THE ROLE OF FEAR-WITHDRAWAL AND RELAXATION - APPROACH IN AVOIDANCE RESPONDING

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ABSTRACT

THE ROLE OF FEAR-WITHDRAWAL AND RELAXATION-APPROACH IN AVOIDANCE RESPONDING

By

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Fear-withdrawal and relaxation-approach were identified as two components of one-way avoidance responding. The control of the withdrawal component that was exercised by the shock area stimuli and the control of the approach component that was exercised by the distinctive safe area stimuli was maximized by a procedure which combined a sequence of active and passive avoidance trials with apparatus rotation. Good stimulus control was required in order to isolate the contributions of both the approach and the withdrawal components to the overall level of avoidance responding. In general, this was done by measuring the resistance to extinction of the avoidance behavior when either the shock or the safe area stimuli were removed from the apparatus before the extinction test or when these stimuli were reinstated before the spontaneous recovery test. The overall level of avoidance responding was measured with the original shock and safe area stimuli (No Change condition).

Experiment I determined the effects of inter-trial interval (ITI, 20 sec. versus 150 sec.), varied only during acquisition, on

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avoidance behavior. The ITI did not affect the rate of acquisition. But the Long ITI No Change group was more resistant to extinction than the Short ITI No Change group.

The strength of the withdrawal component was measured for both ITI levels when the shock area stimuli were isolated by replacing the original safe area stimuli with more neutral stimuli before the extinction test was conducted (Change Safe condition). Withdrawal was also measured during a spontaneous recovery test when the original shock area stimuli were reinstated after the extinction criterion had been reached with neutral shock area stimuli and the original safe area stimuli (Change Shock condition). Both tests indicated that the higher resistance to extinction of the Long ITI No Change group was not produced by a stronger fear-withdrawal component of avoidance responding.

Two parallel tests were used to measure the strength of the relaxation-approach component. The Long ITI group was more resistant to extinction when the safe area stimuli were isolated (Change Shock condition). But no difference was obtained during the spontaneous recovery test when the original safe area stimuli were reinstated (Change Safe condition). These approach data suggest that the relaxation-approach component can not be measured effectively after fear has been largely extinguished. Presumably, this explains the failure of the Change Shock and the Change Safe groups to add up to yield the resistance to extinction obtained with the appropriate No Change group.

Experiment II used the tests described in Experiment I to measure the relative contributions of fear-withdrawal and relaxation-approach at different levels of avoidance training. The four levels of training were specified in terms of two acquisition criteria (Low, Medium) and either 11 (High) or 28 (Highest) additional nonshock, long ITI trials conducted after the medium acquisition criterion had been met. The number of short ITI trials to reach an extinction criterion was then measured during the extinction and the spontaneous recovery tests under the No Change, the Change Shock and the Change Safe conditions. As hypothesized, the withdrawal component was relatively more important than the approach component when the avoidance responses were first being learned (Low Criterion). The Medium Criterion No Change group was most resistant to extinction during the extinction test--an effect produced primarily by conditioned relaxation and approach. The overall resistance decreased progressively across the High and the Highest Criterion groups as relaxation and approach became conditioned to shock area stimuli.

THE ROLE OF FEAR-WITHDRAWAL AND RELAXATION-APPROACH IN AVOIDANCE RESPONDING

By

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INTRODUCTION

This study investigates the presumptive role that two classes of response, fear and relaxation, play in avoidance responding. In a situation in which the aversive stimulus is electric foot shock, fear is associated with shock presentation and relaxation is associated with shock termination. In the present studies, the characteristics of fear and relaxation are inferred from observations of active and passive avoidance responding.

Both active and passive avoidances serve to prevent an organism from receiving an aversive stimulus. The two forms of avoidance are distinguished by the way in which the aversive stimulus is avoided. Avoidance is active if _S_ prevents the reception of an aversive stimulus by _making_ a response which might not otherwise occur. For example, a bar press is classified as an active avoidance if it prevents the _S_ from receiving a painful shock. In distinction, a response is classified as a passive avoidance if _S_ prevents the reception of an aversive stimulus by _not making_ a response which might otherwise occur. Passive avoidance is frequently identified as being equivalent to the effects of punishment.

In this study the topography of an active avoidance (or an escape) response was limited, by the species of _S_ and by the design of the apparatus, to a running response that would take the rat from the shock area to the safe area of a long narrow box (called a one-way box). The most variable characteristic of this response was its latency. In contrast, the topography of the passive avoidance response was not clearly delimited. Any response other than the punished response, a run from the safe to the shock area of the apparatus, was classified as a passive avoidance.

Control of avoidance responses of both types was based on the use of electric foot shock--the primary aversive stimulus. The unconditioned response to shock presentation includes both activity regulated by the autonomic nervous system and skeletal muscle responses. Commonly identified skeletal muscle responses include running, jumping, flinching, and crouching (Kimble, 1955; Trabasso & Thompson, 1962). Of these, running is most compatible with active avoidance responding and, to a limited extent, an improvement in avoidance responding can consist of the direct conditioning of this response (Dinsmoor, 1955). But the effects of many variables on avoidance conditioning cannot be explained in such a direct manner. Reference to mediating responses, including fear or anxiety, also seems to be required (Seward & Raskin, 1960; Solomon & Turner, 1962). Fear is the conditioned counterpart to the autonomic component of the unconditioned response to shock presentation.

Fear

Fear is typically assumed to be a complex internal response which can be indexed by various physiological responses such as heart rate and the galvanic skin response. But these measures are frequently not used to assess the strength of fear. More commonly, fear is indexed by measures of learning to escape stimuli to which fear has presumably been conditioned, by changes in performance resulting from conditioned punishment, by changes in the rate of an ongoing response (e.g. conditioned suppression), or by an increase in the magnitude of an unlearned response (McAllister & McAllister, 1971). It is clear that fear has not been consistently defined in terms of any particular response measure and that the correlations between the various measures are far from perfect. Only one characteristic seems to be common to all situations in which the presence of fear has been asserted--namely, the prior pairing of a neutral and an aversive stimulus under conditions known to produce classical conditioning. In this study, fear is said to be present after the occurrence of these antecedent conditions and its strength is inferred from measures of active and passive avoidance responding under several conditions.

Fear is a classically conditioned response, and the rate and strength of fear conditioning are influenced by the same variables that control the conditioning of other responses. But, in addition to these, other variables that affect the conditioning and measurement of fear were considered in the design of the present experiments. For example, it has been demonstrated that the generalization gradient for the fear response flattens with time after conditioning (McAllister & McAllister, 1963). Since many of the critical determinations in this study required Ss to maintain a discrimination between shock and safe area stimuli, it was decided to conduct all conditioning and testing in a single session even though these sessions were over 6 hours long for some Ss. Also various intersession effects, mediated in part by changes in fear, seem to accentuate an apparent dichotomy between Ss which reach an avoidance extinction criterion by freezing and those by relaxing (Bagne, 1968; Kamin, 1957; Brush, Myer, & Palmer, 1964). These studies suggest that the number of Ss that extinguish by freezing could be reduced by conducting all training and testing during a single day.

Relaxation

Most theories of escape and avoidance behavior emphasize only those responses elicited by the presentation of aversive stimuli. Such an emphasis is not difficult to understand even though it presumably makes all of these theories incomplete. Presentation of a stimulus is probably the most common experimental manipulation in psychological research. The resulting responses are usually said to be elicited by the stimulus. That is "stimulus presentation" is equated with "the stimulus." But stimuli can also be terminated and the cessation of a prevailing stimulus can be used as a CS or an S^D (Myers, 1960). This suggests that it may be generally useful to differentiate that which is usually called "the stimulus" into two events--stimulus presentation and stimulus termination.

Even though the aversive stimuli used to control escape and avoidance behavior are usually presented by the experimenter, they are frequently terminated by the behavior of S. Responses elicited by a stimulus event that is controlled by S are more easily overlooked by the experimenter.

Neglect of stimulus termination has affected the way responses are identified and classified. For example, psychologists frequently classify the transition in behavior from "standing still" to "running" as a response while not according similar status to the transition from "running" to "standing still." In this example, neglect of stimulus termination will not retard the analysis of behavior if the responses elicited under the S^D and the S^{Δ} conditions are reciprocal--that is, if stimulus termination returns the organism to essentially the same state it was in before the stimulus was presented. But the responses elicited by the presentation and the termination of aversive stimuli are not reciprocal especially if emotional responses are considered. The postshock response differs from the preshock state.

Both shock presentation and shock termination elicit distinctive responses. So far in this paper only the effects of shock presentation have been discussed. Yet it is clear that the termination of a shock elicits changes in behavior that are almost as easy to identify as the responses elicited by shock presentation. Once shocked, S does not continue to run or to jump forever; these responses generally cease when shock terminates. And just as the shock area stimuli may come to elicit running so too may the safe area come to elicit "stopping." But the responses elicited by shock termination have not been studied intensively; they are usually characterized merely as the cessation of a response elicited by shock onset.

Autonomic responses, as well as skeletal muscle responses, are elicited by shock termination. Shock offset produces a shift from sympathetic to parasympathic dominance within the autonomic nervous system. In a few studies, this shift has been measured in terms of physiological responses. Using curarized dogs, Black, Carlson, and Solomon (1962) and Church, LoLordo, Overmier, Solomon and Turner (1966) demonstrated that the heart rate increases abruptly during shock. This is evidence for sympathetic dominance. When the shock is terminated, the heart rate decreases to a rate below the preshock rate before slowly returning to normal. The abnormally low rate is evidence for parasympathetic dominance.

The response class associated with the termination of an aversive stimulus has been labeled relaxation (Denny & Adelman, 1955; Miller, 1951). The strength of relaxation, though it can be indexed by measures of physiological response, is more frequently inferred from observations of instrumental-motor behavior. These indirect methods for measuring relaxation are usually based on the assumption that relaxation is incompatible with the excitatory fear response. Two general approaches have been used. First, as mentioned previously, the strength of fear elicited by a stimulus can be indexed by measuring the extent to which the stimulus suppresses an ongoing appetitive response. If this fear can be reduced, the suppression of the appetitive response should be reduced or, if the stimulus was previously established as a conditioned relaxer, the rate of fear conditioning, and thus response suppression, should be retarded. Second, fear plays an important role in mediating avoidance responding. A stimulus which elicits relaxation, a response incompatible with fear, should depress active avoidance responding when appropriately placed. Most of the following studies, cited as successful attempts to measure relaxation, were conceived and interpreted within a theoretical framework which stresses the inhibition of fear rather that the elicitation of a relaxation response that is incompatible with fear. Nevertheless, these studies provide good evidence for conditioned relaxation. And of these two theoretical orientations, only the one which stresses the elicitation of relaxation can also account for the evidence which suggests that relaxation produces distinctive stimuli.

Rescorla (1969a) studied the conditioned inhibition of fear in two experiments using the first approach. He established conditioned inhibitors (relaxers) by using several levels of negative contingency between a CS and shock. In the first experiment he demonstrated that the acquisition of fear, measured by the disruption of an ongoing appetitive response, was retarded when the stimulus was previously established as a conditioned relaxer. Fear conditioning was retarded most for the CS that was previously most effective in predicting safety. In a second experiment, the conditioned relaxer was presented together with a conditioned suppressor of an appetitive response. The best safety signal was most effective in reducing the suppression of the appetitive response. Hammond (1967, 1968) obtained similar results using both the retardation of excitatory conditioning and the summation methods to measure the effectiveness of conditioned relaxers. Braud (1968) demonstrated that a stimulus paired with the termination of a conditioned fear eliciting stimulus could also be used to diminish the suppression of an appetitive response.

