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Positive Conditioned Supperssion: A Replication and Extension

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POSITIVE CONDITIONED SUPPRESSION: A REPLICATION AND EXTENSION

by

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The present study was designed to evaluate the "general emotional state" interpretation of positive conditioned suppression by replicating the main features of the Azrin and Hake (1969) study. Evidence of the comparability of the two instances of the phenomenon of suppression, both positive and negative, was investigated by applying a reinstatement procedure typically effective with negative conditioned suppression to the positive suppression procedure.

Traditionally, conditioned suppression is produced by pairing a conditioned stimulus (CS) and shock, according to the Pavlovian conditioning procedure, on an operant baseline. An operant baseline response is established on an intermittent schedule of repetitive reinforcement. At infrequent intervals a stimulus is superimposed on the baseline performance and terminated coincidentally with a brief, response-independent shock. The subsequent reduction in the rate of responding during the originally new trial stimulus has been termed conditioned suppression (Estes and Skinner, 1941).

The interpretation of the phenomenon thus defined by Estes and Skinner (1941) states that the reduction in responding during a preshock stimulus is evidence of "anxiety" created by the anticipation of a "disturbing event". They suggest that respondents which were incompatible with the baseline response were elicited by the shock and conditioned through Pavlovian conditioning procedures to the CS (tone). Suppression, according to this widely accepted interpretation, is dependent upon the degree of aversiveness of the UCS. An alternative interpretation, supported by Azrin and Hake (1969), is that suppression

reflects a general increase in behaviors which interfere, or are incompatible, with the baseline behavior of bar pressing. This theory predicts that a stimulus paired with any strong reinforcer, whether positive or negative, should produce suppression. The Azrin and Hake study replicated the main features of the Estes and Skinner procedure using three high magnitude positive reinforcers (food, water and intracranial stimulation) in place of shock. Their findings indicate that reduction in response rate during a stimulus preceding a high magnitude, non-contingent positive reinforcer is similar in several ways to "negative" conditioned suppression. Both instances of the phenomenon occur rapidly (within one or two sessions), are durable over continued sessions, affect primarily the CS periods, and response rates recover rapidly upon discontinuation of the UCS. Due to the relative recency of its appearance as an experimental phenomenon, positive conditioned suppression has not received the extensive attention paid to the negative condition of the instance. Consequently, little is known about the relevant variables which determine the strength of the effect, or about relative effects of those variables in comparison with their effect on the negative instance.

Of particular interest to the present investigation is the series of studies of negative conditioned suppression done by Hoffman, Fleshler and associates. In a study dealing with stimulus generalization of conditioned suppression in pigeons (Fleshler and Hoffman, 1961), a 1000 cps training tone preceded the 8 second pain shock. The birds were returned to their home lofts after generalization tests were given, and following

a three year period, the five surviving animals were again presented the generalization test. The results indicated that the interruption had little, if any, effect on performance. In their next experiment (Hoffman, Fleshler and Jensen, 1963), the effect of increased emotional stress upon the previously extinguished aversive training was investigated. Shock was again presented, but never in the testing situation. A sudden and marked increase in the level of suppression occurred in the presence of all test stimuli; the baseline responding was unaffected. Campbell and Jaynes (1966) published a review of the theoretical and behavioral aspects of reinstatement of aversive training. Animals were given approximately 30 shocks each in the dark compartment of a two compartment (one black, one white) shuttle box. After this initial aversive training, single shock presentations were interpolated at 7, 14 and 21 days following training for one group. Measured in terms of the time spent in the non-aversive stimulus-associated compartment, the animals experiencing the reinstatement procedure spent an average of 55-70% of their time there, while groups experiencing either the initial aversive training or the reinstatement procedure only spent a maximum of 20% of their time there. The authors suggested, on the basis of these data, that periodic repetition of highly aversive (or emotional) experiences is sufficient to maintain an early learned response to that experience through time. It appears that the phenomenon of reinstatement may be a factor of major importance, then, in the ontogeny of behavior.

