Effects of some stimulus probes upon negatively accelerated conditioned suppression responding*

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The stability of negatively accelerated response rates during a preshock stimulus was assessed with neutral tone and shock probes and through manipulations of the temporal parameters of the preshock stimulus. The results suggest that these typical response patterns during a preshock stimulus depend upon an intact preshock stimulus-shock relationship and that an inhibition of delay interpretation of such behavior may be inappropriate.

When conditioned suppression training is extended considerably beyond the point of initial acquisition (e.g., 100-150 trials), the uniform response rate during the preshock stimulus (Kamin, 1965) gives way to a negatively accelerated response rate. Anticipated by Estes & Skinner (1941) and first demonstrated by Azrin (1956), the temporally graded preshock response rates have been reported by several other investigators (Blackman, 1968; Brady & Ross, 1960; Davis, McIntire, Ochs, & Cohen, 1967; Hendry & Van Toller, 1965; Lauener, 1963; Millenson & Hendry, 1967; Stein, Sidman, & Brady, 1958; Zill, 1967). In addition, Azrin (1956) has reported that pigeons develop negatively accelerated responding during a stimulus that precedes response-contingent shock (punishment) and noncontingent shock (conditioned suppression) procedures. Hoffman & Fleshler (1965) found that such rate curvatures develop with the punishment procedure but reported that yoked control pigeons did not exhibit the negatively accelerated preshock response pattern. When the preshock stimulus is of variable duration (Davis et al, 1967; Millenson & Hendry, 1967) or when electric shock is delivered variably during the preshock stimulus interval (Azrin, 1956), the negative response gradient does not appear. However, neither increased shock intensities (Millenson & Hendry, 1967) nor decreased deprivation levels [higher body weight and shorted deprivation (Carman, 1969)] appears to disrupt the temporal characteristic of the preshock stimulus responding, although both manipulations substantially reduce the absolute rate of responding.

Most investigators have assumed that conditioned suppression results from the interference by respondents, conditioned

to and elicited by the preshock stimulus, with the emission of the referent operant. This assumption has been accepted without question (Davis, 1968), questioned from a peripheral interference viewpoint (Lyon, 1968), or suggested as an inevitable consequence of the Pavlovian "fear" conditioning paradigm (Kamin, 1965; Maier, Seligman, & Solomon, 1969). The negatively accelerated preshock response rate that develops with extended conditioned suppression training has been interpreted as evidence for Pavlovian "inhibition of delay" (Hendry & Van Toller, 1965; Millenson & Hendry, 1967; Lauener, 1963). Questions arising from such an interpretation focus upon the stability of the referent behavior when subjected to stimulus circumstances other than those used to develop and maintain the temporally graded preshock stimulus response rates. The present study investigated the susceptibility of the negatively accelerated response rate during the preshock stimulus to disruption by neutral tone and electric-shock probes and changes of the temporal parameters of the preshock stimulus.

METHOD

A single-lever Scientific Prototype rodent test cage, contained in an insulated

wooden box, served as the experimental chamber. A continuous 50-dB white-noise background was present during all experimental sessions. Programming and recording was accomplished by standard electronic and electromechanical components contained in an adjoining room.

Four 150-day-old male rats were reduced to and maintained at 85% ad lib body weight. All Ss were trained to leverpress under 22-h food deprivation for 45-mg Noyes rodent pellets. Reinforcement was gradually shifted from CRF to a VI 1 schedule, and responding was allowed to stabilize over eight daily 90-min training sessions. The 90-min VI 1 program, preceded by 22-h food deprivation, remained in effect throughout the experiment. On each of the following 3 days, Ss were exposed to four 3-min presentations of an illuminated 7-W white lamp mounted in the experimental chamber. Conditioned suppression training followed these stimulus adaptation sessions. After the S was placed in the experimental chamber, the 3-min light was presented at four regularly spaced 20-min intervals and terminated with 0.5 sec of 25-V ac scrambled foot shock. The shock intensity was increased in 10-V increments between two-session blocks to a terminal intensity of 75 V. Twenty-nine training sessions were given at the 75-V shock intensity. Cumulative records were taken of all sessions.

After the negatively accelerated response rate during the preshock stimulus had developed and stabilized for all Ss, their performances on certain predetermined trials from the 24th through the 29th 75-V sessions were systematically probed as follows. In a counterbalanced design a 700-Hz tone of either 40 or 20 dB (above the ambient 50-dB background) was presented for 1 min from the back or front of the experimental chamber during either

Fig. 1. Cumulative record segments of the tone probe effects upon negatively accelerated preshock stimulus and intertrial performances during Session 24.

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Fig. 2. Effects of shock probes upon negatively accelerated preshock stimulus performances during Session 29.

the 1st or 3rd min of the preshock stimulus. The tone probes were presented on the second and fourth trials of the 24th session for all Ss. In addition, the effects of the tone intensities and source locations upon intertrial responding was assessed during Session 24. On the second and fourth trials of Session 29, electric shock (75 V at 0.5 sec duration) was presented 20 sec after onset of the preshock stimulus and was followed 160 sec later by the preshock stimulus offset plus the regularly scheduled shock. During the second trial of Session 26, the preshock stimulus was terminated 20 sec after onset with the shock occurring at its regularly scheduled time 160 sec later. On Trials 2 and 4 of Session 27, the preshock stimulus was maintained for an additional 2 min (total preshock stimulus duration of 5 min) with shock occurring only at the regularly scheduled time (i.e., 3 min from the preshock stimulus onset).