Rescorla and LoLordo (1965) demonstrated that a stimulus used to signal a shock free period depressed the unsignaled (Sidman, 1953) avoidance responding of dogs in a shuttle-box. Weisman and Litner (1969a) obtained similar results using rats as experimental Ss and a wheel manipulandum. Denny (1971) extended these results by investigating the time course of relaxation during a postshock period by using a probe stimulus technique. Presumably, a probe CS is most likely to become a conditioned relaxer when it just precedes and overlaps the onset of the unconditioned relaxation response. During acquisition a stimulus probe was presented in the safe area of a one-way box after S made an escape response from shock. Probes of various durations and placements were used. During extinction the strength of relaxation elicited by each CS probe was determined by presenting it while S was still in the shock area of the apparatus. This test indicated that a 30 second probe stimulus was most effective in facilitating extinction of an active avoidance response when the probe had been presented 30 seconds after shock termination. Using a related procedure and 5 second probe stimuli Denny also identified a short-latency relaxation or "relief". Relief was conditioned most effectively between 5 and 15 seconds after shock termination. Further investigation revealed that relaxation was elicited after escape from either shock or a conditioned aversive stimulus while relief was elicited only by termination of the primary aversive stimulus.

The fear inhibiting properties of conditioned relaxers have been well established. But this may not be their most important property. Conditioned relaxers also have been used to positively reinforce instrumental responses. Although some investigators have theorized that relaxation (Denny, 1971) or the Pavlovian inhibition of fear (Rescorla, 1968) is the reinforcement mechanism in active avoidance learning there have been few attempts to condition relaxation independent of the avoidance behavior it is said to reinforce. The studies of Rescorla (1969a) and Weisman and Litner (1969a) are exceptions.

Rescorla (1969a) first trained dogs to avoid unsignalled shock by pressing either of two panels. The *S*s were given Pavlovian conditioning which established a CS as a predictor of the nonoccurrence of shock. During a test session this CS was made contingent upon a press of first one and then the other of the two panels. The *S*s tended to press and follow the panel that produced the conditioned relaxer.

Weisman and Litner (1969a) trained rats to run in a rotating wheel to avoid shock presented on a Sidman (1953) schedule. A safety signal, established in a separate Pavlovian conditioning situation, was then used successfully to differentially reinforce first a high and then a low rate of responding. The reinforcing function of the safety signal was very durable--it was observed across 14 Sidman avoidance sessions after Pavlovian conditioning had been discontinued.

Fear, Relaxation, and Active Avoidance Responding

This research was conceived and interpreted primarily within the framework of elicitation theory (Denny & Adelman, 1955; Denny, 1966, 1967). This theory relies almost exclusively upon a detailed analysis of stimulus and response and assumes that both the presentation and the termination or removal of a stimulus (incentive) elicit characteristic classes of response (Denny, 1971).

Motor withdrawal and approach reactions have been identified as the two major classes of skeletal muscle response (Schneirla, 1959; Denny & Ratner, 1970). The withdrawal responses include the innate species-specific defense reactions elicited directly by aversive stimuli (Bolles, 1970). These withdrawal responses can be conditioned to stimuli associated with shock. By withdrawing from these conditioned stimuli S could avoid shock in the present learning situation. But avoidance learning is seldom, if ever, this direct. The unconditioned response elicited by shock presentation also includes autonomic components; when conditioned, these are called fear. It is assumed that fear has distinct stimulus accompaniments that can elicit responses. These fear produced stimuli are present (at least after a minimum amount of fear has been conditioned) while S is making a motor withdrawal response from shock and thus become conditioned elicitors of that response. In the terminology of elicitation theory, fear mediates a withdrawal component of avoidance responding.

Unconditioned approach responses probably play a relatively minor role in most avoidance learning situations. But it is conceivable that an "avoidance" study could be run using a one-way box, a very mild aversive stimulus, hungry Ss, and food in the safe area to elicit unconditioned approach. It is also possible that Ss would approach the safe area stimuli just because they are novel or that some organisms possess an innate mechanism whereby they approach distinctive and more distant stimuli when the immediate situation is aversive. Whatever the actual importance of any of these possible sources of approach responding, they do conform to the appetitive model of the approach component of avoidance learning that is offered here except for the assumption that most of the approach responding is conditioned.

In the present experiments, distinctive safe and shock areas are located at opposite ends of the avoidance response path. Direct and fear-mediated withdrawal are conditioned to shock area stimuli and both increase the probability that S will escape the shock area before shock is presented (to avoid). But as a logical consequence of withdrawing from the shock area, S is, in effect, approaching the safe area. Whatever the reason, S is making an approach response in the presence of safe area stimuli. These constitute the conditions for a pardigm at least as effective as simultaneous conditioning. In this way, a motor approach response can be directly conditioned.

Escape from shock or a fear-CS elicits relaxation. This long latency response occurs in the safe area of the apparatus if S stays there long enough after escaping or avoiding. Safe area stimuli then become conditioned elicitors of relaxation because of the contiguity between these stimuli and the response. Therefore, after avoidance learning has gone sufficiently far, S also relaxes as it approaches safe area stimuli.

Evidence, cited earlier in this chapter, suggests that relaxation, like fear, produces distinctive stimuli that can be conditioned to responses (Denny & Dmitruk, 1967). Because the stimuli produced by conditioned relaxation occur while S is approaching the safe area, these stimuli become conditioned elicitors of approach responding. In this way, relaxation can mediate an approach component of avoidance behavior. The approach response, whether controlled directly by situational stimuli or mediated by relaxation, is not necessarily anything more than the "logical consequence" of the original withdrawal response. It is assumed, however, that other responses, e.g., exploratory approach and grooming, are compatible with relaxation and can be used an an index of relaxation.

Presumably, relaxation-mediated approach and fear-mediated withdrawal contribute most to avoidance learning when either there is little external stimulus support for the response or when the avoidance response is low in the hierarchy of innate defense reactions. It is probably safe to assume that the discriminated running responses required of _S_s to actively avoid shock in the present experiments are at an intermediate position on this hierarchy and are controlled, to a considerable extent, by fear and relaxation.

According to elicitation theory, behavior traditionally identified as avoidance responding includes important appetitive or approach components. Presumably, there is a parallel between a fearful _S_'s approach to the safe area and a hungry organism's approach to food. Hunger stimuli, together with the incentive, reliably elicit approach to food. Fear stimuli, together with the conditioned elicitors of approach in the safe area, elicit direct (unmediated) approach to the safe area. One difference is that the approach elicited by food is unconditioned while the approach that facilitates avoidance responding is, to a large extent, conditioned. Mediated approach also depends on fear to be operative because conditioned relaxation cannot be elicited unless S is fearful. Without conditioned relaxation, relaxation produced stimuli are not available to elicit approach. Both sources of control for approach responding would be markedly reduced if either the fear were eliminated or the safe area stimuli were removed.

The appetitive aspects of avoidance behavior, together with the long latency of the relaxation response, focus attention on the duration of safe area confinement as an important variable in avoidance learning. This variable was investigated parametrically by Denny & Weisman (1964) in a study which varied safe area confinement while inter-trial interval was held constant. A minimum of 150 seconds in the safe area was optimal for facilitating avoidance acquisition when shock and safe areas were different. Weisman, Denny and Zerbolio (1967) gave separate consideration to the avoidance responses to both of the distinctive chambers of a shuttle-box while they varied the nonshock confinement associated with these chambers. After 60 training trials, rats in one group made less than 10% avoidances to the 10 second confinement area while making over 80% avoidances to the 200 second confinement area. This difference in the percentage of avoidances is explained in terms of the relative time to relax and the strength of the approach responding that is mediated by relaxation.

The present analysis of avoidance learning stresses both the conditioning of fear and withdrawal responses to stimuli in the shock area and the conditioning of relaxation and approach responses to stimuli in the safe area. Because of stimulus generalization, the rate of learning depends on the similarity of these two sets of situational stimuli. There are two reasons why acquisition of an avoidance response should be faster when shock and safe areas are dissimilar. First, fear and withdrawal are less likely to generalize to the safe area to interfere with elicitation of relaxation and the conditioning of approach responses. Second, relaxation and approach responses are less likely to generalize to the shock area to interfere with fear and withdrawal conditioning. These hypotheses are supported by the work of Knapp (1960, 1965) using a jump-out box and relatively long safe area confinement intervals. Both withdrawal from the shock area and approach to the safe area are compatible with avoidance responding and are conditioned most rapidly when shock and safe areas are different. Under these conditions, Knapp found that rats learned to avoid in about 3 trials.

On the other hand, extinction of avoidance responding is more rapid when the shock and safe areas are similar because relaxation and approach responses generalize to the shock area stimuli. This hypothesis was supported by Denny, Koons and Mason (1959) and by Knapp (1960, 1965). A minimum safe area confinement of 150 seconds is optimal for speeding extinction of an avoidance response when safe and shock areas are homogeneous.

According to Denny (1971), relaxation originally occurs in the safe area many seconds after the escape from aversive stimuli. Because of a conditioning process called backchaining, relaxation presumably moves forward in the response sequence to mediate the approach responses that are instrumental in drawing S out of the shock area in time to avoid shock. This process depends on the assumption that the response path between the shock area and the safe area is bridged by a series (chain) of distinctive proprioceptive and situational stimuli. Relaxation works it way back along this chain in what can be compared to a higher-order conditioning process of many orders. Extinction effects, which prevent conditioning from going beyond the third or fourth order in most conventional demonstrations of higher-order conditioning, are minimized when the primary elicitor is retained at the end of the chain. In this way successively earlier stimuli occurring along the response path become conditioned elicitors of relaxation. Relaxation produced stimuli are then available to become conditioned elicitors of approach responding. In the present experiments, mediated approach responding would be expected to condition quite rapidly because the relatively homogeneous safe area permits generalization of conditioned relaxation to the very brink of the shock area.

The entire backchaining process is based on the simple fact that stimuli consistently preceding a response can become conditioned elicitors of that response. This process explains the persistent tendency for many responses to move toward the initial portions of a behavioral sequence. Backchaining can be used (but seldom is used) to explain many aspects of such interesting phenomena as masochistic behavior (Brown, 1969), the successful use of an intense electric shock as a CS in a salivary conditioning situation (Pavlov, 1927), and a rat's preference for signaled or escapable shock over unsignaled or inescapable shock (Maier, Seligman & Solomon, 1969).

The present analysis implies that the relative importance of the withdrawal and approach components of avoidance responding will change systematically as learning and extinction progress. Before S learns to avoid, it is shocked on almost every trial. It is assumed that the probability of withdrawal from the primary aversive stimulus is large for Ss that do not freeze. It would be expected that the direct conditioning of these withdrawal responses would proceed quite rapidly. Also, fear conditioning is rapid; the strength of this conditioned response can reach a maximum within 20 trials (Weisman & Litner, 1969a). As soon as some fear is conditioned it is available to mediate conditioned withdrawal. All these sources of withdrawal--unconditioned, directly conditioned and mediated conditioned--combine to elicit a strong withdrawal reaction from the shock area during the early phases of avoidance learning.

Relative to withdrawal, the importance of approach responding increases during the later stages of avoidance learning. There are several reasons for this. First, unconditioned approach responses are assumed to play a minor role in most avoidance learning situations; most approach is conditioned and this requires a number of trials. Direct conditioning of approach responses may be rapid but these are, presumably, of minor importance when compared to the conditioned approach responses mediated by relaxation. Second, the relaxation that initially occurs in the safe area must partially backchain (or generalize) before its response produced stimuli can become conditioned elicitors of the approach responses that can draw S out of the shock area. Again, this process is indirect and can be expected to require a number of trials. Third, the strength of conditioned relaxation can increase even after S is avoiding reliably; as long as the presentation of a CS elicits fear, its removal elicits unconditioned relaxation. It is for this reason, presumably, that avoidance latencies frequently continue to decrease after the last shock is received (Solomon & Wynne, 1953). Thus, the strength of relaxation mediated approach can increase while fear and withdrawal can extinguish as relaxation backchains into the shock area.

