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Some effects of type of auditory CS on self-punitive running in rats

BRIAN M. KRUGER and PATRICK E. CAMPBELL
Wright State University, Dayton, Ohio 45435

Self-punitive behavior was demonstrated in prepunishment speeds during extinction following shock escape training in a straight runway under buzzer-CS and tone-CS conditions. Relative to the tone, the buzzer enhanced punished running (shock in the last half of the runway) and nonpunished running. These results extend the findings of Myers (1962), who reported better avoidance conditioning with a buzzer than with a tone. Self-punitive behavior, defined as the difference between punishment conditions with faster running under punishment conditions, was not significantly enhanced by the buzzer. These results do not support the suggestion (Delude, 1973) that self-punitive behavior may be uniquely affected by the use of a buzzer CS.

Numerous experiments have reported facilitative effects of punishment during extinction following electric shock escape training in a straight runway (see Brown, 1969; Melvin, 1971, for reviews). Self-punitive behavior, as the phenomenon has been labeled, is demonstrated during extinction if rats receiving self-administered shock punishment after leaving the start-box show enhanced running speeds or increased resistance to extinction relative to nonpunished controls.

The most frequently cited explanation for self-punitive behavior was proposed by Mowrer (1947). Self-punitive running, according to this view, is maintained by fear conditioned to stimuli in the startbox during training. This fear provides the motivation for running during extinction and is maintained by the onset of shock punishment in the alley. The running response is maintained by the reinforcing reduction in fear that occurs when the goalbox is entered and fear-eliciting stimuli are terminated.

Delude (1973) has questioned the frequent addition of a buzzer as a conditioned stimulus (CS) in self-punitive behavior studies. When used, the buzzer is typically turned on a few seconds prior to the start of each trial and turned off as the rat enters the goalbox. Delude suggests that a buzzer may not be an initially neutral stimulus; he implies that running during extinction may be maintained by unconditioned properties of the buzzer rather than by fear conditioned to the buzzer. Delude also implies that self-punitive behavior (the difference between self-punished and nonpunished running) may be enhanced by using a buzzer; however, he does not indicate how the unconditioned properties of a buzzer CS might favor maintenance of self-punished running relative to nonpunished running.

In support of his assertion that unconditioned properties of the buzzer may affect self-punitive behavior, Delude (1973) cited Myers (1962), who reported better avoidance conditioning with a buzzer than with a tone. The experiment to be reported here was designed to assess whether a similar difference between buzzer and tone can be demonstrated for self-punished running, nonpunished running, and/or self-punitive behavior. Clearly, the buzzer might enhance both self-punished and nonpunished running without affecting self-punitive behavior, defined as the difference between self-punished and nonpunished group performances with greater persistence or stronger responding under self-punishment conditions.

In the present experiment rats were given brief escape training, half with a buzzer and half with a tone of equivalent physical intensity. In extinction, half of each acquisition group received nonpunishment conditions, and half received punishment conditions. All rats received the same CS type during extinction as they had during acquisition.

METHOD

Subjects

Forty male albino rats of Sprague-Dawley descent from the colony maintained by the Department of Psychology at Wright State University were used. The animals ranged in age from 150 to 190 days. All were individually caged and maintained with free access to water and Purina Laboratory Chow on a 14-h light, 10-h dark cycle. All rats were run during dark phases.

Apparatus

The apparatus consisted of a two-compartment (upper and lower) startbox, straight alley, and goalbox. The lower startbox and alley had grid floors (2.4-mm-diam stainless steel rods spaced every 1.3 cm). The walls and subfloors (3.2 cm below the grid) of the lower startbox and alley were translucent white plastic (Plexiglas), as was the lid of the upper startbox. The lids above

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the alley were transparent plastic. The walls and floor of the goalbox were painted in a black-and-white checkerboard pattern with 2.5-cm squares. The goalbox lid was opaque black plastic except for the translucent cover over the goalbox light centered in the lid. The goalbox light provided an average illumination level of approximately .16 lx in the goalbox. Similarly, a light in the lid of the upper startbox, offset 8.9 cm toward the alley, provided an average illumination level of 10.3 lx in the upper startbox. This light provided the subject with a stimulus for orienting toward the alley within the otherwise uniformly structured upper startbox.

The startbox was divided into an upper gray compartment (20.3 cm long x 8.9 cm wide x 17.8 cm high, inside) and a lower compartment (30.5 cm long x 10.2 cm wide x 22.9 cm high, inside) by a gray metal trapdoor-like floor. This floor was hinged 22.9 cm above the grid. When released, the floor swung down and became the back wall of the lower starting area. The light in the upper startbox lid was turned off when the trapdoor fell. Activation of a series of incandescent lights below the alley and startbox produced a uniform illumination level of approximately 6.5 lx. For shaping trials the upper startbox could be placed over the alley adjacent to the goalbox or at a distance of 61 cm from the goalbox.