The intent of the present study is to systematically replicate one group of the Azrin and Hake study of positive conditioned suppression in

order to assess the validity of the "general emotional state" interpretation. Further investigation of this phenomenon and extension of the information concerning its similarity to the negative instance will be attempted by applying the Hoffman et al reinstatement procedure.

METHOD

Subjects

The subjects were four experimentally naive, male, albino rats, approximately 90 days old at the start of the experiment, of the Holtzman Sprague-Dawley strain. The animals were maintained within 10 grams of 80% of their ad lib weight. Water deprivation was initiated 48 hours prior to the first experimental manipulation. Access to water was limited to 17 cc per day in the home cage and scheduled presentations in the test chamber, for the duration of the experiment. All animals were housed in individual cages in an animal colony room.

Apparatus

The experimental chamber was a modified standard rodent test chamber, Grason-Stadler model # E3125A. The test chamber, with interior dimensions of 9 1/2" x 7 5/8" x 11 1/2" was housed within a sound insulated chest. The chamber front, back and top was of Plexiglas. The side walls were aluminum and the floor consisted of a grid of stainless steel bars 1/2" apart. A Gerbrands stainless steel rat lever, 1/2" thick x 2" wide was mounted 3" above the floor; a downward force of approximately 20 g defined a response. An aperture for the delivery of food was located 1 1/2" below the response lever. Two 10 watt incandescent white stimulus lights were located 3" to either side of the response lever. Two in to the right of the aperture was located a 1 1/4" diameter loudspeaker, connecting to an 80 db sonalert for pre-

sentation of the conditioned stimulus (CS). A water apparatus was added 2" to the left of the aaperture and 3/4" above the floor, which consisted of a .5 cc volume copper bowl mounted on a brass pipe extending from the chamber wall. The water (UCS) presentations were accompanied by a solenoid click. A fan, mounted on the enclosing chest wall, provided ventilation and masking noise.

An additional chamber of like interior dimensions, was constructed out of cardboard. It was equipped only with a house light and water fountain identical to that present in the test chamber. A 4" x 3" window of one way glass was positioned in the chamber wall opposite the water fountain and provided an unobstructed view of all areas of the chamber. Experimental contingencies and recordings were automatically controlled by a system of conventional relay circuitry, located in the adjacent laboratory. Scheduled events were programmed with two Gerbrands variable interval tape timers. Continuous, detailed recording of response rate was provided by a dual-pen (cumulative and event) Gerbrands cumulative recorder. Responding during the 10 sec pre-CS and CS periods was recorded on a Grason-Stadler Digital Printer Model # 1238.

Procedure

All rats were trained to bar press for food reinforcement (45 mg Noyes pellets) on a manually controlled schedule of continuous reinforcement (CRF). Following the shaping procedure, intervals between reinforcements were gradually lengthened, using a 1 hour tape which

had previously been divided into 3, 20 minute sections with mean inter-reinforcement intervals of 15, 30 and 60 seconds, respectively. The bar-pressing behavior was maintained on a variable interval 1 min (VI 1 min) schedule throughout the duration of the experiment.

Training was continued with daily sessions varying from 1 to 1 1/2 hours, until a stable rate of responding was reached. Stability was indicated by less than 15% variability in responses per minute for four consecutive experimental sessions. After stabilization was reached, an average of four neutral stimulus (NS) presentations per session were scheduled at random intervals. The 80 decibel sonalert and solenoid click presentations were scheduled independently of each other and base-line responding, and were presented daily until the response rate was unaffected by stimulus presentations. The purpose of the random NS presentations was dual: To demonstrate their neutral properties (i.e., lack of inherent disruptive qualities), and to mitigate any suppression which might be caused by the introduction of novel stimuli during conditioning. The CS-UCS pairings were response independent, occurring with a mean inter-reinforcement interval of 6 minutes (VI 6 min). The CS (tone) remained on for 10 seconds, terminating coincidentally with a brief presentation of the .5 cc water UCS. Water consumption was limited to 17 cc per day in the home cage for 48 hours prior to the first experimental manipulation, with additional scheduled presentations during manipulation.