These extinction effects predominate during the final phases of avoidance learning if shock is turned off after an avoidance criterion has been met. Extinction is primarily the result of new learning; stimuli that elicited the original response become elicitors of an incompatible response. It is assumed that relaxation is incompatible with fear and that approach is incompatible with withdrawal. And the relaxation and approach originally elicited by stimuli in the safe area, can backchain along the response sequence and into the shock area if the primary elicitor (shock) has been removed. When the stimuli that elicited fear and withdrawal become conditioned elicitors of relaxation and approach, S no longer avoids reliably.

Weisman, Denny, Platt and Zerbolio (1966) studied the role of relaxation on the extinction of avoidance responding by, in effect, shortcutting the normal backchaining process. They differentially paired a neutral stimulus (CS) with long safe area confinement periods. The presentation of this CS in the original shock area facilitated extinction of the avoidance response by, presumably, eliciting conditioned relaxation, a response incompatible with fear. This study also indicates that a stimulus can become an elicitor of conditioned relaxation as required by the backchaining analysis. Through backchaining, a response elicited by the termination of an aversive stimulus can eventually serve to extinguish the response conditioned by the presentation of an aversive stimulus.

True to the spirit of elicitation theory, which stresses a detailed analysis of all the actual stimuli and responses that occur in a behavioral situation, additional responses can be identified that might contribute to the "new learning" aspect of extinction. For example, Ss typically stop and turn around at the far end of the safe area after the initial escape and avoidance responses. The unconditioned stimulus for these responses is probably the wall of the apparatus working in conjunction with a reduction of aversive stimulation. But these responses do occur and, it is safe to assert, can be conditioned. The present investigator cannot cite any active avoidance studies in which these responses have been studied systematically. But informal observations do suggest that these responses backchain to the extent that it is sometimes difficult to close the door between shock and safe areas during the last trials of avoidance extinction.

Extinction of an avoidance response is primarily the result of learning incompatible responses. But unconditioned responses may also be partially responsible for the nonoccurrence of avoidance behavior. These responses--including exploratory activity, resting and grooming--seem to be quite compatible with relaxation but rather incompatible with fear. After fear has been reduced by the backchaining of relaxation, these unconditioned responses can occur in the shock area to facilitate extinction. For example, handling of S and other conditions of an experiment produce stimuli that would normally elicit grooming. But grooming is not compatible with fear and rapid escape and it seldom occurs in the shock area during the early phases of avoidance learning. Yet it is not unusual to see a rat groom for 10 to 15 seconds in the shock area shortly before reaching an extinction criterion.

The degree of extinction of avoidance behavior is typically assessed by simple measures of performance. These measures do not indicate that all learning that contributed to conditioned avoidance responding is extinguished even when S reaches a stringent extinction criterion. Such a criterion would almost surely indicate that directly conditioned withdrawal and approach responses are very weak. Under most conditions, it can also be assumed that fear has been brought to a very low level. But what is the fate of conditioned relaxation after S ceases to make the avoidance response?

After the last shock has been received and after fear has been extinguished, there is no source of unconditioned relaxation; the strength of conditioned relaxation cannot be expected to increase. But neither can relaxation be expected to extinguish under these conditions. Repeated presentation of a conditioned relaxer is not a sufficient condition to extinguish the response because relaxation cannot be elicited unless S is fearful. Therefore conditioned relaxation remains intact even after most avoidance extinction criteria have been met unless it has been counterconditioned by an incompatible response such as fear.

When conditioned relaxation is not extinguished by counter-conditioning, the approach responses, mediated by relaxation, are protected from extinction; a response elicited by a stimulus (relaxation-produced) is not generally extinguished in the absence of that stimulus. Mediated approach responses can be elicited again only when S relaxes after aversive stimuli have been reinstated. These approach responses, together with any withdrawal responses mediated by fear, account for the reappearance of an "extinguished" avoidance response after a fear-CS was presented in the test situation (Kamano, 1970) and the general observation that the "reacquisition" of avoidance responding is rapid.

A Model of Active Avoidance

Figure 1 expresses, in diagrammatic form, part of what has just been said about the relative contributions of withdrawal and approach to avoidance performance throughout the acquisition and extinction phases of training. Resistance to extinction is defined as the number of trials required before Ss reach an extinction criterion. Acquisition criterial trials may consist of avoidances and other non-shock trials and are counted to specify a level of avoidance learning. Resistance to extinction is plotted (Figure 1) as a function of the number of acquisition criterial trials.

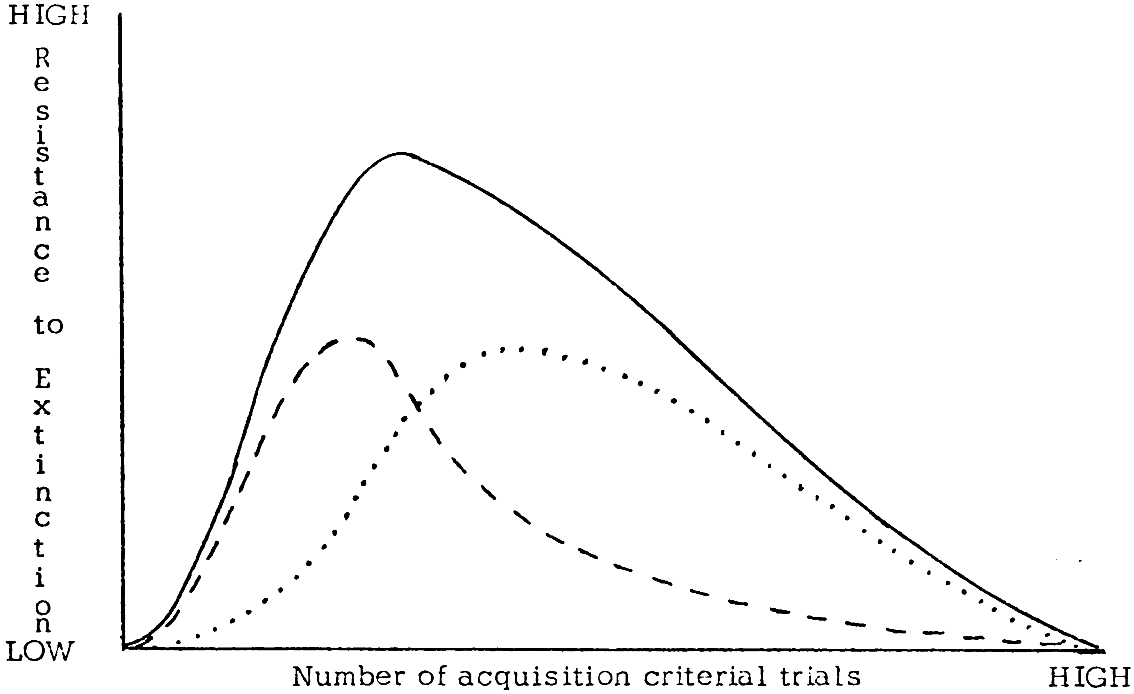

Figure 1. Model showing the resistance to extinction of an avoidance response as a function of the number of acquisition criterial trials. Total resistance (solid line) is sum of contributions from fear-withdrawal (dashed line) and relaxation-approach (dotted line).

Total resistance to extinction (solid line) first rapidly increases as the avoidance response is learned. But this function eventually decreases because the criterial trials are, in effect, extinction trials (no shock is presented). Total resistance to extinction is the sum of the contributions of withdrawal (dashed line), elicited primarily by shock area and fear produced stimuli, and approach (dotted line), elicited by safe area and relaxation produced stimuli.

This model is novel primarily because of the inclusion of relaxation-approach as a component of avoidance responding. Most accounts of avoidance rely almost exclusively on fear and withdrawal. The need for the relaxation-approach component has been suggested by a variety of familiar observations and laboratory data. For example, Sheffield and Tremmer (1950) observed that the avoidance response increases in probability and decreases in vigor as training progresses. If, as they assumed, response vigor is an index of fear motivation, it appears that the strength of the instrumental response increases as the motivation for the response decreases. In a similar vein, Woodworth and Schlosberg (1954) suggested that two phases of avoidance responding can be distinguished. During the first and early phase the effects of fear, evidenced by variable behavior, predominate. During the second or adaptive phase of avoidance learning there are few signs of fear even though S avoids smoothly and efficiently. These rather informal observations have been substantiated by more recent studies. Black (1959) measured the heart rate, an index of fear, of dogs during the extinction of an avoidance response. He concluded that continued avoidance responding does not depend on fear of the CS. Kamin, Brimer and Black (1963) used rats and a conditioned suppression measure to plot the strength of fear elicited by the CS through the acquisition and extinction of avoidance responding. The function relating the suppression measure to avoidance criterion was U-shaped. The observation common to all these studies is that the strength of fear first increases, then decreases, as instrumental avoidance becomes more reliable. This suggests that a factor other than fear-withdrawal, here identified as relaxation-approach, is also responsible for the maintenance of avoidance responding.

The two-component (fear-withdrawal and relaxation-approach) model of avoidance conditioning can be transformed into an experimental paradigm by devising an experimental situation in which the following assumptions are reasonable:

a) avoidance behavior is controlled by intra-apparatus stimuli,
b) the fear-withdrawal component of avoidance responding is elicited by the set of cues in the shock area of the one-way box,
c) relaxation-approach is elicited primarily by a second distinctive set of cues in the safe area,
d) there is a third set of stimuli that elicits a minimal amount of both fear-withdrawal and relaxation-approach, and
e) the fear-withdrawal and relaxation-approach components function independently.

If the above assumptions can be met the following general procedure can be employed to separate the contributions of fear-withdrawal and relaxation-approach to avoidance responding. A group of _S_s is trained in the one-way avoidance apparatus with dissimilar shock and safe areas until a specified acquisition criterion has been reached. After acquisition, this group is divided into 3 subgroups. One subgroup is used to test the contribution of relaxation-approach to avoidance performance. This is done by substituting, after acquisition, a third set of stimuli for those originally available in the shock area. The response decrement, measured in terms of resistance to extinction, that is produced by this manipulation represents the effect of reducing the fear-withdrawal component of avoidance responding. The number of trials required to reach an extinction criterion after this manipulation was intended to be primarily a measure of the relaxation-approach component.

The second subgroup is used to measure the contribution of fear-withdrawal to avoidance performance and this is done by changing the safe area cues. A third subgroup is used to determine if the contributions of fear-withdrawal and relaxation-approach, when measured independently, add up to yield the resistance to extinction obtained when no change of shock or safe area stimuli is made between the time that the acquisition criterion is reached and the beginning of the test. Thus, each of the 3 subgroups yields a point on one of the three curves of Figure I. This entire procedure is repeated for groups trained to different criteria levels, i.e., different points along the abscissa of Figure 1.

Passive Avoidance

In the present experiments, passive and active avoidance trials were combined in an attempt to increase the control of shock and safe area stimuli over avoidance responding as required to meet the assumptions for testing the model. On a passive avoidance trial, S was placed in the safe area of the apparatus. If S did not enter the shock area, a correct passive avoidance was scored. Active and passive avoidance responding were entirely compatible, so long as Ss responded primarily to shock and safe area stimuli, and both can be parsimoniously explained in the same terms. The S would, presumably, avoid passively if approach to the safe area and withdrawal from the shock area were sufficiently well conditioned. If S ran into the shock area in response, perhaps, to handling or directional stimuli, the shock, presented after 5 seconds, would strengthen conditioned fear and withdrawal responses. Conditioned relaxation and approach responses would be strengthened when S returned to the safe area. Thus, a correct passive avoidance, in conjunction with correct active avoidance, would indicate a discrimination between shock and safe area stimuli. An error on a passive avoidance trial led to conditions that strengthened withdrawal from the shock area and approach to the safe area.

