The buzzer as a primary aversive stimulus: I. Unconditioned acceleration and summation of conditioned and unconditioned acceleration

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Seven rats were given 1-min buzzer presentations during Sidman avoidance (Experiment 1). Four of these Ss with a classical conditioning history (light-shock pairings) were also given light presentations alone and light-buzzer presentations during avoidance (Experiment 2). The buzzer presentations increased avoidance rates (unconditioned acceleration) and the light-buzzer compound increased rates even further than either stimulus alone (summation effect).

In the course of an extended program of research attempting to replicate various Pavlovian phenomena in conditioned acceleration (Riess, 1969, 1970a, b), an effort was made to reproduce external inhibition (Pavlov, 1960), wherein a novel or "alien" stimulus, when cooccurring with an established CS, will greatly inhibit or even eliminate an established conditioned response.

The "conditioned response" chosen was increases in response rates which occur when a stimulus previously paired with an aversive UCS is superimposed on avoidance. Using the model of salivary conditioning, it was predicted that these increases (conditioned acceleration) could be eliminated or reduced if the CS was copresented with a second unfamiliar stimulus ("external inhibitor"). A 76-dB buzzer was used as the alien stimulus and, instead of producing the predicted inhibition of acceleration, resulted in even greater increases than could be elicited by the CS alone. The present two experiments are a follow-up on this preliminary finding.

EXPERIMENT 1: UNCONDITIONED ACCELERATION WITH A BUZZER UCS

Subjects

The Ss were seven male albino Wistar rats from the colony maintained by the Psychology Laboratory at the Galesburg State Research Hospital. Ss 1, 3, and 4B were experienced avoiders under conditions identical to those used here. Ss 4A, 6, 69, and 73 were holdovers from previous experiments in which they had extensive avoidance experience under conditions identical to those used here, as well as an unextinguished history of fear conditioning (light-shock pairings). All seven Ss were naive with respect to the buzzer.

Apparatus

The apparatus consisted of a modified Miller-Mowrer shuttlebox, a shock generator, and a scrambler, described previously (Riess, 1969), with the addition of a light masking noise. The buzzer was 76 dB, as measured by a Model 1551-A General Radio Corporation sound-level meter. A more detailed sound analysis was also undertaken with a Model 1564A sound and vibrator analyzer, a Model 1521B graphic level recorder, and a 1551C sound-level meter, all of General Radio Corporation.[1] The conclusion of this analysis was that the buzzer generated widely variable frequencies and intensities. Since the specific acoustic properties of the buzzer were thought to be critical to the behavioral effects obtained, the actual distribution of the intensities and frequencies is presented in Fig. 1.

Procedure

The seven Ss were given daily 30-min Sidman avoidance sessions with a response-shock (RS) interval of 30 sec, a shock-shock (SS) interval of 5 sec, and a shock intensity of 2 mA. Two 1-min buzzer presentations were made per session on a randomized basis. Ss 1, 3, and 4B were given five sessions, and Ss 4A, 6, 69, and 73 were given three sessions. A conditioned inflection ratio was calculated from the formula CIR = 4B/(A + 4B), where A (baseline) = responding during the 4 min preceding the buzzer and B = CS responding.

Results and Discussion

The results are presented in Fig. 2. All seven Ss except 4B showed a reliable avoidance acceleration to the buzzer, although the mean increases ranged widely from about 15% in S 6 to about 70% in Ss 4A and 73.

Since the data require little comment, only three observations need to be discussed: (1) the specific behavioral property of the buzzer responsible for the increases; (2) the specific acoustic property responsible; and (3) the relationship of the present phenomenon to other phenomena involving avoidance rate increases occurring in the presence of other noncontingent aversive events.