The runway (122 cm long x 10.2 cm wide x 20.3 cm high, inside) was physically uniform throughout. Sets of three photocells (3.2, 6.4, and 8.9 cm above the grid) and associated infrared sources were positioned at the beginning, middle, and the end of the alley. By means of associated electronic equipment (Kruger, 1974), measurements to the nearest .01 sec were made of starting time (the interval from the release of the trapdoor until the interruption of any one of the three horizontal beams falling on the first set of photocells) and the time elapsed in traversing each of the two 61-cm alley segments.

An automatic black guillotine door (Kruger, 1979) separated the alley from the goalbox (20.3 cm high x 10.2 cm wide for 5.1 cm adjacent to the door and 20.3 cm wide for the remaining 40.6 cm). Single photocells, employed in sensing the rat's location and located 3.2 cm above the floor, were spaced every 5.1 cm in the goalbox beginning 2.5 cm inside the doorway plus one at 1.3 cm inside the doorway. The door closed in less than .6 sec when the rat entered the goalbox far enough to first obstruct and then reinstate the first infrared beam inside the goalbox. The door stopped and locked 1.3 cm above the grid to prevent pinching the rat's tail if it was in the doorway. The alley and startbox lights were turned off when the door closed to prevent light from entering the goalbox through the gap below the door.

The startbox grid and the two halves of the alley grid could be separately activated for electric footshock administration. The output lines of the 70-V ac shock source were connected to alternate grid bars with a 10-kohm resistor connected in series with the grid. The rear wall of the lower startbox (the metal trapdoor) was connected to one side of the startbox shock source to reduce the probability of a rat's escaping shock by leaning against this wall with its forepaws.

The rats were run in a carpeted sound-reduction room. Ceiling-mounted speakers provided background white noise, raising the noise level from approximately 54 dB to 72 dB within the alley (General Radio Company Type 1565-A sound level meter, C scale). A buzzer mounted externally on the rear wall of the upper startbox raised the sound level to 93 dB when activated. Similarly, a 1,000-Hz tone, when presented via a speaker mounted behind the lower startbox, also raised the sound level to 93 dB. The room was dark except for low-level ambient light from the illumination sources employed for the apparatus. Illumination provided in all sections of the apparatus prevented dark adaptation in the rats, while the darkened room reduced the likelihood of influences on behavior by visual stimuli external to the apparatus.

Procedure

Fifteen trials were administered in acquisition with shock present throughout the grid areas. On each trial the rat was placed in the upper startbox and dropped after a 10-sec delay. For a random half of the rats, onset of the buzzer occurred 2 sec before the drop; for the other half, onset of the tone occurred 2 sec before the drop. Unseen by the rats through the opaque trapdoor, the lights for the lower startbox and alley were turned on 2 sec before the drop on all trials in all places. These lights and the buzzer or tone, if present, were terminated when the door to the goalbox began to close. The rat remained in the goalbox for 40 sec after door closure. The end of this interval was signaled to the experimenter by a small lamp. Approximately 10 sec elapsed in removing the rat from the goalbox, placing it in the upper startbox and pressing a switch to begin the 10-sec delay. The latter interval completed the 60-sec interval from goalbox door closure to drop. The upper startbox was placed adjacent to the goalbox for the first two trials and 61 cm from the goalbox for the next three trials. Speed measures were not taken during these five shaping trials. The remaining 10 trials were the full length of the alley.

Eighty trials were administered in extinction with essentially the same procedures as used in acquisition. For a random half of the rats in each of the acquisition groups, there was no shock in the startbox or alley during extinction. For the remaining rats there was shock in the last 61-cm section of the alley but not in the first alley segment or in the lower startbox.

On each extinction trial, if the rat did not enter the goalbox within 30 sec after the drop, the rat was removed from the alley or startbox and placed in the goalbox for the 40-sec goalbox confinement interval. Trials in this phase were terminated after four successive failures to leave the startbox within 30 sec or after 80 trials. Arbitrary times of 30 sec were entered for all measures not obtained on criterial or precriterial trials and for all trials not actually run so that each subject had 80 times recorded for each measure for this phase.

RESULTS

Acquisition

None of the three speed measures taken during acquisition (see Figure 1) was significantly affected by CS type (buzzer vs. tone). There were no significant differences between any of the four groups on the final block of acquisition, indicating that the groups were performing equivalently at the end of acquisition.

