THE PRESENCE OF A TEMPORAL DISCRIMINATION IN THE CONDITIONED EMOTIONAL RESPONSE WITH HUMANS^{1, 2}

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Six college students participated in matching-to-sample tasks. Conditioned emotional response (CER) training consisted of pairing a tone with a "painful" level of shock. Three of the subjects demonstrated response suppression, one subject showed facilitation, and two showed no change. Analysis of response rate during the tone interval indicated that, for those subjects who showed response suppression, the decrease in response rate was greatest immediately before onset of the unconditioned stimulus. This temporal discrimination was similar to that obtained with infrahumans.

Research in the area of the conditioned emotional response (CER), using humans as subjects, has failed to show the same reliable effect as has been obtained with infrahumans. Kanfer (1958a, b) reported a slight, but significant facilitory effect of the CER paradigm on rate of free verbalization. Edelman (1965), using an eight-stimulus matching task, reported that of his subjects, one showed response suppression, two showed response facilitation, and three showed no change from baseline. Sachs and May (1967) found that CER procedures failed to change their subjects' rate of lever pressing. Wherry and Curran (1966), using a color matching task, reported a slight decrement in correct performance as the time of shock onset approached.

The differences reported in the previous studies may be due to the different types of responses used, varying from a simple bar-press to an eight-stimulus matching task. The only evidence for response suppression occurred when the CER paradigm was superimposed on complex behavioral tasks (Edelman, 1965; Wherry and Curran, 1966). The present study examined the CER with humans

while the subjects were engaged in tasks of equal or greater complexity than those previously cited.

METHOD

Subjects

Three male and three female undergraduate students from The Florida State University were selected from a pool of students who responded to a posted request for long-term subjects. All reported no history of cardiac disorder, high blood pressure, or epilepsy.

Apparatus

The stimulus consisted of eight configurations constructed so that 90° rotations would give 32 perceptually distinct patterns. The eight configurations used are presented in Fig. 1. Task complexity was increased by increasing the number of stimuli to be matched. Levels of task complexity were 8, 16, and 32 stimuli.

The subjects were seated in a room facing a 21 in. (0.53 m) by 26.5 in. (0.67 m) screen made of 0.010 in. (0.254 mm) rigid vinyl, produced by Transilwrap. Slides were projected by a Davis Scientific PP-153 Slide Projector. Two toggle switches, 42 in. (1.07 m) apart, were mounted on the bottom of the table on which the screen and projector rested. Both switches had to be simultaneously depressed to change slides.

The response apparatus consisted of two double-banked panels. Eight toggle switches, located 2.75 in. (69.85 mm) apart, were

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Fig. 1. The eight stimulus patterns for the matching-to-sample task in the 0° position. Rotations of 90° , 180° , and 270° produced 32 perceptually distinct stimulus configurations.

mounted on each bank. One of the double-banked panels was on each side of the screen.

For the eight-stimulus task, only the eight stimulus configurations in the 0° position were mounted on the response banks, with two of these stimuli being randomly assigned to each bank. For the 16-stimulus task, there were four stimuli per response bank. This was accomplished by randomly selecting one of the remaining possible rotations of each of the original eight stimulus configurations and then randomly assigning two of these additional stimulus configurations to each response bank. The remaining 16 stimulus configurations were randomly placed above the available switch positions for the 32-stimulus task.

Conditioned stimulus and unconditioned stimulus. The conditioned stimulus (CS) was a 2100-Hz tone, produced by a General Radio Oscillator, and amplified to a power of -25 db. The reference intensity was 0 db = 1 milliwatt at 600 ohms. The CS was delivered via a 12 in. (0.305 m) speaker, located 4.5 ft (1.37 m) directly in front of the subject, but hidden from view by the projection screen.

The unconditioned stimulus (UCS) was a 0.75-sec dc shock, produced by a Variac and a rectifier, delivered to the subject through finger-tip electrodes. Both leads of the shock circuit were fused between the rectifier and the subject with a 5-ma fuse as a safeguard against any unexpected power surge.

The intensity of shock to be delivered was individually determined for each subject using an ascending method of limits. Separate thresholds were obtained for right and left hands. A Variac setting of approximately 5 v above the level at which each subject reported feeling

a "painful" shock was used as the intensity of the UCS. The range of intensities for the six subjects was 1.8 to 3.2 ma (55 to 95 v). Thresholds were initially determined during the first day on which each subject participated in the experiment and were randomly rechecked throughout the course of the experiment. Intrasubject variation in "pain" thresholds was less than 5 v and did not show a directional trend during the course of the experiment. Thresholds were always redetermined at the beginning of a session and with the slide projector off.

All scheduling and recording were accomplished by electromechanical devices located in a separate, sound-attenuating room.

Procedure. Electrodes were placed on the second and third fingers of each hand and held in place with rubber finger tips. Subjects were told that the electrodes were used for recording physiological data and for administering shock. Subjects were then shown how to present the stimuli to themselves and how to respond. Responses were reinforced on a VI 2-min schedule, with reinforcement indicated on a point counter mounted beside the screen to the right of the subject. At the conclusion of each session, each subject received 5¢ for each point obtained on the counter. In addition to these daily reinforcers, each subject received a \$1.00 bonus on Friday if no sessions had been missed during that week, and a bonus of \$5.00 for every 20 consecutive sessions without an absence.

Sessions lasted approximately 60 min, during which each subject was to match the stimulus that appeared on the screen by pressing the response key with the picture of the correct stimulus above it.