With respect to the first observation, the increases could be due to either the aversive or the novel stimulus properties of the buzzer or a combination of both. In this case the novel properties of the buzzer are ruled out entirely for the following reasons: (1) Two other novel stimuli were used during the experiment on external inhibition, an elimination of the masking noise and an innocuous-sounding (60-dB) clicker, both of which failed to elicit any increases at all or at least any of durability or magnitude comparable to those of the buzzer; (2) the high resistance to habituation, which characterizes the phenomenon, is contrary to the expected quick adaptability of behavior in response to repeated presentations of a novel stimulus (Pavlov, 1960). This resistance to

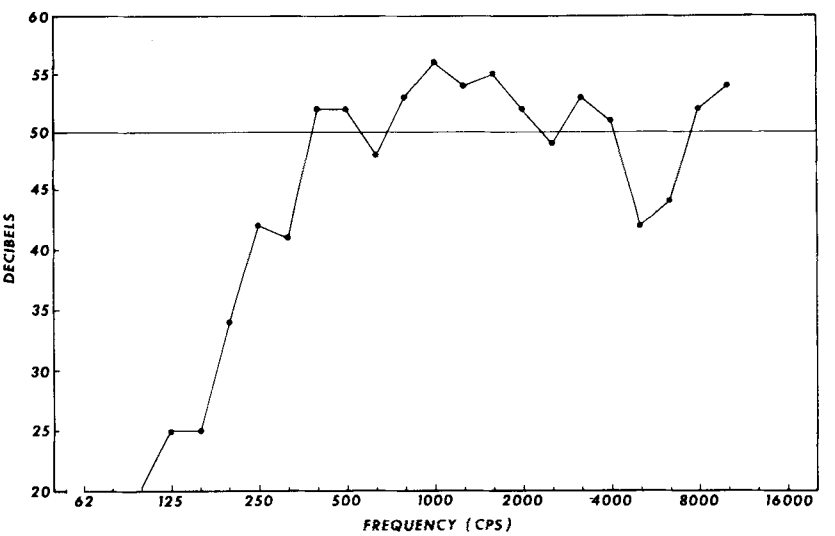

Fig. 1. Intensity (dB) and frequency (cps) distributions for the buzzer UCS.

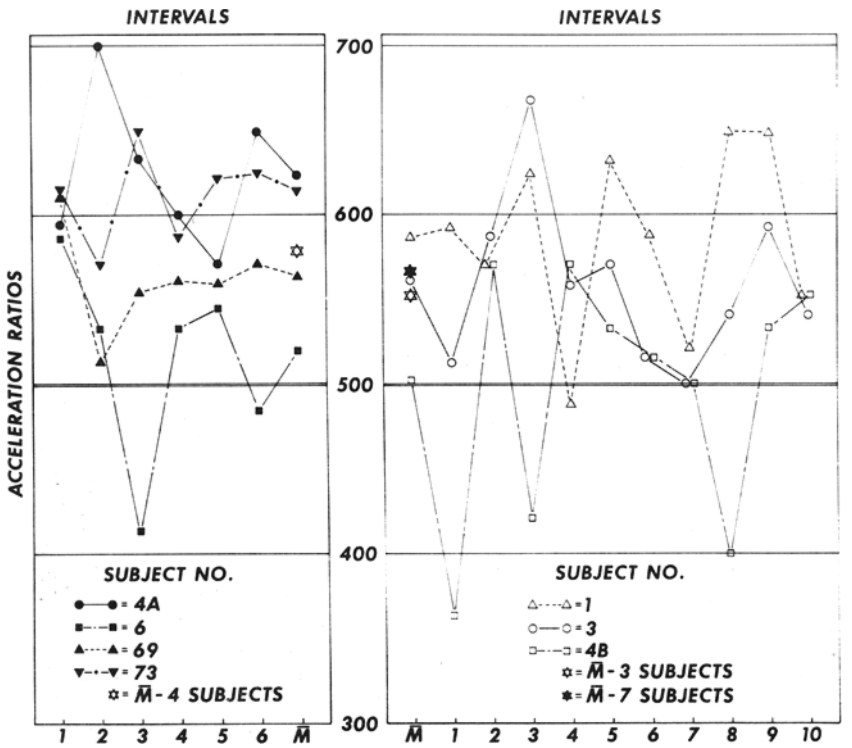

Fig. 2. Increases in avoidance rates during six 1-min buzzer presentations for four Ss (left) and for 10 presentations for three other Ss (right). A ratio of .500 represents no change in rate and .667 indicates a doubling of rate.