A running response to the opposite chamber is correct on an active avoidance trial but incorrect on a passive avoidance trial. Therefore, stimuli produced by this response are not as central to the control of passive avoidance responding in these experiments as they may be in situations in which these stimuli can become conditioned elicitors of responses incompatible with the punished response (e.g., Dinsmoor, 1955). Because stimuli produced by the running response may initially become conditioned elicitors of fear, the punishment received after an error on a passive avoidance trial may produce regressions on subsequent active avoidance trials.

EXPERIMENT I

Purpose

Previous research indicated that rats require a minimum of 150 seconds of relaxation time between trials in order to maximally facilitate the acquisition of a one-way avoidance response. This finding has been interpreted as evidence for an approach response, mediated by relaxation, to the safe area of the apparatus. Shorter relaxation times produced both slower acquisition and slower extinction of the one-way avoidance response. One purpose of this experiment was to study the effect of acquisition relaxation time using a new experimental procedure designed to increase the control of shock and safe area stimuli over responding. A second purpose was to determine the role of shock and safe area stimuli in controlling any difference that might be produced by different relaxation times. In addition, control groups were run in order to test two aspects of the new procedure--the importance of eliminating directional stimuli by rotating the apparatus and the effect of safe area color (white or black) on acquisition and extinction.

Subjects

The *S*s were 64 experimentally naive, male albino rats obtained from Spartan Research Animals, Haslet, Michigan and were approximately 90-110 days of age at the time of the experiment. They were housed 3-5 per cage with *ad lib* food and water.

Apparatus

The basic apparatus for this experiment was a modified Miller-Mowrer shuttlebox. Two 4 x 18 x 14 in. compartments were separated by a guillotine door. This door, as well as the painted masonite liners on the inner walls of the compartments, could be removed and replaced with alternate sets of stimuli. Either compartment could be black, white or black with white diagonal, three-quarter inch, stripes. Appropriately painted smooth or rough (coarse sandpaper) inserts could also be placed on the floor of either compartment. The grid floor under the shock area consisted of 1/8 in. stainless steel rods placed 5/8 in. center to center. Scrambled shock was delivered to the grid of the shock compartment by an Applegate constant current stimulator. The floor under each compartment was hinged and supported by a spring over a microswitch to permit automatic measurement of response latencies. A latency timer started when the floor under one compartment was depressed by the weight of S and turned off when the floor under the opposite chamber was depressed. Both hinged floor sections were adjusted so that a 100 gram weight placed 12 in. from the guillotine door would close the switch.

Each chamber was diffusely illuminated by two 6-w. light bulbs built into the Plexiglas ceiling. These lights were connected to rheostats so that the incident light intensity on the floor of the apparatus could be adjusted to the same level regardless of the stimulus condition used in a compartment. Appropriately painted (black, white or striped) window screening placed over the Plexiglas ceiling in combination with dim lighting in the experimental room permitted S to be observed while S's view out of the apparatus was greatly restricted.

Access to the apparatus was provided by doors running the entire length of both sides of the compartments. The entire experimental chamber was mounted on a bearing and could be rotated. White noise was provided from a speaker mounted above the apparatus. A holding bucket, used to confine Ss during the intertrial interval, consisted of a large gray wastebasket.

A separate habituation box consisted of the end to end placement of replicas of the three stimulus conditions (black, white and stripes) used during training and testing.

Procedure

The training and testing procedure consisted of five phases--counterconditioning the aversiveness of handling, habituation to the apparatus, acquisition, extinction and a spontaneous recovery test.

The Ss were deprived of food for approximately 24 hours before counterconditioning began. The hungry rats were then placed in individual cages with a few food pellets in clean food cups. After eating the pellets, S was removed from its individual cage with one hand while another pellet was added to the food tray. The rat was then returned to the cage and allowed to eat. This procedure was repeated until the rat would eat almost immediately after being returned to the individual cage on a majority of trials. As handling became a CS for food presentation, S generally ceased to struggle in the hand. After meeting this informal criterion the rats were returned to the home cage with ad lib food and water for a least 12 hours before habituation and training.

The habituation phase began approximately 1/2 hour before training. First, the individual S was placed in the habituation box for 20 minutes. Next, S spent 3 minutes in the freshly washed avoidance apparatus with the shock turned off while the door between the shock area and the safe area remained open.

A procedure which combined active and passive avoidance trials was used throughout acquisition, extinction and spontaneous recovery. An active avoidance trial began when S was placed in the center of the shock area facing the open guillotine door that led to the safe area. The CS-US interval, the time between placement of S in the shock area and onset of shock, was 5 seconds. Active avoidance and escape response latencies were measured automatically and recorded. A response on an active avoidance trial was called an active avoidance if S entered the safe area within the CS-US interval.

After an avoidance or an escape response the door which separated the shock area from the safe area was closed. The safe area confinement period (SAC) for all Ss was 30 seconds throughout acquisition, extinction and spontaneous recovery. At the end of a trial, S was manually transferred to a holding bucket for the intertrial interval (ITI) defined as the time between the end of one trial and the beginning of the next.

A passive avoidance trial began when S was placed in the center of the safe area facing the open door to the shock area. If S remained in the safe area for 5 seconds, the guillotine door was closed for the remainder of the 30 second SAC and a passive avoidance was recorded. If S made the error of running into the shock area, the guillotine door was left open and the subsequent sequence of events was the same as for an active avoidance trial. That is, S could avoid primary punishment after making an error on a passive avoidance trial by returning to the safe area within the 5 second CS-US interval. After 5 seconds, S could escape by returning to the safe area. The latencies for entering the shock area, the punished response, and for returning to the safe area were measured automatically and recorded.

On some trials S was under the guillotine door that separated the shock area from the safe area at the end of 5 seconds. When this was the case, an attempt was made to close the door without bumping the rat. These partial responses added little ambiguity to response identification. Electric switches were opened and closed as S moved across the grid and floor of the apparatus. These switches controlled latency clocks upon which response identifications were based.

Active avoidance and passive avoidance trials were alternated on a predetermined schedule. The avoidance chambers were also rotated 180° on a schedule throughout acquisition, extinction and spontaneous recovery for all Ss except those in the Rotation Control group. Using "A" to indicate an active avoidance trial, "P" to indicate a passive avoidance trial and "-" to indicate apparatus rotation, the combined schedule of trials and rotations can be represented as A-P-AA-PP-A-AP-A-PP-AP-A. This sequence was repeated every 15 trials.

Grid shock, used only during acquisition, was adjusted within a range of 0.3 ma. to 0.5 ma. for individual Ss to reliably elicit agitated behavior. Several Ss that ran into the safe area without receiving a shock on the first acquisition trial were restarted after a 5 minute delay. The acquisition shock area was painted with diagonal black and white stripes for all Ss. The acquisition safe area was always white, except for the Color Control group, and the safe area floor was smooth. The acquisition criterion consisted of 7 consecutive correct responses. All but one possible combination of criterial responses required at least 3 active avoidances and 3 passive avoidances.

Extinction trials began 5 minutes after the acquisition criterion was met and continued until S reached the extinction criterion or for a maximum of 250 massed trials. The extinction criterion consisted of the back to back occurrence of one active avoidance trial on which S remained in the shock area for 30 seconds and one passive avoidance trial on which S ran into the shock area and remained there for 30 seconds. Whenever S remained in the shock area for 30 seconds it was removed and transferred directly to the holding bucket for the ITI. The ITI for all extinction trials was 20 seconds; the SAC was 30 seconds. The extinction shock and safe area stimuli were as required by the experimental design.

Spontaneous recovery was tested 30 minutes after the extinction criterion had been reached. The Ss which did not reach the extinction criterion within 250 trials were not tested for spontaneous recovery. Spontaneous recovery was always tested with the same shock and safe area stimuli that had been used during acquisition and trials were conducted in the same way as they had been run during extinction. The spontaneous recovery test was continued until S met the same criterion that was used during extinction or for a maximum of 150 trials.

Counters, operated by photocells, recorded the number of times that two light beams, passing through the safe area, were interrupted. The readings of these counters were recorded at the end of acquisition, extinction and spontaneous recovery and these readings served as an index of S's safe area activity.

Experimental Design

The six experimental groups in this study were formed by the factorial combination of a Short, 20 seconds, and a Long, 150 seconds, acquisition ITI with three extinction stimulus conditions. The ITI was a measure of relaxation time. The levels of the extinction variable were labeled the No Change (N.C.), Change Shock (C.Sh.), and Change Safe (C.Sa.) conditions. These extinction stimulus conditions were selected to facilitate identification of the stimuli controlling the predicted ITI effect.

The standard procedure for testing the effect of relaxation time on the acquisition and extinction of avoidance responding would have been to vary SAC while maintaining a constant interval of time between the start of consecutive trials. With this procedure, Ss having a long SAC would have relaxed in the safe area of the apparatus and would have been confined in the holding bucket for only a short interval of time between trials. The Ss trained with a short SAC would have been confined in the holding bucket for the long interval between the end of one trial and the beginning of the next (ITI). The latter Ss presumably would have relaxed in the holding bucket. Under these conditions there was good reason to expect rapid backchaining of this relaxation from the holding bucket to the safe area of the apparatus. On every trial, active or passive, S was transferred from the safe area to the holding bucket. The stimuli in the safe area would have been in a forward classical conditioning relationship with the unconditioned relaxation response which would have occurred in the holding bucket. The effects of relaxation on avoidance responding would have been comparable whether it had originated in the safe area or if it had originated in the holding bucket and backchained into the safe area. In effect relaxation time, a major experimental variable, would not have been varied if the time between the beginnings of consecutive trials had remained constant. This difficulty was encountered in a previous experiment (Denny and Weisman, 1964).

For this reason a procedure was adopted in which SAC was constant at 30 seconds while ITI, and therefore time between the start of consecutive trials, varied. This alternative procedure was accepted without great risk because measures of the effect of the extinction stimulus variable permitted direct evaluation of other possible explanations of the expected ITI effect--consolidation of a conditioned fear response, for example. Also, this procedure provided a test of the backchaining process upon which the rejection of the standard procedure was based.

The ITI for the standard extinction trials was 20 seconds--the same value used during acquisition for the short ITI groups. Thus, any generalization decrement produced by the change in ITI at the beginning of extinction for the Long ITI groups would work against the hypothesized higher resistance to extinction of these groups.

In this experiment, 24 Ss were trained with each of the two ITI's. Eight Ss from each ITI group were assigned to the No Change, Change Shock and Change Safe extinction stimulus conditions. No Change Ss were extinguished with the same shock and safe area stimuli that had been used during acquisition--namely, a black and white diagonally striped shock area with a grid floor and a white safe area with a smooth floor. After Change Shock Ss reached the acquisition criterion, the stimuli of the shock area were changed to black with a rough floor. The safe area for Change Safe Ss was changed to black with a rough floor.

The Ss in all groups were given a spontaneous recovery test which consisted of extinction trials run with the same stimuli that had been used during acquisition.

Two control groups were run. The Rotation Control group was run in the same manner as the Long ITI, Change Shock group except that the apparatus was never rotated. The Color Control group was run in the same way as the Long ITI, Change Safe group except that the safe area was black (instead of white) during acquisition and spontaneous recovery and the extinction safe area was white.

Results--Experimental Groups

Various measures of acquisition, extinction and spontaneous recovery were tested with a two-way fixed effects analysis of variance. The significance level for all comparisons is .01 unless specified otherwise. The results of these tests, summary statistics, and the raw data are presented in Appendix A. None of the measures, except those of safe area activity, include criterial trials.

The length of the ITI (20 sec. versus 150 sec.) had little effect on performance during acquisition. The two ITI groups reached criterion in about the same number of trials (17.3 versus 17.8). For both groups, these trials included a similar number of active avoidances (3.6 versus 3.3) and passive avoidances (5.6 versus 5.8). The mean trial number for the first active avoidance was 8.1 for the Short ITI group as compared to 10.0 for the Long ITI Ss. The Short and the Long ITI groups were also similar in terms of the trial number for the last error on an active avoidance trial (14.9 versus 15.0) and the trial number for the last error on a passive avoidance trial (11.1 versus 9.9).