When suppression predictably occurred at the onset of the CS, with recovery to baseline rate occurring with the termination of the CS, ex-

tinction procedures were introduced. UCS presentations following the CS were withheld until CS presentations produced no observable change in response rate. Finally the animals were placed in a cardboard box, with interior dimensions identical to those of the test chamber. The box was equipped only with a house light, a water apparatus of the type present in the experimental chamber, and a solenoid to provide the click accompanying water presentations. Four, randomly timed, non-contingent .5 cc UCS presentations were distributed throughout a brief 20 minute exposure to the box. Immediately following completion of the 20 minute reinstatement period, extinction trials in the test chamber were continued for the duration of the hour session; the 20 minute warm-up period was discontinued. When CS responding again stabilized, testing was discontinued.

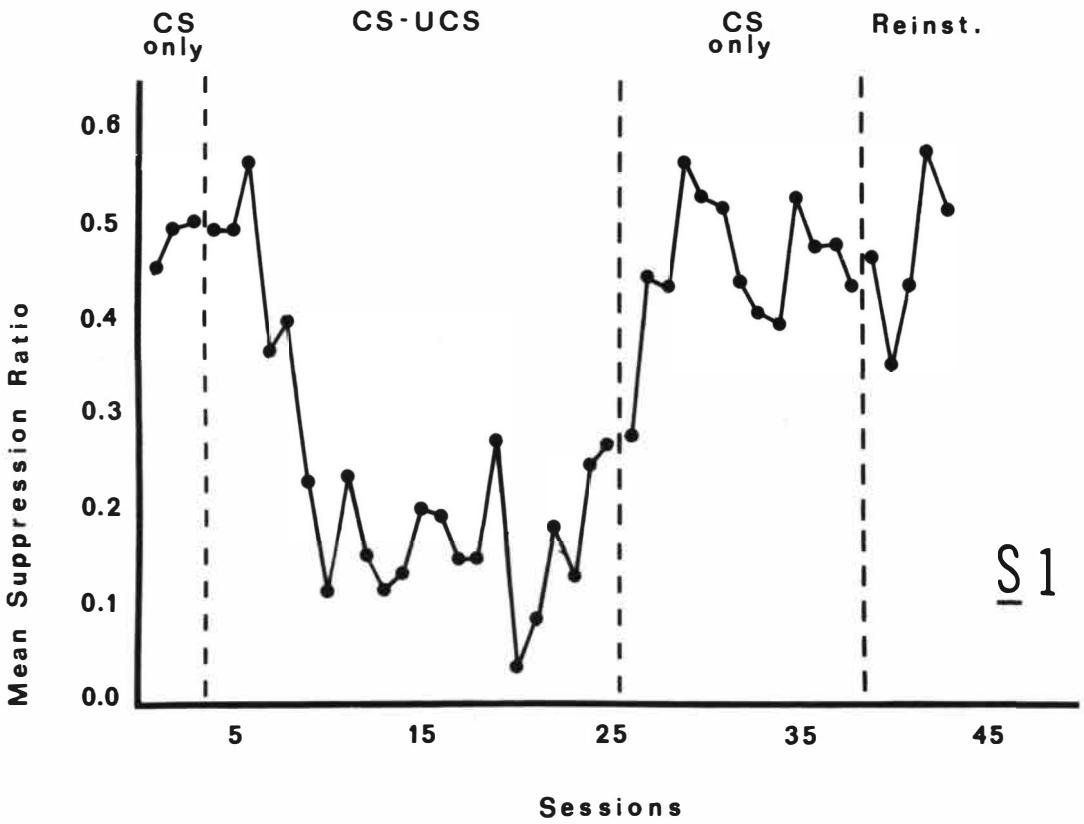
RESULTS

The degree of suppression, measured in terms of the rate of responding during the CS relative to responding during the baseline period, was assessed in terms of the "suppression ratio" suggested by Annau and Kamin (1961). Rates of responding during the 10 sec CS period (B) and a control period of equal length (A) immediately preceding it are compared in the ratio B/A+B. Maximum suppression is indicated by a 0.0 suppression ratio. A rate during the CS equal to the control rate, indicating no suppression, produces a .5 ratio; acceleration is evidenced by ratios greater than .5.

