Response suppression by response-contingent noise: Effects of conditioning history*

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Ss performed in a button-pushing task in which 0.75 sec of either 95-dB SPL or 30-dB SPL noise was delivered contingent on each response for a RRLRL pattern of responses. Ss who received high-level noise in their first exposure to the task generally learned to avoid the noise. About half (13) of the Ss who received low-level noise in their first exposure to the task learned to avoid the noise, while the other half (12) learned to deliver the noise on every response. Eight of the 12 Ss who learned to deliver low noise continued to deliver noise for every response when the noise level was increased to 95 dB. There were no consistent differences in the amount of time required to learn the pattern in low-noise and high-noise conditions.

Several investigators have demonstrated that when loud (90-110 dB SPL) noise is delivered contingent upon given responses, those responses decrease in frequency (Flanagan, Goldiamond, & Azrin, 1958; Azrin, 1960; Holz, Azrin, & Ayllon, 1963). It appears to be generally accepted that loud noise, delivered contingent upon given behaviors, constitutes punishment of those behaviors, resulting in their suppression.

The literature on punishment suggests two kinds of situations in which loud noise, delivered contingent upon given responses, might *not* lead to suppression of those responses, given Ss with certain kinds of conditioning histories. First, if an aversive stimulus such as loud noise has been used as a signal to the S that positive reinforcers are available or if the aversive stimulus has been paired with delivery of positive reinforcers, then response-contingent delivery of the stimulus is likely not to lead to response suppression (Azrin, 1958; Holz & Azrin, 1961, 1962; Ayllon & Azrin, 1966). Second, if an aversive stimulus is delivered contingent upon responses which were originally established with that aversive stimulus (e.g., avoidance responses), then response-contingent delivery of the stimulus is not likely to lead to response suppression (Solomon, 1964).

There are also studies in the literature which suggest that the effects of response-contingent aversive stimulation may also depend upon the response which is made the occasion for delivery of the aversive stimulus. In general, these studies suggest that sometimes when aversive stimuli are delivered contingent upon responses which are concurrently receiving positive reinforcement (Tolman, Hall, & Bretnall, 1932) or when aversive stimuli are delivered contingent upon responses which are intrinsically "correct," those responses may be facilitated rather than suppressed.

In summary, then, the effects of response-contingent aversive stimulation such as loud noise appear to be a function of both the individual's previous experiences with the aversive stimuli and the nature of the response which is made the occasion for delivery of the aversive stimulus. It appears that even painful aversive stimuli may not be effective in suppressing behaviors if individuals have had certain kinds of previous experiences with those stimuli. It also appears likely that response-contingent aversive stimuli may have facilitating effects if the responses are also receiving positive reinforcement and if the responses which cause the noise to be delivered are perceived by the S as "correct" or "desirable."

The experiment reported here was designed to evaluate these conclusions. The experimental questions posed were: (1) If loud noise is delivered contingent on certain responses in a learning task in which there are no implicitly "correct" or "incorrect" responses, will Ss learn to avoid the noise? (2) If low-level noise is delivered contingent on certain responses in a learning task like that above, will Ss learn to avoid the noise? (3) If Ss learn to deliver low-level noise on every response in the above task, will they continue to deliver noise for every response if the intensity of the noise is increased to aversive levels?