RESULTS AND DISCUSSION

The effects of the tone probes upon the preshock stimulus and intertrial performances are shown in the cumulative record segments of Fig. 1 for S 1. Figure 2 depicts the effect of brief shock that occurred 20 sec after onset of the preshock stimulus upon the performances of Ss 1 and 2. The effect of the 20-sec preshock stimulus upon the performance of Ss 3 and

Fig. 3. Effects of 20-sec preshock stimulus upon performances during Session 26.

4 are displayed in Fig. 3. Figure 4 shows, for Ss 1 and 2, the effect of extending the preshock stimulus 2 min beyond its usual time of termination. While the effects of the stimulus probes presented here were selected for their clarity, the results are consistent with and representative of the probe effects upon the performances of all Ss.

For S 1 (Fig. 1) as for Ss 2, 3, and 4, the tones exerted no noticeable effect upon responding, regardless of their intensity, source location, or temporal location during the preshock or intertrial performances. The negatively accelerated response rate of S 1 in Fig. 2 appeared to be disrupted by the shock probe, but this result was an isolated instance and the shocks were not observed to disrupt the typical preshock stimulus performance for other Ss. The 20-sec preshock stimulus did not control reduced responding during the period of its duration or through the following 160 sec to the termination of the 3-min interval by shock for any S. Following shock delivery at the end of the usual 3-min preshock stimulus interval (Fig. 4), a brief run of responding occurred, but this was followed by uniform and complete suppression until the preshock stimulus terminated. This effect was quite consistent for all Ss. These results suggest that the negatively accelerated preshock response rate is quite resistant to disruption by the probe stimuli used in this investigation. Hendry (1967) reported the "disinhibition" of conditioned suppression using a differentially conditioned inhibitory stimulus, but the present study offers no evidence for disinhibition by stimuli which should qualify as Pavlovian external inhibitors. The tone probes had no disruptive effect upon the temporally graded preshock stimulus response rates, nor did they disrupt intertrial responding. Later investigation has indicated a mild and transitory disruptive effect by such stimuli early in VI training, but rats with extensive VI histories appear to be completely unaffected. The preshock stimulus onset does not appear to initiate a temporal discrimination independently maintained in absence of the preshock stimulus itself (Fig. 3). Likewise, shock that occurs after only 20 sec of the preshock stimulus interval does not terminate the temporal discrimination initiated and maintained by the preshock stimulus (Fig. 2).

The temporal pattern of responding during the preshock stimulus appears to be controlled exclusively by a "long" and intact preshock stimulus that terminates with shock, although the suppressive aspects of the preshock stimulus are more prepotent than are the "safety" aspects of

Fig. 4. Effects of 5-min preshock stimulus upon negatively accelerated preshock stimulus performances during Session 27.

either the termination of the preshock stimulus interval as based upon the temporal discrimination or shock offset (Fig. 4) (cf. Leaf, 1966). How any temporal discrimination may be mediated in absence of exteroceptive "clock" cues cannot be answered at present, but it is suggested that an inhibition of delay explanation may be inappropriate.

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testing taking place from October 5, 1969 to January 11, 1970. The laboratory's overhead lights were turned on during most of the daylight hours and during night-time testing.

SUBJECTS

Isolates

Nine of 16 females survived being separated from their mothers at birth and reared in social isolation for 3 months. The female neonates were released from the foetal membranes, dried by the E, and placed in individual plastic boxes (12 x 12 x 12 in.). Each box had a heating pad on the floor. Flood lamps (150-W) were placed 3 ft above the boxes and were constantly turned on during the pup's first week of life. During the first 2 weeks, the pups were periodically hand-fed Mead Johnson Enfamil. In addition, a dish of Enfamil was present in each box at all times. Between Days 21-25 the females were placed in rabbit cages that were lined with aluminum foil. Starting at 95-111 days, the females were manually examined each night for lordosis. Following the first display of the lordotic response, the female was given a sexually potent male for the night. Until adulthood, therefore, these females had neither seen nor had physical contact with a congener. Seven of the nine females became pregnant. Two of the seven died during the experiment, leaving an experimental group of five.

Mother Reared

Ten pregnant guinea pigs were purchased from a commercial breeder. Eight of these females survived pregnancy and parturition and constituted the mother-reared group.

PROCEDURE

The Ss and their offspring were observed

Effects of social isolation until adulthood on maternal behavior in guinea pigs*

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Five female guinea pigs were separated from their mothers at birth and reared in social isolation until adulthood. Following impregnation and parturition the maternal behavior of these females was compared to that of a mother-reared group. No differences were found on nursing time, nursing posture, pup-oriented responses, or on weight gain of offspring.

Thoman & Arnold (1968) developed a method for maintaining newborn rats in an incubator. Using this technique, 17 Holtzman albino females were reared in isolation for Days 1-25. For Days 26-84 the females were housed individually. On Day 85 males were placed with the isolates and left until the females were found to be pregnant. Following parturition the maternal behavior of these females was found to differ little from that of females reared in groups.

Arling & Harlow (1967) separated female rhesus monkeys from their mothers at birth and reared them in social isolation for 10-24 months. These females, in contrast to the rat isolates, were found to be deficient in the basic patterns of maternal behavior. In general, the rhesus monkey isolates were indifferent or abusive to their offspring.

The purpose of the present study was to examine the effects of social isolation on the maternal behavior of a third mammal, the guinea pig.

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MAINTENANCE

The 13 Ss and their offspring were housed in standard rabbit cages with guinea pig chow and water available ad lib. The animals were on a natural light cycle with

Fig. 1. Mean percentage of nursing time over the 4 weeks of observation.