The mean suppression ratios were calculated for each session for each animal. These data are presented in Figures 1-4 for the four animals as a function of the presence or absence of the UCS. The initial "CS only" period refers to the last three sessions of the baseline, or control condition, only. Suppression ratios for that condition averaged approximately .5 for all subjects. With the addition of the noncontingent UCS presentation at the termination of the CS, CS-UCS condition, all subjects showed marked decreases in suppression ratios. Three of the four subjects reached near-zero ratios within a week of the CS-UCS condition onset. The effect endured, in the case of Subject #5 in increasing degrees, as long as the condition was in effect. Upon removal of the UCS following the CS, the extinction procedure or second CS only condition, the mean suppression ratio for each animal increased markedly. All animals recovered their initial CS only (baseline) ratios within several sessions.

FIGURES 1-4

Mean suppression ratios for each session for subjects #1, 2, 4 and 5 as a function of the presence or absence of the UCS.


CS only
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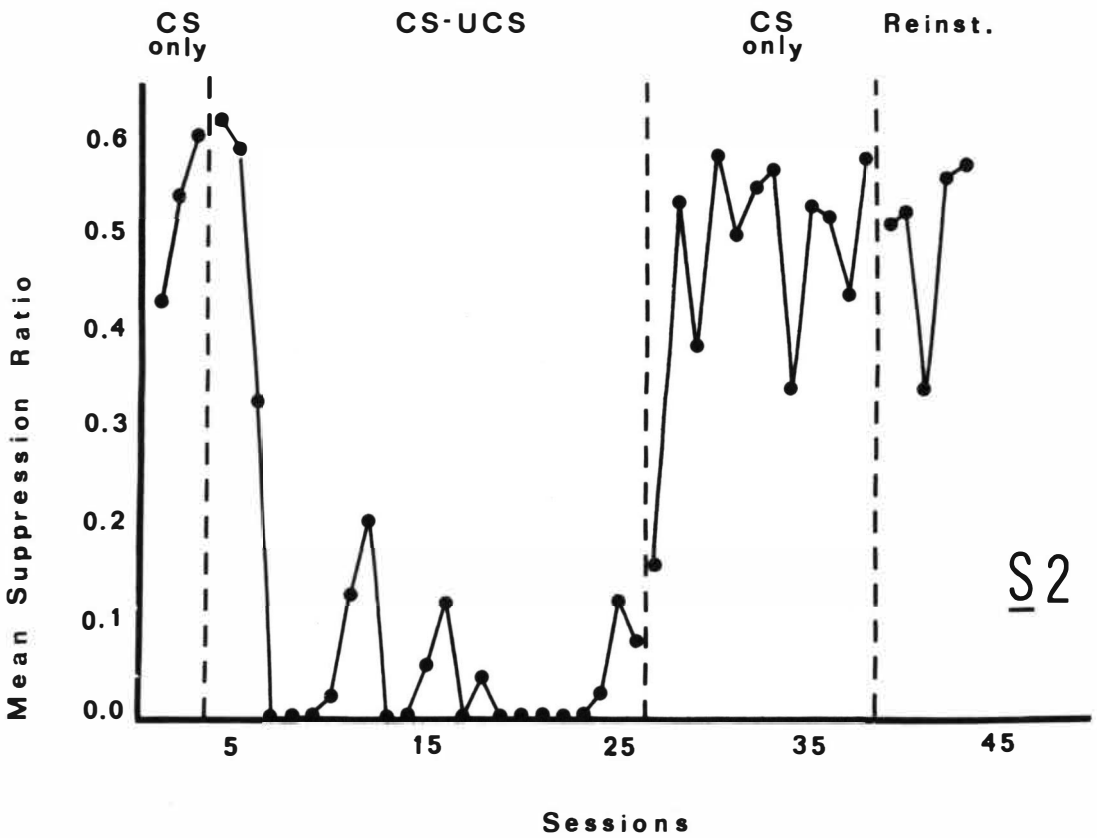
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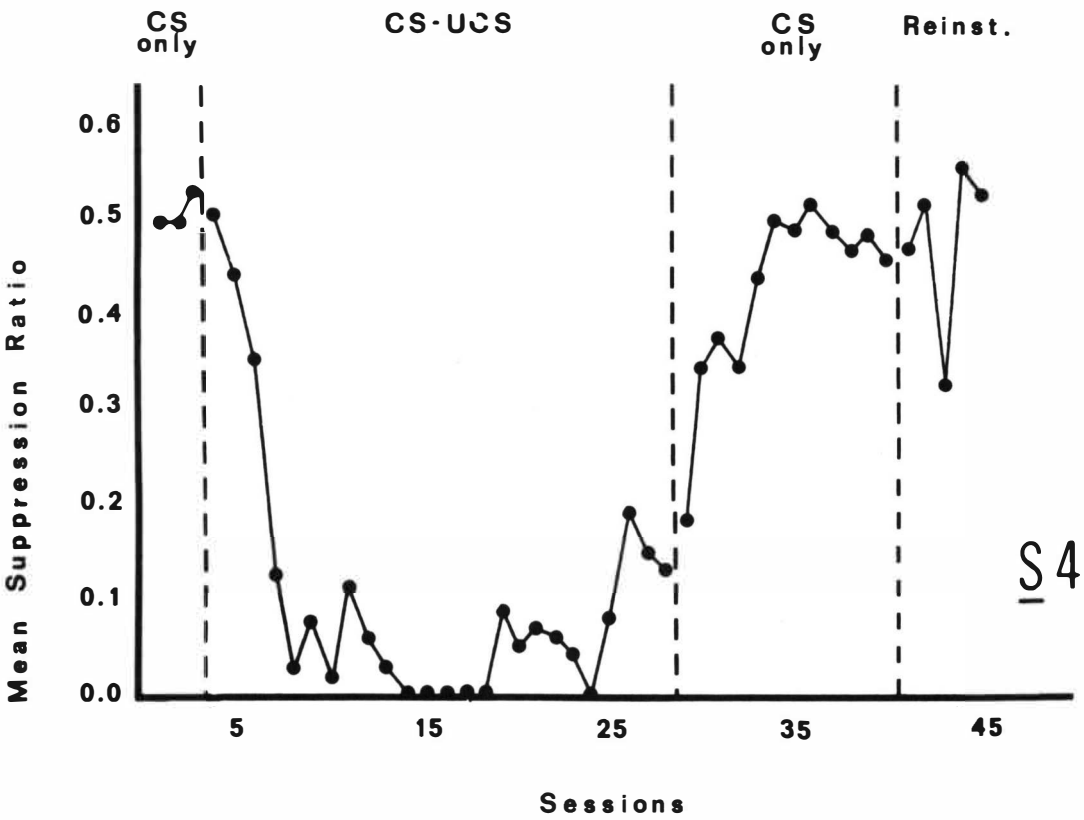
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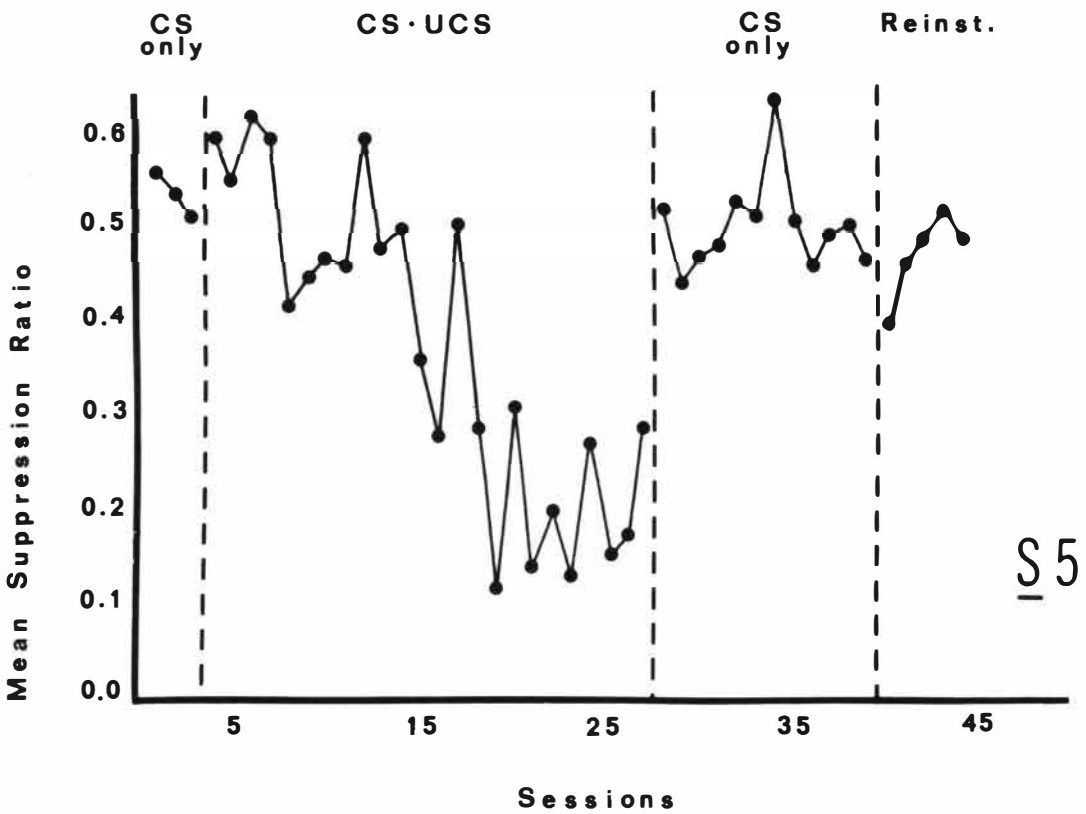
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Introduction of the reinstatement procedure produced no marked change in mean suppression ratios. As seen in Figures 1-4, all animals maintained approximately equivalent mean suppression ratios throughout the duration of this condition as were evident in the final sessions of the extinction condition.