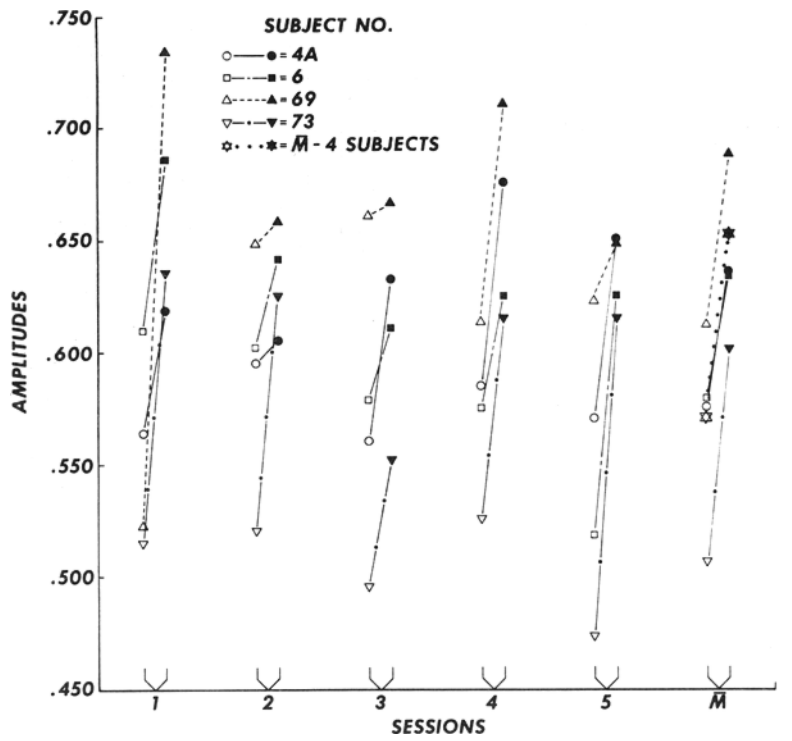

Fig. 3. Mean inflection ratios ("amplitudes") for four Ss for a conditioned aversive stimulus (light) and a compound conditioned and unconditioned aversive stimulus (dark).

habituation is evidenced by (a) a higher mean ratio (.575) for the final day than for the first (.566); (b) the mean for the first buzzer presentation (.562) equals that for the second (.560) within sessions, and (c) 47% of all buzzer responding occurred in the last half of the intervals. The interpretation that the aversive properties are responsible, on the other hand, is supported by the informal observation that the predominant reaction of the Ss to the buzzer appears to be fear, as evidenced by increased defecation, respiration, and hyperactivity during the presentations.

The specific acoustic property responsible for the behavioral changes observed appeared to be the auditory variability per se or the number of intensity and frequency changes per unit time, since the intensity as such is not sufficiently different from tone intensities in decibels routinely used in classical conditioning (LoLordo, 1967).

There appear to be two closely related phenomena in the literature. One is a form of conditioned acceleration first demonstrated by LoLordo (1967) in which it was shown that the usual acceleration of avoidance which occurs in the presence of a conditioned aversive stimulus previously paired with shock will also occur virtually undiminished in strength when the UCS has, instead, been a noxious auditory stimulus. This comparison is weakened somewhat, however, by the finding that the loud-noise UCS presented alone elicited suppression. The other related phenomenon appears to be the unconditioned acceleration elicited by presentation of unavoidable shocks (Sidman et al, 1957). The present study completes the circuit by showing that auditory aversive stimuli, which can elicit conditioned acceleration when the CS for them is presented during avoidance, will also do this on an unconditioned basis without any CS, when present for longer periods of time than normally occupied by a US.

EXPERIMENT 2: SUMMATION OF CONDITIONED AND UNCONDITIONED ACCELERATION

Having shown the buzzer capable of accelerating avoidance on an unconditioned basis, it remained to replicate the original finding in the external inhibition experiment.