METHOD

The Ss were volunteers from the staffs at Kansas City and Minneapolis Veterans Administration Hospitals. The Ss were seen one at a time. Each was seated at a table in a sound-attenuating booth. On the table in front of S was a response console containing two 1½-in.-diam Plexiglas pushbuttons, one red and one green, both illuminated from below. Programming equipment outside the booth was connected to the pushbuttons so that 0.75 sec of either 95-dB SPL or 30-dB SPL bursts of white noise could be delivered to a speaker 3 ft behind the S. (Noise levels were established at S's chair, with a B & K 3301 sound-level meter.) The delivery of noise bursts was programmed so that a LLRLR, LLRLR pattern of responses would avoid the noise on 100% of trials or a RRLRL, RRLRL pattern would deliver the noise on 100% of trials. The Ss were instructed that they were to learn a pattern of responses on the pushbuttons. They were told nothing about how they were to learn the pattern or what stimuli would be delivered as they responded. They were told that they would have to "guess" at first but that the task would become more meaningful as they continued to respond. They were also instructed not to operate both pushbuttons at once and to respond only when the pushbuttons were illuminated. Each time the S responded, the light beneath the pushbuttons went out and came on again 2 sec later. Responses made while pushbuttons were not illuminated were ignored by the programming equipment. Ss' responses and delivery of noise bursts were recorded on a Gerbrands event recorder.

In the initial section of the experiment, Ss were assigned randomly to high-noise and low-noise conditions until we had 15 Ss in each condition who learned the response pattern. After these Ss had finished, an additional 10 Ss were assigned to the low-noise condition in order to evaluate more adequately the findings from the performance of the first 15 Ss in that condition. In the high-noise condition, Ss received 0.75 sec of 95-dB SPL bursts of white noise according to the pattern described above. In the low-noise condition, Ss received 0.75 sec of 30-dB SPL bursts of white noise according to the same pattern.

Three outcomes were possible for any given S: (1) He could fail to learn the pattern. In this case, after 500 trials, he was dismissed from the experiment. (2) He could learn the pattern and learn to avoid the noise on every response. In this case, as soon as he avoided the noise for 20 consecutive trials, he was dismissed. (3) He could learn the pattern and learn to deliver the noise on every response. If a S received 95-dB noise in

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Table 1
Number of Ss Learning to Deliver or Avoid Noise in High Noise and Low Noise Condition

Condition	N	Delivered Noise	Avoided Noise	Did Not Learn
High Noise	17	2	13	2
Low Noise	30	12	13	5
Low Noise*	2	2	0	0
High Noise†	12	8	4	0

**Subsequent to high noise for Ss who learned to deliver high noise on every response.*
†Subsequent to low noise for Ss who learned to deliver low noise on every response.

his first exposure to the task and if he learned to deliver the noise on every response for 20 trials, on the 21st trial the noise level was decreased to 30 dB and remained there until the S emitted 40 more consecutive responses which delivered the noise, until he emitted 20 consecutive responses which avoided the noise, or until he emitted 200 responses without meeting the above criteria. If he received 30-dB noise on his first exposure to the task and if he learned to deliver the noise on every response for 20 trials, then on the 21st trial the noise level was increased to 95 dB and remained there until the S emitted 40 more consecutive responses which delivered the noise, until he emitted 20 consecutive responses which avoided the noise, or until he emitted 200 responses without meeting the above criteria.

RESULTS AND DISCUSSION

The results of the experiment are summarized in Table 1. Seventeen Ss were placed in the high-noise condition before we obtained 15 who learned the pattern. Of these 15, 13 Ss learned to avoid the noise and 2 learned to deliver the noise on every trial. Both of the latter continued to deliver the noise when it was subsequently lowered to 30 dB.

Thirty Ss were placed in the low-noise condition before we obtained 25 who learned the pattern. Of these 25, 13 Ss learned to avoid the 30-dB noise and 12 learned to deliver the noise on every trial. Of the 12 Ss who learned to deliver 30-dB noise on every trial, 8 continued to deliver noise for every response when the noise level was increased to 95 dB and 4 learned to avoid the 95-dB noise.

The length of time it took Ss in the various conditions to learn the pattern was computed by converting distance on the graphic event record to time. (The event recorder paper moved at 2 mm/sec.) The mean time (in minutes) between the initial response and the first response in the sequence of 20 consecutive responses which either delivered or avoided the noise for each condition is given in Table 2. Mean differences among conditions were not striking, except for the two Ss who learned to deliver high noise in their first exposure to noise. However, several Ss in other conditions took almost as long as either of these to learn the patterns. Consequently, it appears that the disparity in mean scores may be a result of the small number of Ss who learned to deliver high noise in the initial high-noise condition rather than being representative of a reliable difference.