The Short and the Long ITI groups received nearly identical amounts of shock when measured either in terms of the total number of shocks (5.8 versus 6.4) or the total amount of shock in seconds (34.9 versus 28.2). If it is assumed that the amount of shock is an important determinant of fear and withdrawal conditioning, this finding is one of several indications that the strength of the fear-withdrawal component of avoidance responding was not differentially affected by the ITI's used in this study.

The only acquisition variable yielding a significant main effect was the amount of activity during safe area confinement with Long ITI Ss being more active. Since exploratory activity is frequently identified as an observable sign of relaxation, this finding indicates that Long ITI Ss were more relaxed even though the effects of this additional relaxation were not evident in other measures of acquisition.

Although acquisition ITI had little effect on measures of avoidance responding during acquisition, the effects of this variable and of the extinction stimulus condition were clearly evident during extinction. Table 1 shows the mean number of trials to extinction for all six experimental groups. Both main effects and the interaction were significant.

Table 1. Extinction, Experiment I--Mean number of trials to criterion.

	N.C.	C.Sh.	C.Sa.	Marginal Means
Short ITI	101.8	13.8	68.0	61.2
Long ITI	203.3	37.6	68.1	103.0
Marginal Means	152.5	25.7	68.1	

No Change Ss were extinguished with the same shock and safe area stimuli that had been used during acquisition. Five out of eight No Change Ss trained with the long acquisition ITI were terminated after 250 massed extinction trials. Of the Short ITI Ss, the slowest to extinguish required 168 trials. Still, on the average, Long ITI No Change Ss required slightly over twice as many trials to extinguish as comparable Short ITI Ss. A look at the two change conditions helps to explain the origin of the very large ITI effect seen for the No Change groups.

The shock area was not altered at the beginning of extinction for Change Safe Ss. When the safe area was changed the overall level of responding dropped markedly. Perhaps of more interest is the fact that both Change Safe groups required, on the average, 68 trials to extinguish. Because the shock area stimuli were not changed, the extinction responses of Change Safe Ss were probably controlled primarily by shock area stimuli that elicit directly conditioned and fear-mediated withdrawal from the shock area. The nearly identical extinction performances of the two groups under the Change Safe condition, together with the similarities between these groups in acquisition performance and the amount of shock received, suggest that fear-withdrawal conditioning was equally effective for both ITI groups. The higher resistance to extinction of Long ITI Ss under the No Change condition is presumably the result of the superior conditioning of relaxation-mediated approach to the safe area made possible by the long opportunity to relax.

Change Shock Ss were extinguished with new shock area stimuli and the original safe area stimuli. This stimulus change produced an even larger overall response decrement than the one produced by changing the safe area stimuli. Change Shock Ss trained with a long ITI during acquisition required almost three times as many trials to extinguish, on the average, as Short ITI Ss indicating that safe area cues were more effective in supporting avoidance responding for Ss given more time to relax during acquisition. The individual comparison between the two Change Shock groups yields a difference, significant at the .05 level, when the scores are transformed to logarithms. This borderline level of statistical significance, together with the failure of the Change Shock and the Change Safe groups to add up to yield the resistance to extinction obtained with the appropriate No Change groups, suggests that the Change Shock manipulation is not fully adequate for the measurement of conditioned approach. The change in shock area stimuli produced a large overall response decrement. Presumably this decrement was the result of a reduction in the strength of the fear-withdrawal component. But the data and the theory both suggest that relaxation-mediated approach cannot be measured in the absence of fear. According to the theory, Ss must be fearful before they can relax. Also, the data provide clear evidence for both a large ITI effect and comparable levels of fear-withdrawal conditioning for the two ITI groups. Thus the relaxation-approach component is necessary to explain the higher resistance to extinction of Long ITI Ss but cannot be adequately measured under the Change Shock condition.

The number of trials that an individual group would require to extinguish cannot be accurately estimated if the effects of the two main variables, acquisition ITI and extinction stimulus condition, are considered individually. Although the overall effect of ITI was significant, the scores of the two Change Safe groups were almost identical. The 20 second and 150 second acquisition ITIs produced comparable levels of fear conditioning. The obtained difference between the No Change groups was much larger than would be expected from consideration of ITI alone. The ITI effect worked through the safe area stimuli and was especially large when Ss were extinguished with both the original shock and safe area cues.

The data on trials to extinction also reflect another type of non-additivity which was especially evident for the Long ITI groups. The total obtained by summing the trials to extinction of the Change Shock and the Change Safe groups fell far short of the trials required by No Change Ss. This finding provides additional evidence that relaxation does not mediate approach responding in the absence of fear.

Table 2 presents the number of active avoidances, the number of passive avoidances, and the total number of correct responses made during the extinction phase of testing.

Table 2. Extinction, Experiment I--Mean number of active avoidances (Act.), mean number of passive avoidances (Pas.), and mean total number of correct responses made before criterion.

	N.C.			C.Sh.			C.Sa.		
	Act.	Pas.	Total	Act.	Pas.	Total	Act.	Pas.	Total
Short ITI	46.0	39.3	85.3	5.1	2.8	7.9	28.3	22.3	50.8
Long ITI	102.8	83.1	185.9	12.9	9.3	22.1	26.8	20.4	47.1

Examination of the total number of correct responses made during extinction, as well as the measures of active and passive avoidances considered separately, reveals essentially the same relationships described for the trials to extinction measure.

When comparing the number of active avoidances with the number of passive avoidances, it is important to realize that for every 8 active avoidance trials there were only 7 passive avoidance trials (see

"Procedure"). Thus, the small margin by which active avoidances consistently outnumber passive avoidances is largely artifactual. But these data do make it clear that performance with the combined active-passive avoidance procedure cannot be understood by assuming a separate active avoidance response, elicited by shock area cues independently of safe area stimuli, and a separate passive avoidance response, elicited by safe area cues independently of shock area stimuli. Rather, both active and passive avoidance responses were controlled by both shock and safe area cues. A change in either shock or safe area stimuli reduced the number of both active and passive avoidances to comparable levels.

Table 3 presents the means for the percentage of active avoidances on active avoidance trials, the percentage of passive avoidances on passive avoidance trials, and the total percentage of correct responses made before the extinction criterion was met.

Table 3. Mean percentage of active avoidances on active avoidance trials (Act.), mean percentage of passive avoidances on passive avoidance trials (Pas.), and mean total percentage of correct responses during extinction.

	N.C.			C.Sh.			C.Sa.		
	Act.	Pas.	Total	Act.	Pas.	Total	Act.	Pas.	Total
Short ITI	87.1	79.3	83.6	53.3	49.6	49.6	67.8	64.6	66.3
Long ITI	93.0	87.1	90.1	59.1	41.1	51.1	74.9	51.8	63.5

The measure of the percentage of correct responses during extinction yields a significant extinction stimulus condition effect. Neither the

ITI effect nor the interaction approach significance. No Change Ss responded most accurately; Change Shock Ss responded least accurately. This ordering of the means is of interest since it has been suggested that fear and withdrawal responses can continue to support some degree of avoidance responding in the absence of the original safe area stimuli but that relaxation cannot mediate approach responses in the relative absence of fear. For this reason, the fact that Change Safe Ss responded more accurately than Change Shock Ss could be meaningful and this particular comparison is statistically significant ($t = 2.69$, $df = 14$, $p < .01$).

The extent to which running responses were based upon a discrimination between shock and safe area stimuli was tested with an index of discrimination. In calculating this index, only running responses with latencies less than 5 sec. were considered. The number of short latency runs that occurred on passive avoidance trials was subtracted from the number of these responses that occurred on active avoidance trials. In this way, Ss that would persistently withdraw from the shock area and approach the safe area would receive a high value on the index of discrimination. The Ss that ran in response to other stimuli would receive a low value even if they required many trials to reach the extinction criterion. The means for all groups on this measure are tabulated in Table 4.

Table 4. Extinction, Experiment I--Mean index of discrimination.

	N.C.	C.Sh.	C.Sa.	Marginal Means
Short ITI	39.6	2.0	22.3	21.3
Long ITI	94.6	6.9	18.0	39.8
Marginal Means	67.1	4.4	20.1	

The effects of acquisition ITI, extinction stimulus condition and the interaction between these two variables on the index of discrimination were all significant. No Change Ss made the largest number of discriminated responses. The discrimination index dropped to about one-fifteenth of the No Change level when the shock area stimuli were changed. A change in safe area stimuli dropped this index to less than one-third of the No Change level.

The Ss trained with a long ITI made more discriminated responses during extinction. But the significant overall ITI effect was produced almost entirely by No Change Ss. The individual comparison for the two No Change groups was highly significant ($F = 25.319$, $df = 1/42$, $p < .005$). This difference would be even larger if the extinction test for five Long ITI, No Change Ss was not discontinued after 250 trials. Clearly the long acquisition ITI produced a better discrimination between shock and safe area stimuli during extinction.

The extinction responses of Change Safe Ss were presumably controlled primarily by the original shock area stimuli. If the superior performance of the Long ITI Ss under the No Change condition was controlled by the fear and withdrawal conditioned to shock area stimuli, then Long ITI Change Safe Ss would have scored much higher than Short ITI Change Safe Ss on the index of discrimination. The actual difference between the means of the two Change Safe groups was small and in the opposite direction. The index of discrimination provides no evidence to suggest that the large ITI effect was controlled by shock area stimuli. The relaxation-approach component presumably controlled the ITI effect.

In addition to requiring more trials to extinguish, Ss trained with a long acquisition ITI were more active in the safe area during extinction ($p < .05$). Other data suggest that the higher resistance to extinction of Long ITI Ss was due to a stronger relaxation-approach component of avoidance responding. Since it is assumed that exploratory activity is an observable correlate of relaxation, this interpretation of the data is supported.

As a final test, all Ss that reached the extinction criterion within the alloted 250 trials were re-extinguished with the same shock and safe area stimuli used during acquisition. The mean number of trials of spontaneous recovery for each group is listed in Table 5.

Table 5. Spontaneous recovery, Experiment I--Mean number of trials to extinction criterion.

	N.C.	C.Sh.	C.Sa.	Marginal Means
Short ITI	7.5	60.4	9.3	25.7
Long ITI	6.0	60.0	10.1	30.5
Marginal Means	7.1	60.2	9.7	

The effect of the extinction stimulus variable is significant. No Change Ss required only about 7 trials to reach the extinction criterion a second time. But when the acquisition shock area stimuli were reinstated, both Change Shock groups required about 60 trials to reach the same criterion. This finding testifies to the high degree of stimulus control attained with the combined active-passive avoidance procedure. It also bolsters the evidence for comparable levels of fear-withdrawal conditioning in both acquisition ITI groups.

Only about 10 trials of spontaneous recovery were attained when the safe area stimuli were reinstated--only a few more trials than required by No Change Ss. Since the fear which Change Safe Ss had of the shock area had been extinguished, relaxation-mediated approach responding could not be elicited when the safe area cues were reinstated.

Table 6 separates the mean number of correct responses made during spontaneous recovery into active avoidances and passive avoidances.

Table 6. Spontaneous recovery, Experiment I--Mean number of active avoidances (Act.), mean number of passive avoidances (Pas.), and mean number of correct responses.

	N.C.			C.Sh.			C.Sa.		
	Act.	Pas.	Total	Act.	Pas.	Total	Act.	Pas.	Total
Short ITI	3.0	0.3	3.3	25.1	24.9	50.0	2.9	1.0	3.9
Long ITI	2.0	0.3	2.3	23.4	22.8	46.1	2.1	2.6	4.8

The effect of the extinction stimulus condition was significant for all three variables--number of correct responses, number of active avoidances and number of passive avoidances. These data corroborate the conclusions made on the basis of an analysis of the trials of spontaneous recovery measure, namely, the high quality of the stimulus control, the effectiveness of the reinstated shock area cues in eliciting the fear-withdrawal component, and the ineffectiveness of the reinstated safe area stimuli in eliciting the relaxation-approach component after fear of the shock area had been extinguished.