Subjects and Apparatus

The Ss were those four of the original seven who had previous histories of classical conditioning (light-shock pairings) in the first component of a multiple schedule along with their avoidance histories. The apparatus was identical to that of the first study, with two 60-W lights

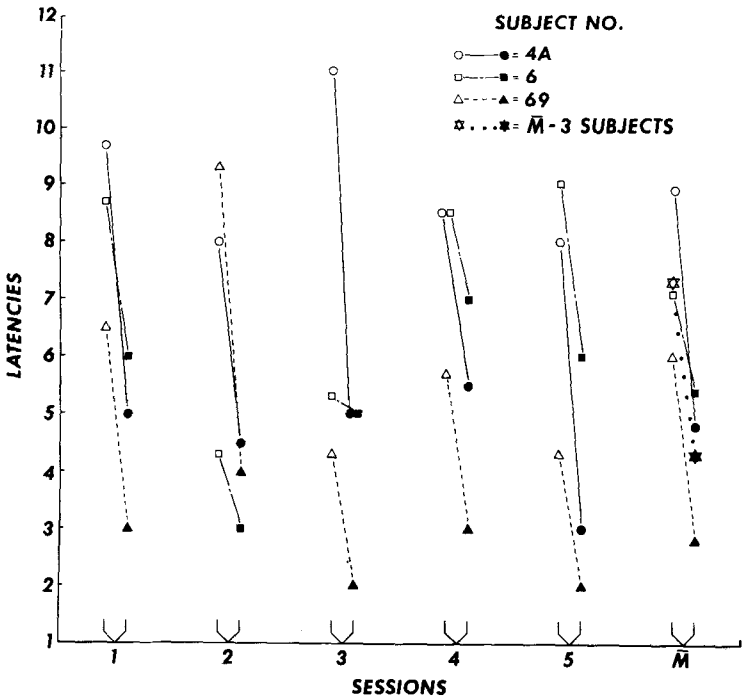

Fig. 4. Mean latencies for three light presentations (light) and two light-buzzer presentations (dark) for 5 days.

in either side of the shuttlebox ceiling.

Procedure

The procedures involved four Ss run for 5 days each in a multiple schedule. The first component (classical conditioning) consisted of eight light-shock pairings administered in a coterminous delay paradigm (intensity 2 mA). The CS-US interval was variable (VI 30 sec), with values of 5, 10 (2), 20, 30, 45, and 60 (2) sec administered in a random order. The intertrial intervals were 60, 90, or 120 sec, also in random order (VI 90 sec). Following this, the compartment divider, lowered to prevent abortive avoidances during classical conditioning, was raised, thereby serving as the exteroceptive stimulus signaling the onset of the next component. The second component consisted of Sidman avoidance with parameters identical to the first study. The avoidance was divided into 5-min blocks. The first 5-min block (warm-up) involved no exteroceptive stimuli. The CS (light) was presented during the fifth minute of each of the five remaining 5-min blocks. The buzzer sounded for the fifth minute of two of these five blocks, randomized so that each of the five intervals was equally represented after the fifth session. For each session, two inflection ratios were computed. The CS ratio used totals for the three light-only blocks and the ratio for the compound used the totals for the two light-plus-buzzer blocks. Since the three Ss in this experiment all had lengthy experience with the multiple schedule used in this study, including a previously established fear CR to the light, they were exposed to the terminal experimental conditions on the first day. The procedure for S 73 was identical to that for the other three Ss except that only one compound stimulus interval occurred per session, and latency data were not recorded.

Results and Discussion

The results are presented in Figs. 3 and 4.

The data require little comment. The quite elegant and reliable stimulus control obtained here was evidenced by the fact that all 20 sessions uniformly produced amplitudes to the compound stimulus which exceeded those to the CS alone. In addition, for all 15 sessions for which latency data were recorded, the mean latency to the CS alone exceeded that for the compound stimulus. The results thus clearly demonstrate a summation of conditioned and unconditioned acceleration, as well as replicating the classical inverse relation between latencies and amplitudes in salivary conditioning.

Although the buzzer alone was not compared with the compound in this study, it is possible to obtain an estimate of this comparison by returning to Fig. 2. The mean acceleration ratio for the same four Ss to the buzzer alone was about .580, and the mean ratio to the light alone in Experiment 2 was about .570. According to Pavlov's old rules on additive summation, salivary CRs to compounds can be predicted as a simple additive function in the special case where CS_1 and CS_2 both elicit approximately equal CRs. Applied to the present results (after the assumption of a "zero CR" = .500 is made), the increases above .500 for the two stimuli singly (.80 for the buzzer and .70 for the light) can be added to .500 (no CR) and the results for the compound in Experiment 2 (.650) are predicted exactly as they were obtained.

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NOTE

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