With regard to the experimental questions posed, it appears that almost all human Ss, if placed in an indeterminate ("indeterminate" = no classes of responses have been a priori labeled, either by S or for S, as "correct" or "incorrect," "good" or "bad," and so forth) learning situation, will work to avoid loud (95-dB) noise if given the opportunity to do so. However, there apparently exists a small, but theoretically embarrassing, proportion of Ss who will work to deliver the noise. Whether these Ss have had previous experiences with noise that would explain their behavior or whether their performance reflects what they believe the E expected them to do, we can only conjecture. Noise of about 30-dB intensity, on the other hand, appears to represent a relatively neutral stimulus; that is, Ss are as likely to work to receive it as to avoid it in indeterminate learning situations.

The most intriguing part of the results of this experiment concerns those Ss who learned to deliver 30-dB noise during their initial exposure to noise. In this experiment, 12 Ss initially learned to deliver low-level noise for every response. When the noise level was then increased to 95 dB (which almost all "naive" Ss learn to avoid), 8 of the Ss who learned to deliver low-level noise continued to deliver the 95-dB noise for every response. An observer, coming into the session for the first time during this latter condition, might label these Ss "masochistic" or "self-punitive." An observer with some knowledge of the literature concerning punishment and aversive stimulation might suspect that the response which delivers the noise had previously served as a discriminative stimulus or a secondary reinforcer. Both observers, of course, would miss the true state of affairs. Here we have a situation in which the Ss had previously interpreted delivery of low-level noise bursts contingent on certain responses in an ambiguous learning situation as signaling the occurrence of a "correct" response. Given this history, they continued to emit this "correct" response, even when the noise was increased to a level which made it highly aversive. It appears that, in some cases at least, if aversive stimuli are delivered contingent upon responses which the S considers to be "correct," the result will be maintenance or even facilitation of the responses which deliver the aversive stimuli rather than suppression of those responses. Results of a study by Siegel & Martin (1966) are compatible with this interpretation. Siegel and Martin determined that the sound of a door buzzer was a relatively "neutral" stimulus, when the sound of the buzzer was delivered contingent on pushing one of two pushbuttons, and operating the other pushbutton had no consequence. However, when the sound of the buzzer was delivered contingent on disfluent speech responses by these same Ss, the frequency of disfluency decreased markedly. Here, then, we have the converse of the situation described earlier, that is, response-contingent delivery of a nonaversive stimulus which serves to decrease the frequency of responses which the S considers "incorrect."

In summary, then, it appears that the effects of response-contingent stimuli are a function of the response which they follow as well as of the characteristics of the response-contingent stimuli

Table 2
Time Between First Response and Learning of the Response Pattern for Ss Who Avoided or Delivered High and Low Noise Contingent on Responses

Condition	S Performance	N	Mean Time to Learning (Min)	Range (Min)
High Noise	Delivered Noise	2	13.61	11.23-15.99
High Noise	Avoided Noise	13	7.69	1.13-13.21
High Noise	Did Not Learn	2	—	
Low Noise	Delivered Noise	12	7.61	1.46-14.50
Low Noise	Avoided Noise	13	6.11	1.25-13.87
Low Noise	Did Not Learn	5	—	
High Noise*	Delivered Noise	8	2.21	1.05- 2.86
High Noise*	Avoided Noise	4	3.76	1.90- 5.12
High Noise*	Did Not Learn	0	—	

**Subsequent to low noise for Ss who learned to deliver low noise on every response.*

themselves. Aversive stimuli may not cause response suppression if they are delivered contingent on responses which the S considers "correct," and neutral stimuli may cause such suppression if they are delivered contingent on responses which the S considers "incorrect." The results of this study illustrate once again that the effects of response-contingent stimuli upon behavior cannot be predicted without knowledge of the S's previous experiences with those stimuli.