Three dependent measures were recorded as each subject performed. Response latency was the amount of time between the presentation of a stimulus and the occurrence of the matching response. Stimulus presentation time was the amount of time between the occurrence of the matching response and the presentation of the next stimulus. Both response latency and stimulus presentation time were recorded to the nearest 0.5 sec. Response rate was the total number of stimulus presentations and responses emitted in a 45-sec period.

Baseline training. Each subject began with the eight-stimulus task. Baselines of performance were obtained by taking 10 probes per

session, each probe consisting of two consecutive 45-sec periods. Neither the tone nor the shock was presented during a probe but the first period was treated as the pre-tone period (A) and the second period was treated as the tone period (B). The formula $(A - B)/(A + B)$ was used to compute suppression ratios.

A subject's level of performance was considered stable when for a period of four consecutive days none of the mean daily ratios for the dependent measure was $> \pm 0.05$, and in addition, the ratios from no more than 5% of the individual probes during this four-day period was as large as ± 0.20 .

After performance had stabilized, each subject was presented with five trials of the tone alone to test for pseudoconditioning. If pseudoconditioning occurred (mean ratio $> \pm 0.05$), continued tone presentations were delivered with five presentations per session until it extinguished.

Conditioned emotional response training. A conditioned emotional response (CER) trial consisted of the presentation of the CS for a 45-sec duration, with CS termination being paired with the "painful" electric shock. Shock was randomly dispersed in the session for a total of seven sessions. Additionally, for comparison, responding was measured during five equivalent periods when the stimuli were absent (Baseline).

After completing CER procedures for the eight-stimulus task, each subject was trained to the 16-stimulus task. Baseline and Shock procedures for the 16, and finally the 32-stimulus task, were identical to those of the eight-stimulus task.

RESULTS

The mean number of responses for successive 15-sec intervals for each of the six subjects during Baseline and shock conditions is presented in Fig. 2. The period from -45 sec to 0 sec was the pre-tone period, while the period from 0 sec to +45 sec was the tone interval. Subjects 5 and 6 showed no change in response rate as a function of CER training, Subject 1 showed a slight facilitation in response rate, and Subjects 2, 3, and 4 showed response suppression.

The pattern of response suppression for Subjects 2, 3, and 4 was consistent with the reported temporal discrimination cited by Azrin (1956) and by Millenson and Hendry

(1967). Two of the three subjects who showed response suppression in the present study did not show the consistent linear decline that Millenson and Hendry reported. Subjects 2 and 3 did show a temporal discrimination that was accented during the 15-sec interval immediately before shock onset. However, their response patterns during the tone interval did not show a continued decrease in responding for the second 15-sec interval, relative to the decrease in responding during the first 15-sec interval, that was shown by Subject 4.

DISCUSSION

Within the experimental design of the present study, the results indicated that the CER may be obtained using human subjects. However, the magnitude of the CER was slight and the procedural effects were inconsistent across subjects. In those subjects who showed response suppression, a temporal discrimination in which response rate decreased as UCS onset approached was noted. This finding is consistent with CER behavior in other species (Azrin, 1965; Millenson and Hendry, 1967).

An observation of interest is that for Subjects 2, 3, and 4, the amount of response suppression appeared to increase as task complexity increased. With the eight-stimulus task, Subject 4 showed clear suppression and Subject 3 showed slight suppression. When the task complexity increased to 16 stimuli, Subjects 3 and 4 showed clear suppression and Subject 2 showed some suppression. For the 32-stimulus task, all three subjects visibly demonstrated response suppression. It is possible that the increase in suppression may have been due to increased exposure to the CER paradigm, independent of the change in task complexity. However, the results reported by Millenson and Hendry (1967), which indicated that there was a diminution of the CER based on median response rates as the number of sessions of exposure to a fixed duration CS increased, would suggest that increased exposure to the CER paradigm should produce a decrease rather than an increase in response suppression.

The theoretical literature has considered the CER as being due to the presence of motor responses that anticipate the noxious stimulus and which interfere with the subject's performance on the operant task. A possible ex-

Fig. 2. Mean number of responses per 15-sec interval for each of the six subjects for each level of task complexity. The pre-tone interval extends from -45 sec to 0 sec and the tone interval extends from 0 sec to $+45$ sec. Data points are means of number of stimulus-matches and number of stimulus-presentations and are plotted at the mid-point of the respective time interval. Baseline condition consisted of two consecutive 45-sec intervals in which no experimental manipulations occurred. For the Shock condition, the period from -45 sec to 0 sec was free of experimental manipulations. CS onset occurred at 0 sec, as indicated by the arrow, and remained on until the UCS was delivered at 45 sec.

planation of the observation that humans do not respond in similar fashion to infrahumans might be that, in the presence of the anticipated noxious stimulus, humans may emit verbal or non-task interfering motor behaviors which do not interfere with their operant responding. Although all of the subjects ver-

balized feeling "anxious" during the CS-UCS interval, such verbalizations do not imply that the behavioral manifestations of the verbalized anxiety will be demonstrated via the CER.

Sidman (1960) stated that "the effect on a given response of a stimulus that precedes a

shock will depend on the history of that response." It may be that, in using college students as subjects, a biased sample is produced of subjects who have a history of maintaining their behavior in the presence of an anticipated aversive outcome.

Although the term CER is typically associated with conditioned suppression, this may be an unfortunate connotation of the term largely traceable to infrahuman research and Wayson and Rayner's (1920) utilization of this term to describe the behavior of an infant in a fear situation. The present data support previous studies in finding both facilitation and suppression. Considering the small magnitude of both of these changes, and the inter-subject variability with respect to outcome, it may be that neither suppression nor facilitation is a characteristic reaction of humans to the CER procedure, and the overriding variable might be, as Sidman implies, the behavioral history of the organism.

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