Table 1 shows the mean number of responses per minute for each subject in each of the four experimental conditions. A general decrease in response rate occurred during CS-UCS conditioning. The decrease was minor in most case, averaging 4.8 responses per minute less during conditioning procedures than during the previous CS only condition.

Table II shows the results of a sequential analysis of mean suppression levels for all animals during the reinstatement procedure sessions. Mean suppression ratios were investigated as a function of the sequential position of the CS presentation. A marked difference was found between the first and the last CS presentations for sessions 1 and 2 of the reinstatement procedure. By the third day of that condition, the marked difference had disappeared. The final day of the condition showed facilitation during both CS presentations, the larger increment occurring in the mean suppression level for the first CS presentation.

TABLE I

Mean Number of Responses Per Minute For Each Subject
For All Sessions Under Each Condition

Subjects	CS Only 12 Sessions	CS-UCS	CS Only 23 Sessions	Reinstatement
1	34.4	30.9	51.7	54.7
2	48.2	36.7	38.5	39.4
4	24.5	23.9	48.6	22.4
5	27.4	22.8	22.4	37.6

TABLE II

The Mean Suppression Ratio for All Subjects for the First and Last CS Presentations for Four Reinstatement Sessions

Session	First CS Presentation	Last CS Presentation
40	.26	.60
41	.36	.57
42	.37	.43
44	.63	.51

