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Serial positive patterning: Implications for "occasion setting"

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Rats received positive patterning training in which a serial light-tone compound was reinforced with food and the elements were separately nonreinforced. Conditioned responding of a form characteristic of auditory conditioned stimuli emerged to the tone within the serial compound. Separate presentations of the elements evoked little conditioned behavior. Discrimination performance was better when the light-tone interval was 20 sec than when it was 5 sec. These data suggested that the light acquired a conditional cue or occasion-setting function such that the light signaled when a tone-food relation was in effect. Comparisons with data from previous experiments involving serial feature-positive discriminations indicated that the light's ability to serve as an occasion setter was relatively independent of its response-evoking capacity.

Ross and Holland (1981) examined rats' solution of Pavlovian feature-positive discriminations using an appetitive conditioning preparation in which auditory and visual conditioned stimuli (CSs) evoke topographically distinct conditioned responses (CRs). In two experiments, serial light-then-tone (A → B) compounds were reinforced with food and tone-alone (B) presentations were not reinforced. Several types of conditioned behavior were observed. First, the light feature stimulus (A) acquired rearing behavior unique to visual CSs. Second, responding usually occurring only during auditory stimuli (head jerk) occurred during trace intervals interposed between the light and tone. Finally, the tone (B) evoked substantial tone-specific head jerk behavior, but only when it was preceded by the light.

On the basis of these results, we suggested that conditioned responding in serial feature-positive discriminations was multiply determined. First, the feature (light) stimulus may acquire associations with the unconditioned stimulus (US) by virtue of the consistent feature-US pairings. Those associations would generate rearing and magazine behaviors. Second, associations between the light and the tone within the serial compound might be responsible for the occurrence of tone-specific head jerk behavior during the light and/or trace intervals. That is, the light may come to evoke a representation of the tone that in turn evokes tone-specific behaviors. Holland and Ross (1981) showed that light-tone associations were responsible for head jerk behavior during the light in simple light-tone-food serial compound conditioning. Those experiments also showed that the establishment of within-compound light-tone associations prevented the acquisition of startle responding (normally evoked by auditory CSs) to the tone CS within the serial compound. Ross and Holland (1981) found a similar lack of startle responding to the tone in serial feature-positive discriminations. Finally, the feature (light) stimulus may acquire a conditional cue or occasion-setting function (cf. Moore, Newman, & Glasgow, 1969), signaling when a relation between the more contiguous tone and the food US was in effect.

Ross and Holland (1981) suggested that these various sources of responding might be relatively independent. We noted that extending the light-tone and light-food intervals enhanced the light's ability to set the occasion for head jerk responding to the tone but had no reliable effect on the amount of head jerk behavior occurring during the 5-sec period just prior to the tone on compound trials (presumably due to light-tone associations) or on the level of rearing behavior to the light (indicating the strength of the light-US associations). The present experiment examines the effect on each of these three potential sources of responding in serial feature-positive discriminations of including separate nonreinforced light presentations in a serial positive patterning discrimination (A → B+, A−, B−). Although the inclusion of these trials would further degrade the light-tone and light-food relation, the conditional relation, "tone is reinforced only when preceded by light" would be intact. Thus, in comparison with feature-positive training, serial positive patterning contingencies might result in equivalent occasion setting (i.e., head jerk behavior to the tone within the serial compound), but less rearing and head jerk behavior during the light and prior to tone delivery.

Two groups of rats received serial positive patterning in which a serial 5-sec light → 5-sec tone compound was reinforced and 5-sec presentations of each element were nonreinforced. The interval between light and tone onsets was 20 sec in one group and 5 sec in the other. Our choice of these intervals was based on Ross and

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Holland's (1981, Experiment 3) observation that a 20-sec interval resulted in strong occasion setting in feature-positive discriminations, but a 5-sec interval produced only moderate occasion setting. The effects of adding nonreinforced light presentations to the serial feature-positive discrimination procedures used by Ross and Holland were evaluated by comparing responding in the present experiment with that observed in the prior studies. All parameters of individual stimulus characteristics, temporal intervals, and session durations were identical in the two experiments.