Extinction

First-segment prepunishment speeds were faster in extinction for the buzzer CS than for the tone CS for the last five blocks for both punished and nonpunished conditions [$F(1,36) = 22.10$, $p < .001$, and $F(1,36) = 12.52$, $p < .005$, respectively]. The indication from inspection of the middle section of Figure 1 that self-punitive behavior (the difference between punished and nonpunished conditions) developed over trials is supported by the finding of a significant interaction between extinction punishment conditions and trial blocks [$F(15,540) = 5.21$, $p < .001$]. The occurrence of self-punitive behavior was further substantiated by comparing punishment conditions for the last five blocks of extinction. Punished tone-CS rats ran faster than nonpunished tone-CS rats, and punished buzzer-CS rats ran faster than nonpunished buzzer-CS rats [$F(1,36) = 7.95$, $p < .01$, and $F(1,36) = 15.85$, $p < .001$, respectively]. However, the magnitude of the self-punitive effect (the difference between punishment and

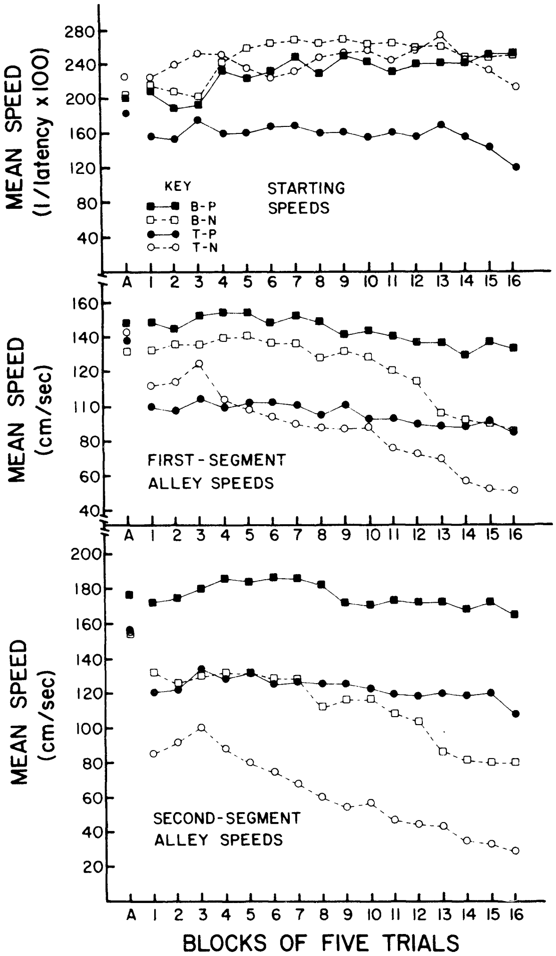

Figure 1. Mean speeds for the last block of acquisition and for the 16 extinction blocks for the punished tone-CS group (T-P), the nonpunished tone-CS group (T-N), the punished buzzer-CS group (B-P), and the nonpunished buzzer-CS group (B-N).

nonpunishment groups) was not significantly different for buzzer and tone conditions ($F < 1.0$) for the last five blocks. Analysis of second-segment punishment-area speeds yielded essentially the same results as for pre-punishment alley speeds.

All buzzer-CS rats ran all 80 trials in extinction; therefore, self-punitive behavior was demonstrated with an equal number of rats in each condition and no arbitrary speed scores. Three punished tone-CS rats and two nonpunished tone-CS rats extinguished prior to Trial 80. These five rats ran 7, 17, 75, 23, and 71 trials, respectively, prior to the first of the four consecutive criterial trials.

Analysis of the extinction starting speeds showed that the buzzer groups did not differ significantly ($F < 1.0$). However, the punished tone-CS group started significantly more slowly than the nonpunished tone-CS group [$F(1,36) = 7.41$, $p < .01$]. The slower starting speeds for the punished tone-CS rats, however, are not attributable to more arbitrary speed scores for punished tone-CS rats than for nonpunished tone-CS rats, since the mean starting speeds for the five punished tone-CS rats running all 80 extinction trials (data not shown) were slower than the mean speeds for the eight nonpunished tone-CS rats (including some arbitrary scores) for every trial block.

DISCUSSION

The type of CS had no significant effect on acquisition performance at the end of the brief training given. However, the buzzer enhanced punished starting speeds and both nonpunished and punished first- and second-segment alley speeds during extinction. Only nonpunished starting speeds were unaffected by the buzzer/tone variable. Thus, generally, the buzzer/tone effect has been extended to punished and nonpunished extinction following escape training.

Self-punitive behavior was demonstrated in both first- and second-segment running speeds for both buzzer-CS and tone-CS conditions. However, the magnitude of the difference between punished and nonpunished groups was unaffected by the type of CS. Thus, these results do not support the view that self-punitive behavior is uniquely affected by the use of a buzzer CS.

All of these results, including the slow starting of punished tone-CS rats, may be attributable to different unconditioned reactions to the buzzer and tone. Myers (1962), in discussing reasons for poorer avoidance performance with a tone CS than with a buzzer CS, cites evidence (Myers, 1959) that poorer performance with the tone may be due in part to elicitation of freezing by the tone and elicitation of startle by the buzzer. In the present situation, as in avoidance training, freezing would be incompatible with and facilitate starting and running. Another possible explanation (Myers, 1962) of better performance under buzzer than tone conditions that seems potentially applicable to the present results is that the buzzer may be more similar to shock than is the tone; thus, responses conditioned to shock should generalize to a buzzer more readily than to a tone, and responding should be better with a buzzer.

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