DISCUSSION

The present results are similar to those obtained in the Azrin and Hake (1969) study of positive conditioned suppression. An appetitive maintained lever-pressing response was disrupted during a conditioned stimulus which reliably preceded non-contingent positive reinforcement. All subjects exhibited response suppression. The positive-reinforcer-produced suppression was large in magnitude, and occurred relatively quickly following initial UCS presentations. The rapid appearance of conditioned suppression characterizes both positive and negative instances of the phenomenon. Termination of the UCS following the CS presentations resulted in recovery to baseline or control response rates within two sessions for three subjects, and soon after that for the other. The effects appeared to be independent of the baseline response rates as the responses per minute varied from 24 to 48 responses per minute (Table I). Although typically both positive and negative conditioned suppression are phenomenon largely restricted to the CS period, general decreases in responding were evident in the present study during the UCS present condition. The mean response rates of all subjects showed two simultaneous fluctuations of high magnitude that lasted approximately three days each. Both low rate periods occurred contiguously with extremes in the weather. As the colony room in which the subjects are housed is not air-conditioned and is located on an outside wall, it is possible that the high 80° weather temporarily affected the water deprivation level. With increased states of water deprivation, animals respond at decreased rates for dry food reinforcement. Although little is known about the interaction of two

deprivation states in relation to conditioned suppression, the suppression ratios corresponding to the two periods in question were not distinguished in any way.

Results of studies investigating the long term effects of aversive training (Hoffman and Fleshler, 1961; Hoffman et al, 1963) have demonstrated that reported "permanent elimination" of the negative effects of such training has not been permanent. Re-introduction of a "stressful" situation" will reinstate suppression. The degree of suppression is largely determined by the similarity between the second and the original aversive situations. This "anxiety interpretation" (Estes and Skinner, 1941) has led to the expectation that high magnitude positive reinforcers would produce opposite effects, i.e. increased response rate usually referred to as "elation" or "joy". An alternative interpretation recently proposed by Azrin and Hake (1969), relates the positive and negative stimuli, the "elation" and the "anxiety". Their "general emotional state" interpretation suggests that suppression is not dependent upon the qualitative aspect of the non-contingent stimulus, but the quantitative aspect. Having demonstrated the viability of this interpretation in terms of production of the phenomenon, investigation of its implications for further similarities was carried out. If re-introduction of a stressful situation reinstates negative conditioned suppression, reintroduction of a situation which produces increased "positive emotion" (a positive stimulus which produces responses which are incompatible with bar pressing) would reinstate positive conditioned suppression, according to the proposed interpretation.

The immediate and extreme suppression which characterizes reinstatement of suppression conditioned with a negative reinforcer was not evident in the mean suppression ratio of any session. An analysis relating mean suppression ratios to order of presentation of the stimulus, however, showed a prominent effect. Differences in the two reinstatement procedures used was necessitated by inherent stimulus differences. That is, time-out (T.O.), a period during which the opportunity to respond and obtain positive reinforcement is removed by darkening the chamber, was effective for the delivery of the negative reinforcer (shock), but inapplicable to the presentation of stimuli requiring a consummatory response. It was impossible, therefore, to achieve the same uniform relationship of the CS to the UCS as typifies the negative instance of the phenomenon. The results of the relative mean suppression levels corresponding to first and last, non-contingent stimulus presentations, though, indicate that an increase in emotionality occurred, and dissipated as the sessions progressed. The decrease in daily first presentations ratios could reflect habituation to the emotional situation as a function of repeated exposures to the reinstatement (cardboard) chamber.

Another procedural difference possibly contributing to the lower mean suppression ratio of the positive reinstatement condition results from the dissimilarity of the inital means of assessment of the "stressful" situations. An appropriate shock level was determined for each of the Hoffman subjects by subjecting them individually to increasing shock intensities until a level was found that produced a "marked but not violent" reaction. Assessment of the intensity of a consummatory response,

or the emotionality created by it, is difficult because the response is always topographically the same. Gross observation of the subsequent activity level would be interesting, but an inadequate measure lacking causality.

According to the present results, rate of responding is reduced during a stimulus which has been paired with a positive reinforcer. The suppression, once extinguished, is susceptable to a reinstatement procedure comparable to that effective with negative conditioned suppression. Although the positive UCS used in the present investigation necessitated minor procedural differences which affected the total suppression level during the reinstatement condition, other positive UCS exist which could circumvent these difficulties. Future investigations of comparability with the shock procedure will, hopefully, include a reinstatement procedure employing intracranial stimulation of appropriate positively reinforcing centers of the brain, enabling minimization of procedural complications.

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