METHOD

Subjects and Apparatus

The subjects were 16 male Sprague-Dawley rats maintained at 80% of their ad-lib weights. All rats were approximately 120 days old at the beginning of the experiment and had no previous experimental history.

Four chambers, 22.9 x 20.3 x 20.3 cm, with clear acrylic sides and aluminum front and rear walls were employed. Each chamber contained a recessed food magazine on the front wall, with a constantly illuminated 6-W jeweled lamp mounted above. The chambers were enclosed in sound-insulated compartments with 30 x 30 cm clear windows to permit viewing access. A 6-W lamp, for use as the visual CS, was mounted in each compartment 10 cm above the center of the rear acrylic wall. Auditory CSs were delivered through a speaker mounted directly to the left of the lamp. Behavior during each trial was recorded on videotape by a low-light television camera positioned 2.1 m from the enclosure.

Behavioral Observation Procedures

Behavioral observations were made from the videotapes. Observation procedures were initiated with the onset of the CS. Beginning with the first rat in the group, one behavior was recorded, and then the observer shifted his gaze to the next rat. This shift occurred every 1.25 sec and was aided by timed auditory signals superimposed on the tape. Thus, each rat's behavior was sampled once in each 5-sec time interval during the course of a trial. The frequency of each behavior was then converted into a percentage of the total number of behavioral observations to aid comparisons with data from other experiments. In addition, the percentage of trials on which startle behavior (see below) occurred during the first 1.25-sec interval after CS onset was recorded for each rat.

The categories of behavior reported here have been extensively described elsewhere (Holland, 1977). The categories of interest in this study were: (1) startle—a sudden gross movement or jump that results in a change of position, typically occurring within 1.25 sec of an auditory CS presentation; (2) head jerk—short, rapid, horizontal, and/or vertical movements of the head; (3) rearing—standing on the hind legs with both front feet off the grid floor, but not engaging in grooming behavior. Previous experiments (e.g., Holland, 1977) have shown that auditory CSs evoke startle and head jerk behaviors, but visual CSs evoke rearing behavior.

Previous checks of interobserver agreement using the technique described above under blind conditions have yielded agreement in a range from 91% to 96%.

Procedure

All rats were first trained to eat from the food magazine. This was accomplished in a single session, during which 10 deliveries of two 45-mg Noyes pellets were given on a variable-time 1-min schedule.

On the following day, rats were randomly assigned to one of two groups (N = 8) and conditioning of the serial positive patterning discrimination began. In each of 22 80-min sessions, both groups received three nonreinforced presentations each of a 5-sec intermittent (two per second) flashing of a light, a 5-sec 1,500-Hz constant tone, and three reinforced serial light-tone compounds. The trials were randomly intermixed, with the restriction that no more than two of each trial type occur consecutively. In Group 5, serial compound trials consisted of a 5-sec presentation of the flashing light followed immediately by a 5-sec presentation of the tone that terminated with delivery of two 45-mg Noyes pellets. In Group 20, a 15-sec trace interval was interpolated between light termination and tone onset. Thus, the light onset to tone onset interval was 20 sec.

All statistical tests conducted used the $p < .05$ level of significance.

RESULTS AND DISCUSSION

Figure 1 shows conditioned behaviors that occurred during the light and during the tone on both reinforced compound and nonreinforced element trials. The rats in both groups acquired the serial positive patterning discriminations. As in Ross and Holland's (1981) feature-positive discrimination experiments, the light "set the occasion" for head jerk responding to the subsequent tone: The tone within the serial compound evoked substantially more head jerk behavior than did the tone alone in both Group 5 (Wilcoxon T = 0) and Group 20 (T = 0).

