. Simple effects of phase at each group showed that the reversal of brightness cues disrupted responding in all groups [smallest $F(1,32) = 9.07$, for Group Blocking].

Planned comparisons between the mean difference score for each of Groups Blocking, Unblocking:S, and Unblocking:S+N against that for Group Control showed that the difference in discriminative responding between Group Blocking and Group Control on the test day was reliable [$F(1,32) = 31.77$, $p < .001$] but that neither unblocking group showed reliably better discriminative responding than Group Control [largest $F(1,32) = 3.16$, for Group Unblocking:S vs. Group Control].

DISCUSSION

The results of this experiment essentially replicate for Groups Blocking and Unblocking:S the results reported by Haggbloom (1984). Both groups acquired a discrimination in Phase 1, in which internal cues were relevant and brightness cues were irrelevant. Compared with the result for Group Control, the acquisition of stimulus control by brightness during Phase 2 was substantially blocked in Group Blocking. In Group Blocking:S, on the other hand, the blocking effect was eliminated by the shift from S to N in S–. The blocking effect was similarly eliminated in Group Unblocking:S+N. That group experienced nonreward-related stimuli on some Phase 1 days, whereas Group Unblocking:S did not. That blocking was similarly attenuated in both unblocking groups suggests that the unblocking effect in this situation is not a consequence of generalization decrement due to a change in reward-produced cues.

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