The means for the percentage of correct responses, the percentage of active avoidances on active avoidance trials and the percentage of passive avoidances on passive avoidance trials during spontaneous recovery are presented in Table 7.

Table 7. Spontaneous recovery, Experiment I--Mean percentage of active avoidances (Act.), mean percentage of passive avoidances (Pas.), and mean percentage of correct responses.

	N.C.			C.Sh.			C.Sa.		
	Act.	Pas.	Total	Act.	Pas.	Total	Act.	Pas.	Total
Short ITI	69.1	33.4	49.9	58.9	63.3	62.8	53.4	31.3	44.0
Long ITI	40.3	5.7	26.3	61.8	63.8	62.5	51.0	41.3	53.6

Of the nine main effect and interaction tests that can be made for these three measures of spontaneous recovery--percent active avoidances, percent passive avoidances and percent correct responses--only the test of the effect of extinction stimulus condition on the percentage of passive avoidances reached significance at the .05 level. The mean for this passive avoidance measure was smallest for Ss extinguished with the original shock and safe area stimuli. These No Change Ss were expected to make very few avoidances during spontaneous recovery because 30 minutes prior to the recovery test they had reached the same stringent extinction criterion. The Change Shock Ss had the highest combined percentage of passive avoidances during spontaneous recovery--63.5 percent. This can be compared with a combined mean of 36.3 percent passive avoidances for the two Change Safe groups. In other words, responses on passive avoidance trials were more accurate after the shock area stimuli had been reinstated than after the safe area stimuli had been reinstated. But fear of the shock area had already been extinguished before the safe area stimuli were reinstated for the Change Safe group at the beginning of spontaneous recovery.

Once again, these data suggest that the safe area does not function as a goal in the absence of fear.

Results--Control Groups

The Rotation Control group was compared with the Long ITI, Change Shock group; the Color Control group was compared with the Long ITI, Change Safe group. The hypothesis of equal means was tested for various measures of acquisition, extinction and spontaneous recovery. Bartlett's method was used to test the equality of variances. When the assumption of homogeneity was rejected at the .05 level, a more conservative two-tailed t-test, based on the Welch approximation, was used (Winer, 1962).

At least two sets of exteroceptive stimuli could control avoidance behavior when the combined active-passive avoidance procedure is employed in a stationary apparatus. These are the extra-apparatus directional stimuli and the intra-apparatus shock and safe area stimuli. When the apparatus is stationary, as it was for the Rotation Control group, avoidance responses could have been elicited by either of these sets of stimuli. A S could either run to a particular end of the apparatus in response to directional stimuli or it could learn to fear and withdraw from the shock area and to approach and relax in the safe area. When the apparatus was rotated, as it was for all experimental groups, correct responses were controlled primarily by a discrimination between these intra-apparatus shock and safe area stimuli. The tests of various acquisition variables, summarized in Table 8, suggest that the directional response was generally learned

Table 8. The effects of a stationary (S) versus a rotated (R) apparatus on the acquisition of avoidance responses.

Variable	Group	Mean	Standard Deviation	t	Adjusted df
Trials to Criterion	S	7.6	4.2	4.522*	14
	R	20.5	6.8		
Last Error-- Active Trial	S	6.8	4.6	3.201*	14
	R	16.9	7.7		
Last Error-- Passive Trial	S	1.6	3.1	2.314**	8
	R	10.5	10.4		
Number of Correct Responses	S	3.6	2.5	3.476*	14
	R	11.1	5.6		
Number of Active Avoidances	S	0.9	1.2	2.496**	9
	R	4.3	3.6		
Trial Number of First Active Avoidance	S	7.9	4.6	0.412	14
	R	8.9	5.1		
Number of Passive Avoidances	S	2.8	2.1	2.663**	14
	R	6.9	3.9		
Trial Number of First Passive Avoidance	S	2.4	1.1	0.200	14
	R	2.5	1.4		
Shocks on Active Trials	S	3.9	2.4	2.289**	14
	R	6.8	2.7		

Table 8. (continued)

Variable	Group	Mean	Standard Deviation	t	Adjusted df
Shocks on Passive Trials	S	0.1	0.4	2.220	8
	R	1.3	1.4		
Total Number of Shocks	S	4.0	2.3	3.434*	14
	R	8.0	2.4		
Total Amount of Shock	S	14.1	11.4	1.774	14
	R	27.9	18.8		

*p .01

**p .05

first and, once learned, this response interfered with discriminated avoidance responding.

The mean number of trials required to reach the acquisition criterion was significantly increased from 7.6 to 20.5, excluding criterial trials, by apparatus rotation. Yet the stationary group and the rotated group both made their first active avoidances at about the same time (mean trial number 7.9 versus 8.9). The first passive avoidances also occurred at about the same time (mean trial number 2.4 versus 2.5). Apparently, the first active avoidances were directional responses regardless of whether the apparatus was rotated or stationary. The most important difference between these two groups is that once Ss trained in the stationary apparatus learned to make the directional response, they reached the acquisition criterion almost immediately. These Ss made their first active avoidance on mean trial number 7.9 but required a mean of only 7.6 trials to reach the acquisition criterion. But when the apparatus was rotated, discriminated avoidance responding had to replace the original directional response. This resulted in a phase of training during which Ss in the rotated apparatus made a mean of 11.1 correct responses before they were able to meet the criterion of seven consecutive correct responses. The Ss in the Rotation Control group (stationary apparatus) made a total of 2 errors on passive avoidance trials as compared to a total of 34 errors by Ss trained in the rotated apparatus. This indicates that directional running responses can interfere with passive avoidance responding when the apparatus is rotated. The Ss in the rotated apparatus also received a significantly larger number of shocks.

In summary, Ss trained in a rotated apparatus had to perform in a manner similar to Ss trained in a stationary apparatus in order to meet a common acquisition criterion. Yet the course of learning was quite different for the two groups and Ss in the Rotation Control group met the criterion by responding to either of two sets of stimuli. Only when the apparatus was rotated could avoidance responding be safely attributed to a discrimination between shock and safe area stimuli.

Tests of the effects of apparatus rotation on several extinction variables are summarized in Table 9. One of the most striking characteristics of these extinction data is the high variability of Ss tested in the stationary apparatus as indicated by comparing the standard deviations of the two groups in Table 9. This is illustrated less abstractly by the individual extinction response patterns of Ss in the Rotation Control group. One S was terminated after 250 consecutive correct responses--all these active and passive avoidances were made after the original shock area stimuli had been replaced. Another S, requiring 140 trials to reach the extinction criterion, made only 2 passive avoidances while responding correctly on 88% of the active avoidance trials. Three Ss, requiring 18, 61, and 64 trials to extinguish, made no active avoidances but responded correctly on all passive avoidance trials. Apparatus rotation, at least when used in conjunction with the combined active-passive avoidance procedure, increases the

Table 9. The effects of a stationary (S) versus a rotated (R) apparatus on the extinction of avoidance responses.

Variable	Group	Mean	Standard Deviation	t	Adjusted df
Trials to Criterion	S	92.8	72.9	-1.854	14
	R	37.6	42.0		
Number of Correct Responses	S	63.5	77.1	-1.426	9
	R	22.1	28.0		
Number of Active Avoidances	S	29.3	47.6	-0.936	8
	R	12.9	13.5		
Percent Correct Active (A)	S	35.8	39.4	1.350	14
	R	59.1	29.0		
2 out of 3 Active Errors	S	49.1	93.7	-1.229	7
	R	8.3	8.5		
Number of Passive Avoidances	S	34.3	35.0	-1.852	10
	R	9.3	15.3		
Percent Correct Passive (B)	S	85.0	33.4	-2.493*	14
	R	41.1	36.9		
2 out of 3 Passive Errors	S	75.6	76.1	-2.638*	7
	R	4.5	4.1		
A+(100-B)	S	50.8	64.3	2.150*	14
	R	118.0	60.8		
Activity in Safe Area--Extinction	S	6.4	1.8	2.372*	14
	R	9.5	3.2		

*p .05

control of intra-apparatus stimuli over avoidance behavior. Good control by shock and safe area stimuli was essential if manipulations of the extinction stimulus condition, a major variable in these studies, were to produce reliable effects.

Despite high group variability, several tests of extinction variables were significant at the .05 level. When the apparatus was stationary, Ss made a larger percentage of passive avoidances and required far more trials to make two errors out of three passive avoidance trials. These passive avoidances were probably controlled by directional stimuli rather than a discrimination between the shock and the safe area stimuli. The Ss trained in the rotated apparatus ran on a larger percentage of all the extinction trials, whether active or passive, as indicated by an index that combined active avoidances with punished running responses, A+(100-B). This finding, together with the acquisition data, indicates that Ss required more trials to learn, and fewer trials to forget, discriminated avoidance than directional running. The Ss tested in the rotated apparatus were also more active in the safe area suggesting that these Ss had formed a better discrimination between safe area stimuli and stimuli to be feared.

The original safe area was white for all experimental groups and it was changed to black during extinction for the Change Safe Ss. A Color Control group was included in the present study to test the possibility that color of the safe area would influence performance. This control group was trained and tested in the same way as the Long ITI, Change Safe group except that the colors of the safe area were

Table 10. The effects of safe area color on the acquisition and extinction of avoidance responses.

Variable	Group[1]	Mean	Standard Deviation	t	Adjusted df
Trials to Acquisition Criterion	B-W	14.9	10.9	0.341	14
	W-B	16.6	9.6		
Number of Correct Responses--Acquisition	B-W	8.5	7.9	-0.178	14
	W-B	7.9	6.0		
Number of Active Avoidances--Acquisition	B-W	2.6	3.1	-0.685	14
	W-B	1.8	1.8		
Number of Passive Avoidances--Acquisition	B-W	5.9	5.5	0.097	14
	W-B	6.1	4.8		
Total Number of Shocks	B-W	6.1	4.0	1.049	14
	W-B	8.1	3.6		
Activity in Safe Area--Acquisition	B-W	9.9	2.1	-0.304	9
	W-B	9.2	5.6		
Trials to Extinction Criterion	B-W	45.5	34.3	1.051	14
	W-B	68.1	50.3		
Number of Correct Responses--Extinction	B-W	34.6	32.5	0.627	14
	W-B	47.1	46.1		
Number of Active Avoidances--Extinction	B-W	16.3	17.8	1.120	14
	W-B	26.8	19.6		
Number of Passive Avoidances--Extinction	B-W	18.4	15.0	0.177	14
	W-B	20.4	28.2		

[1]B-W -- Black safe area during acquisition, White during extinction.
W-B -- White safe area during acquisition, Black during extinction.

reversed, during acquisition and extinction. Tests of several acquisition and extinction measures are listed in Table 10. No significant differences were found. Apparently, color of the safe area did not affect the outcome of these experiments. Since the incident light intensity at the floor of the apparatus had been adjusted to the same level after each change of stimuli, no color effect was expected (see "Apparatus").

Discussion

The pilot work which preceded this study made it painfully clear that a variety of avoidance procedures, consisting of active avoidance and escape trials, would not produce the quality of stimulus control that was required to test the fear-withdrawal, relaxation-approach model. With these procedures, acquisition was rapid but the effects of manipulating the extinction stimulus variable were generally unpredictable. The combined active-passive avoidance procedure, when used in conjunction with apparatus rotation and a demanding acquisition criterion, delayed acquisition but produced enough stimulus control to permit the experimenter to obtain reliable results when the shock or safe area stimuli were changed.

The long acquisition ITI produced high resistance to extinction--especially for No Change Ss. Is this effect produced by the push (fear-withdrawal) or by the pull (relaxation-approach) component of avoidance learning?