The top portion of Table 1 compares responding in Group 20 over the last four sessions of the present experiment with equivalent data from Group 20 in Ross and Holland's (1981) experiments. The lower levels of rearing behavior to the light in the present experiment (Mann-Whitney U = 5) indicate that light-alone presentations weakened the light-food association. Further, the lower levels of head jerk behavior during the trace interval between the light and the tone on compound trials (U = 0) and the higher frequency of startle behavior to the reinforced tone (U = 0) show that light-alone presentations eliminated light-tone associations. Nevertheless, head jerk behavior to the reinforced tone did not differ (U = 23) across the experiments, suggesting that the occasion-setting powers of the light in Group 20 did not depend on the maintenance of the feature/common-element or feature-US associations. Indeed, occasion setting was perhaps more obvious in this experiment than in our earlier feature-positive experiments, since in the present experiment both behaviors normally evoked by auditory CSs, startle (T = 0) and head jerk, were evoked differentially by the tone alone and the tone after light (recall that startle responding did not occur to the reinforced tone in the previous experiments because it was suppressed by the influence of light-tone associations).

The lower portion of Table 1 compares responding in Group 5 of the present experiment with that of Group 5 in Ross and Holland's (1981) experiment. As in Group 20, the ability of the light feature to set the occasion for the display of head jerk behavior was apparently unaffected by the inclusion of nonreinforced light presentations;

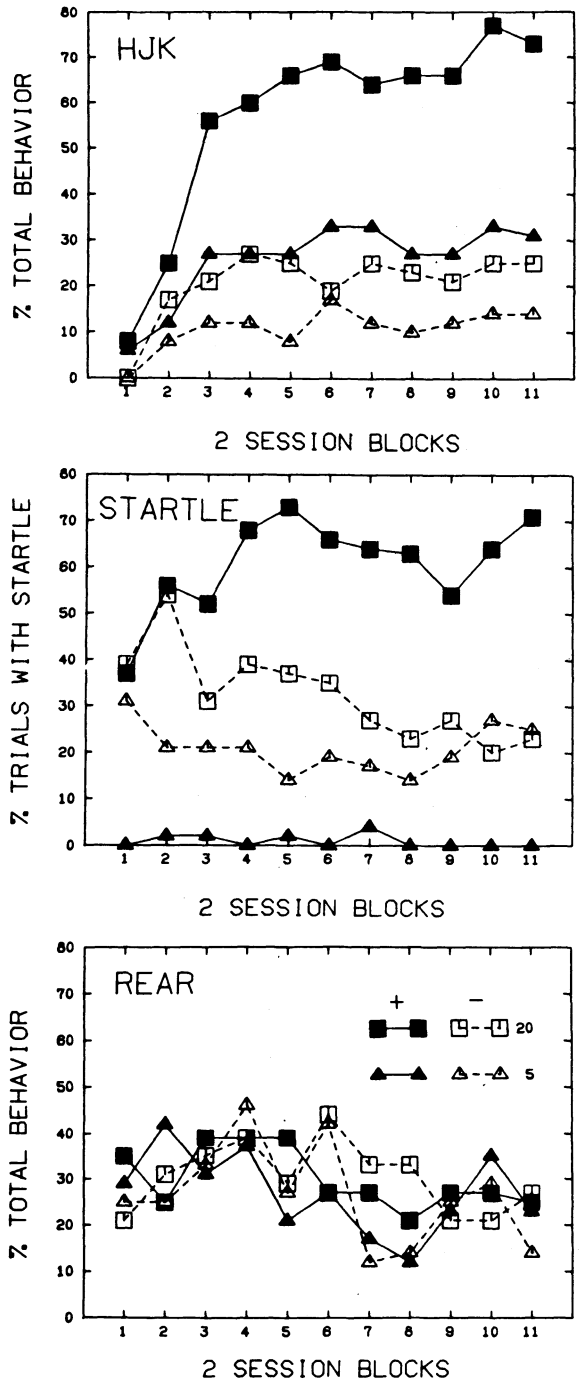

Figure 1. Behaviors occurring during the stimuli when presented in serial compound (+) or separately nonreinforced (−). The top two panels show responding to the tone. The third panel shows responding during the light.

head jerk behavior to the reinforced tone did not differ from that seen in Group 5 in Ross and Holland's (1981) study (U = 21). Nonreinforced light presentation did weaken the light-food association in Group 5 relative to that in the corresponding feature-positive condition, as indicated by substantially less rearing to the light in the present experiment (U = 12). However, light-alone presentations were apparently not effective in preventing the establishment of light-tone associations. Neither frequency of head jerk behavior to the light (U = 30) nor startle to the tone after light (U = 32) differed across experiments, unlike in Group 20. Apparently, the 50% reinforcement schedule was not sufficient to degrade the relation between the highly contiguous light and tone stimuli in Group 5, but it was capable of degrading the relation between the less contiguous light and tone in Group 20. Thus, the present experiment does not provide an adequate test of the effects on occasion setting of degrading the S1-S2 association in a 5-sec condition.