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Effects of excessive temperature change on contrast in temperature perception

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Contrast in temperature perception was investigated in two experiments to follow up a previous report of perceptual assimilation. The results suggest that perceptual assimilation does not occur; instead, large temperature shifts result in periods of tingling or numbness which appear to mask thermal sensations.

If a S adapts his left hand in a water bath maintained at 25° C and his right hand in a bath at 30° C, and then places both hands in a bath at 33° C, he will typically report that the left hand feels warmer than the right. This operation defines thermal contrast. A classical interpretation of this result is that during the interval of exposure to the adapting stimuli (25° and 30° C, respectively), the warmth threshold shifts to a lower intracutaneous temperature level in the left hand than in the right. Thus, upon transfer to the 33° C bath, the temperature gradient for the left hand is steeper than that of the right, and greater subjective warmth results.

A recent study which questions the simplicity of the contrast phenomenon has reported findings of the reversal of classical contrast (i.e., assimilation) in temperature perception (Egeth, Kamlet, & Bell, 1970). In the paradigm described above, assimilation would occur if the S reported that the right hand felt warmer than the left. Although Egeth et al offer no explanation for the assimilation phenomenon, they note that the occurrence of a contrast or assimilation response may depend on the overall range of temperatures spanned. In their study, each S reported a single comparative response between the two differently adapted hands immediately following exposure to the test stimulus. Subjective reports describing the independent sensations and the duration of the assimilation phenomenon were not made. It was the purpose of the present experiment to investigate these aspects of the phenomenon. Based upon our results, we would suggest that thermal receptors exposed to excessive temperature shifts may respond typically in accordance with the contrast phenomenon but that the initial response of such receptors may be masked by the excitation of nonthermal receptors caused by extreme stimulation.

EXPERIMENT 1

Method

Four female undergraduates from an introductory course in psychology at Florida Presbyterian College volunteered to participate in the experiment for academic credit. The stimuli were two aluminum plates. One plate, which served as the adaptation stimulus, was kept at a constant temperature of 42° C through the use of a constant-temperature water bath. The temperature of the other plate was regulated by a Komatsu thermoelectric freezing unit, and it served as the test stimulus. By holding this plate at 30°, 27°, 24°, 21°, and 18° C, five temperature ranges of 12°, 15°, 18°, 21°, and 24° C were established between the two plates. Both plates were arranged horizontally in front of the S.

The Ss participated individually in 1-h sessions and completed the procedures twice in separate sessions on different days. One session consisted of four tests at each temperature range. The five temperature-range conditions were presented in the same random sequence to all Ss following a short practice period. The basic procedure involved adapting the volar region between the fingertip and the last joint on a right-hand finger for 90 sec and then placing it and the corresponding unadapted finger of the left hand on the test plate. Ss then gave a descriptive and comparative report of the temperature sensations perceived in the two fingers. The test trial lasted until the S reported subjective equality of both fingers or until 10 sec had elapsed, whichever came first. In each range condition, four different fingers were adapted, thus allowing a 10-min recovery period for each finger between tests. If the S did not discriminate any difference in temperature between the two fingers during the entire test trial, that trial was repeated. Preliminary instructions emphasized the importance of accurate discrimination in each unique trial.

Results and Discussion

Responses were pooled for all Ss for each range condition. Three response measures were examined: (1) percentage of initial contrast reports, determined from the first discriminated difference between fingers; (2) percentage of discrimination reversal, indicated by reported reversal of the initial discrimination, and (3) percentage of final contrast reports, determined from the status of the discriminated difference prior to the end of the test period. Scores for these measures are presented as a function of temperature range in Fig. 1. Individual percentage scores for each S for each measure were then subjected to Friedman's nonparametric rank test. The hypothesis that the effects of temperature range were zero was