Many observations indicate that fear-withdrawal conditioning was not responsible for the ITI effect. For example, both ITI groups were very similar with regard to one of the most important variables known to control the amount of fear conditioning--number of pairings of the fear-CS with shock. During extinction the Change Safe groups, extinguished with the original shock area stimuli, demonstrated that the fear-withdrawal component was of nearly equal strength for the two ITI groups. Both groups performed alike. Although evident for all variables, this is seen most directly for mean number of trials to extinction (Short ITI, 68.0; Long ITI, 68.1).

All of the spontaneous recovery data for Change Shock Ss supports the argument for comparable levels of fear-withdrawal condtioning for the two ITI groups. For example, compare these groups on mean number of trials to the extinction criterion (Short ITI, 60.4; Long ITI, 60.0). The performances of these Change Shock groups were similar after the shock area stimuli had been reinstated after extinction trials with the original safe area. In fact, the performance of these Change Shock groups during spontaneous recovery was very similar to the performance of both Change Safe groups during extinction. The mean number of trials to reach the extinction criterion for these four groups had a range of only 8.1 trials. It is reasonable to assume that the avoidance behavior of the four groups under these conditions is controlled primarily by fear and withdrawal responses conditioned to shock area stimuli.

For these reasons, the higher resistance to extinction of Long ITI Ss is attributed to relaxation-approach. No major alternative to the push or the pull components is envisioned. And independent evidence for the role of relaxation in producing the ITI effect was obtained from the safe area activity measures obtained during acquisition and extinction.

If only the No Change groups were included in this study it would have been easy for many theorists to conclude, falsely, that the acquisition ITI's used in this study had a large effect on fear and withdrawal conditioning. The extinction data from Change Safe Ss and the spontaneous recovery data from Change Shock Ss effectively discount this interpretation.

It may seem puzzling that ITI, which had such a large effect during extinction, had almost no effect on acquisition performance. But the seven trials which constituted the acquisition criterion intervened between acquisition and extinction. And these trials were also conditioning trials. No fear was conditioned since, by definition, Ss received no shocks during the criterial trials. But unconditioned relaxation is elicited after the escape from aversive stimuli, especially for Ss in Long ITI groups. When conditioned during the criterial trials, this relaxation could mediate approach responding and increase resistance to extinction. The results of Experiment II clarify this process.

EXPERIMENT II

Purpose

The fear-withdrawal, relaxation-approach model of avoidance conditioning specified that the relative contributions of the two components change systematically during the course of training. Early avoidance responses are primarily fear-mediated and directly conditioned withdrawal responses from the shock area stimuli. Later avoidances are controlled primarily by relaxation-mediated approach to safe area stimuli. The present experiment is designed to measure the control exercised by shock and safe area stimuli at different levels of avoidance training.

Subjects and Apparatus

The Ss were 96 rats of the same kind described in Experiment I. The apparatus was also the same.

Procedure

The procedure was the same as in Experiment I except that three additional acquisition criteria were used as required by the experimental design. The low acquisition criterion consisted of two consecutive avoidances, one active and one passive, occurring after at least one error on a passive avoidance trial. If the required avoidances were completed without an error on a passive avoidance trial by trial number 15, S was considered to have met the low criterion. The stipulations about an error on a passive avoidance trial were included in the specification of the low criterion in order to assure minimal conditions for the formation of a discrimination between shock and safe are stimuli.

The medium acquisition criterion consisted of 7 consecutive avoidances--the same criterion that was used for Experiment I. All Ss in the other two levels of the acquisition criterion variable first had to meet the medium criterion. The Ss in the high criterion groups then received 11 additional trials which were conducted in the same manner as the other acquisition trials except that the grid shock was turned off. The Ss in the highest criterion groups received 28, instead of 11, additional trials. Shock was turned off during these additional trials to minimize the high resistance to extinction produced by punishing failures to avoid (Denny and Dmitruk, 1967).

Experimental Design

The twelve experimental groups in this study were formed by the factorial combination of four acquisition criteria and three extinction stimulus conditions. The four levels of the acquisition criterion variable were labeled Low, Medium, High and Highest. As in Experiment I, the three levels of the extinction variable were labled No Change, Change Shock and Change Safe.

The Medium Criterion groups of Experiment II are the same as the Long ITI groups of Experiment I.

Results

Various measures of acquisition, extinction and spontaneous recovery were tested with a two-way fixed effects analysis of variance.

The significance level for all comparisons is .01 unless specified otherwise. The results of these tests, summary statistics, and the raw data are presented in Appendix B.

No significant difference was obtained between the extinction stimulus condition groups on any acquisition variable. The effects of stimulus condition during extinction and spontaneous recovery cannot be attributed to differences in acquisition performance.

Acquisition criterion was expected to affect certain measures of acquisition performance. For example, the trials to criterion measure produced a difference, significant at the .05 level, with Low Criterion groups requiring, as expected, the smallest number of trials. Also, a difference significant at the .05 level was obtained for number of correct responses before criterion with Low Criterion groups making the smallest number of avoidances. But, in addition to these anticipated differences, there is some indication that the criterion groups differed in some other way. When the four criterion groups were measured to a common (low) criterion, a difference significant at the .05 level was still obtained as indicated in Table 11. The Highest Criterion groups reached the low criterion in fewer trials than any other criterion groups. This result was not expected and it does complicate the interpretation of the extinction data.

The groups trained to each of the four criteria also differ at the .05 level in the mean trial number of the first active avoidance (Low, 10.1; Medium, 10.0; High, 8.3; Highest, 6.3). Both measures, trials to low criterion and trial number of the first active

Table 11. Acquisition, Experiment II--Mean number of trials to the low acquisition criterion.

	N.C.	C.Sh.	C.Sa.	Marginal Means
Low	13.5	9.3	13.9	12.2
Medium	11.3	12.4	11.8	11.8
High	14.5	14.3	10.6	13.1
Highest	9.4	8.8	8.0	8.7
Marginal Means	12.2	11.2	11.1	

avoidance, indicate that the Highest Criterion groups were anomalous in that they reached the same level of learning most rapidly. When the Highest Criterion groups were excluded from the analysis, the differences between the Low, Medium and High Criterion groups on trials to low criterion did not approach significance ($F < 1$). Actually, Ss in the Highest Criterion groups were trained and tested several months after all the other groups were completed. Some unknown variable associated with this delay may have produced the superior acquisition performance of the Highest Criterion groups.

There is at least one significant indication that the performances of the High and the Highest Criterion groups were comparable before the extinction phase of testing began. Both of these groups received additional acquisition trials after shock was turned off after 7 consecutive avoidances (medium criterion). The High and Highest Criterion groups were compared in terms of the number of avoidances made during the first 11 trials occurring after the medium criterion had been reached. The High Criterion group made a mean of 9.9 avoidances and the Highest Criterion group made a mean of 9.3 avoidances. This difference does not approach significance ($t = .67$, $df = 46$, $p > .05$). Although the Highest Criterion groups differed from the three other criterion groups during the pre-criterial trials, the High and the Highest Criterion groups were similar during criterion trials even after shock was turned off. Thus, although there is some evidence to the contrary, differences between the criterion groups during extinction and spontaneous recovery probably can be attributed to the effects of acquisition criterion on learning.

Figure 2 shows the mean number of trials to the extinction criterion for all groups. The effects of acquisition criterion and extinction stimulus condition are both significant at the .01 level and there is some evidence for an interaction ($p < .05$).

The effect of acquisition criterion on resistance to extinction is most evident for the No Change groups. Of these, the Medium Criterion group was, by far, the most resistant to extinction. The significantly higher resistance to extinction of the Medium Criterion No Change group over the Low Criterion No Change group ($F = 12.40$, $df = 1/84$, $p < .01$) cannot be attributed to a difference in the number of shocks received during acquisition. If it is assumed that more shocks would produce higher resistance to extinction, the actual difference in the mean number of shocks for these two groups was in the opposite direction (Medium, 6.6; Low, 8.5). This is one reason why the higher resistance to extinction of the Medium Criterion

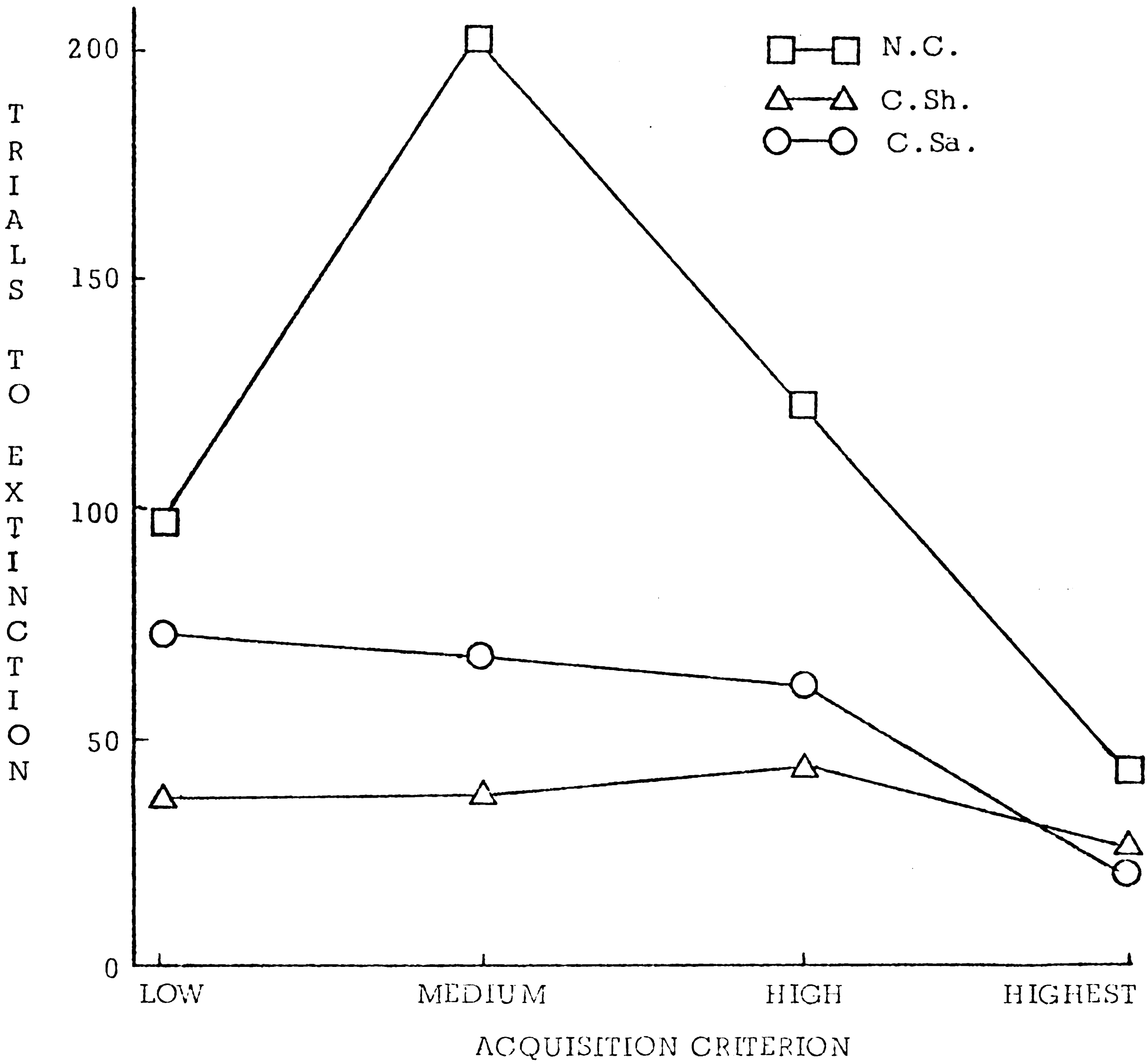

Figure 2. Trials to extinction as a function of acquisition criterion for the No Change, Change Shock, and Change Safe groups.