In summary, rats solved serial positive patterning discriminations (A → B, A−, B−) by using the initial element of the serial compound to set the occasion for responding to the second element. In comparison with previous experiments involving serial feature-positive discriminations, A's ability to serve as an occasion setter was little affected by the degradation of either the A-B relation (Group 20) or the A-US relation (Group 5 and 20). Thus, the establishment of a conditional cue or occasion setting function to a stimulus was experimentally separable from the acquisition of simple associations to that stimulus.

Accounts that postulate additional functions of a stimulus in a conditional discrimination, such as occasion setting, are often contrasted with accounts that posit the involvement of a unique or configural cue (cf. Carter & Werner, 1978; Kehoe & Gormezano, 1980). For example, in the present experiment, the rats may have responded to a unique cue abstracted as "light – aftereffects + tone." Several points argue against a configural account of the present results. It seems reasonable to assume that subjects' ability to use a configural cue would be enhanced by shorter, rather than longer, temporal intervals within the serial compound. But in the present study, the discrimination was better when the longer 20-sec interval was employed. The results of an experiment reported earlier also cast doubt on the configural explanation. Holland and Block (cited in Holland, in press) conducted a simultaneous positive pat-

Table 1
Comparison of Positive Patterning (PP) and Feature-Positive (FP) Discrimination Performance on Reinforced Compound Trials

	Group 20				Group 5			
	Light		Tone		Light		Tone	
Behavior	PP	FP	PP	FP	PP	FP	PP	FP
Rearing	24	52	0	14	29	59	1	9
Startle	0	0	71	0	0	0	0	2
Head Jerk	1	37	72	70	3	0	32	29

Note–Data in the columns labeled "PP" are from the last four sessions of the present, positive patterning, experiment; those in the "FP" columns are from the last four sessions of Ross and Holland's (1981) Experiment 3. In Group 20, the entries for head jerk to the light refer to the 5-sec trace period immediately prior to the tone. Data entries for rearing and head jerk behaviors are in percent total behavior; those for startle refer to the percentage of trials on which a startle occurred.

terning study within the same conditioning preparation employed here. When the light and tone were reinforced in simultaneous compound, a unique response that combined behaviors characteristic of both visual and auditory CSs emerged. Such a unique response was never observed in either group during the course of serial positive patterning in the present experiment.

REFERENCES

CARTER, D. E., & WERNER, T. J. Complex learning and information processing by pigeons: A critical analysis. *Journal of the Experimental Analysis of Behavior,* 1978, **29**, 565-601.

HOLLAND, P. C. Conditioned stimulus as a determinant of the form of the Pavlovian appetitive conditioned response. *Journal of Experimental Psychology: Animal Behavior Processes,* 1977, **3**, 77-104.

HOLLAND, P. C. "Occasion setting" in conditional discriminations. In M. Commons, R. Herrnstein, & A. R. Wagner (Eds.), *Harvard symposium on the quantitative analyses of behavior* (Vol. 4). *Acquisition: Discrimination processes.* New York: Ballinger, in press.

HOLLAND, P. C., & ROSS, R. T. Within-compound associations in serial compound conditioning. *Journal of Experimental Psychology: Animal Behavior Processes,* 1981, **7**, 228-241.

KEHOE, E. J., & GORMEZANO, I. Configural and combination laws in conditioning with compound stimuli. *Psychological Bulletin,* 1980, **87**, 351-387.

MOORE, J. W., NEWMAN, F. L., & GLASGOW, B. Intertrial cues as discriminative stimuli in human eyelid conditioning. *Journal of Experimental Psychology,* 1969, **79**, 319-326.

ROSS, R. T., & HOLLAND, P. C. Conditioning of simultaneous and serial feature-positive discriminations. *Animal Learning & Behavior,* 1981, **9**, 293-303.

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