No Change group is attributed to conditioned relaxation-approach. Presumably, most of this relaxation-approach was conditioned during the initial criterial trials when no shock was given.

When additional shock free trials were added to the acquisition criterion, resistance to extinction under the No Change condition was reduced as indicated by the significant differences between the Medium and High Criterion groups ($F = 7.07$, $df = 1/84$, $p < .01$) and the High and Highest Criterion groups ($F = 7.32$, $df = 1/84$, $p < .01$). Presumably the relaxation which occurred during the long ITI that was used during the criterial trials backchained into the shock area to extinguish the active and passive avoidance responses. Thus, resistance to extinction first increased (Medium Criterion No Change group), then decreased (High and Highest Criterion No Change groups) as the elicitation and backchaining of relaxation continued through the increasing numbers of criterial trials.

The High and the Highest Criterion groups provide evidence that avoidance responses were partially extinguished during the criterial trials. Both criteria required additional shock free trials after the medium criterion had been reached. The overall error rate on the first 11 of these "additional" trials for the High and Highest Criterion groups was 12.6 percent. The overall error rate on the last 17 "additional" trials for the Highest Criterion group increased to 31.4 percent. The percentage of avoidance responses decreased as the criterial trials progressed and as relaxation backchained.

Both the Change Shock and the Change Safe conditions drastically

reduced overall resistance to extinction. The relatively high resistance to extinction of the No Change groups, especially the Medium Criterion No Change group, cannot be attributed to the isolated control of either the shock area stimuli or the safe area stimuli. A change in either of these sets of stimuli reduces resistance to extinction to a comparable level. Even the largest difference in resistance to extinction between a Change Shock group and a Change Safe group is not statistically significant.

When mean trials to extinction are considered across criteria, the Change Safe groups are consistently, though not significantly, higher than the Change Shock groups except with the highest criterion where resistance to extinction is very low even under the no change condition. This generally higher resistance to extinction of the Change Safe groups does not necessarily indicate that the avoidance responses were controlled relatively more by shock area stimuli, than by safe area stimuli at the beginning of the extinction test. The Change Safe condition was similar to the experimental situations that were used in the classical demonstrations of acquired drive. In both, Ss could learn to escape a fear-CS by approaching a relatively neutral safe area. Thus it is possible that much of the resistance to extinction evidenced by Change Safe groups may have been a result of responses conditioned during the extinction phase of testing. This consideration weakens what little evidence these data may provide to indicate that directly conditioned and fear-mediated withdrawal from shock area stimuli contributed more to resistance to extinction than relaxation-mediated approach to safe area stimuli.

The means of the Change Safe groups for resistance to extinction show a slow but steady decline across the low, medium, high and highest acquisition criteria (Figure 2). Although none of the differences among these groups are statistically significant, the steady decline suggests a reduction in fear of shock area stimuli as the number of shock-free criterial trials was increased.

The resistance to extinction of Change Safe groups does not parallel the resistance to extinction of the corresponding No Change groups. Most notably, the high resistance to extinction of the Medium Criterion No Change group cannot be attributed to a higher level of fear and withdrawal conditioned to shock area stimuli. A comparison of Low and Medium Criterion groups indicated that the resistance to extinction of the avoidance responses increased even as the strength of conditioned fear apparently decreased.

The resistance to extinction of the Change Shock groups was low and relatively constant across all criteria. The extinction data from these groups do not explain the effect of acquisition criterion on resistance to extinction. As in Experiment I, the Change Shock condition was probably not suitable for the measurement of conditioned relaxation-approach. In these experiments, the role of the relaxation-approach component is inferred from other observations.

Other measures of extinction performance summarized in Appendix B--namely, number of correct responses, number of active avoidances, number of passive avoidances, and the index of discrimination--yielded essentially the same pattern of results already described for the trials to extinction measure. The number of active and passive avoidances was similar within each criterion-change condition group. This comparison indicates that both classes of response were dependent upon both shock and safe area stimuli. The index of discrimination indicates that there was very little conditioned discrimination between shock and safe area stimuli after the highest criterion had been reached.

Figure 3 shows the mean number of trials required to reach the extinction criterion during the spontaneous recovery test. The No Change groups required an overall mean of only 6.6 trials to reach the extinction criterion a second time. This low level of responding is assumed to approximate the number of trials that would be required to reach the extinction criterion even if no training had been given.

When the original shock area stimuli were reinstated, the Change Shock groups were consistently more resistant to extinction than the corresponding No Change or Change Safe groups. It is possible that the resistance to extinction of the Change Shock groups during spontaneous recovery was primarily a measure of the strength of fear and withdrawal responses conditioned to shock area stimuli before these stimuli were removed from the apparatus at the beginning of the extinction test. But there are other possible ways in which the reinstated shock area stimuli could control behavior. First, in accord with the classical demonstrations of acquired drive, much of the resistance to extinction produced by reinstating the original

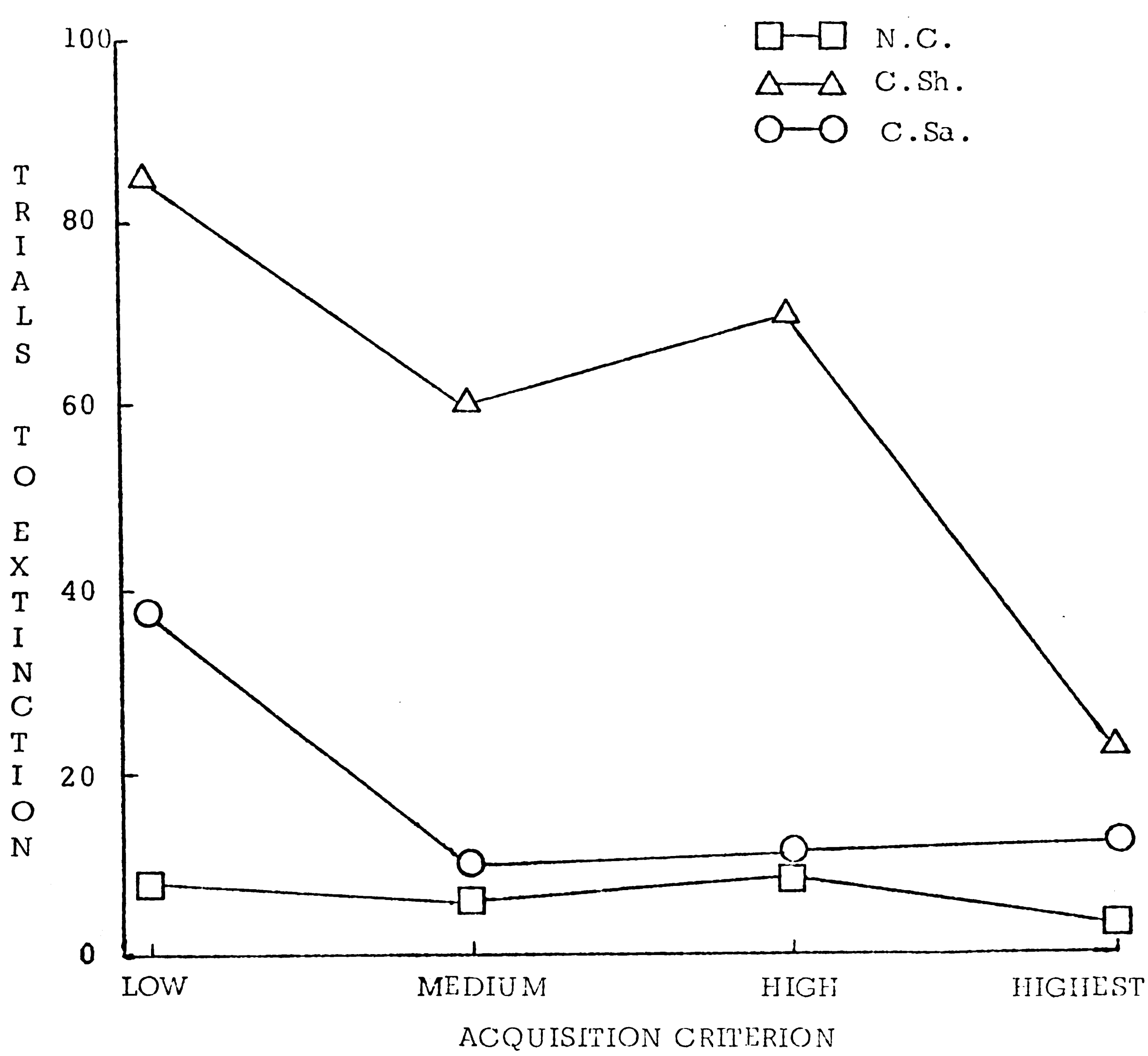

Figure 3. Trials to extinction criterion during the spontaneous recovery test for the No Change, Change Shock, and Change Safe groups.

shock area stimuli may have been the result of responses conditioned during the recovery test itself. Presumably, these conditioned responses would have been mediated by relaxation elicited when the fear-CS was escaped. Secondly, the original safe area stimuli may have become effective in eliciting relaxation and mediating approach only after the shock area stimuli were reinstated since conditioned relaxation cannot be elicited in the absence of fear. The data provide no way of assessing the relative importance of each of these possibilities.

The Low Criterion Change Shock group was most resistant to extinction during the spontaneous recovery test. Apparently fear of shock area stimuli was protected from extinction when these stimuli were removed from the apparatus soon after the last shock had been received. The highest criterion yielded the least resistance to extinction of all the Change Shock groups. Fear was probably counter-conditioned by relaxation during the large number of trials (a total of 35) which constituted the highest acquisition criterion.

During the spontaneous recovery test, the mean resistance to extinction of Change Safe groups was consistently above the No Change level but well below the Change Shock level. The conditioned relaxation-approach that is required to explain so many aspects of these data, including the large effects of acquisition criterion and ITI on performance during the extinction test, was not evidenced in behavior when the safe area stimuli were reinstated because conditioned fear had been extinguished.

Discussion

Experiment II was a parametric investigation of the changing contributions of fear-withdrawal and relaxation-approach to resistance to extinction during the course of avoidance learning. The fear-withdrawal, relaxation-approach model specifies that the fear-withdrawal component is relatively more important when the avoidance responses are first being learned. Two observations support this point most clearly. First, of all the Change Safe groups, the Low Criterion group was the most resistant to extinction. Since Ss of this group were extinguished with the original shock area stimuli, this is an indication of a higher level of fear. Secondly, of all the Change Shock groups, the Low Criterion group was most resistant to extinction during the spontaneous recovery test. These responses occurred when the shock area stimuli were reinstated after extinction trials had been run with the original safe area stimuli. But despite these indications that the Low Criterion groups had the highest level of fear, the Low Criterion No Change group was less resistant to extinction than either the Medium or High Criterion No Change groups.

There are several indications that the high resistance to extinction of the Medium Criterion No Change group was produced primarily by conditioned relaxation and approach. First, a change in safe area stimuli produces a drastic reduction in all the measures of extinction performance that were tested. Secondly, there are some indications that fear decreases, rather than increases, between the Low and the Medium Criterion groups. Thirdly the shock histories of the Low, Medium and High Criterion groups are too similar to account for the large criterion effect.

The evidence for conditioned relaxation-approach is less direct than the evidence for fear-withdrawal. When these experiments were first designed it was expected that the relaxation-approach component could be measured directly during the extinction test under the Change Shock condition. But it has since been realized that relaxation-approach cannot be measured in the relative absence of fear. Thus, although the Change Shock condition produced a very large response decrement, the strength of response which remained did not parallel the strength of response measured across criteria for No Change groups.

The results of Experiment II substantiate the results of Experiment I. The extinction data for the No Change groups provides evidence for the role of a long ITI in facilitating the extinction of an avoidance response. Except for the placement of a 5 minute break between the acquisition and extinction phases of the experimental procedure, the Medium, High and Highest Criterion groups were treated in an identical way except for the length of the ITI during the initial trials of avoidance extinction (acquisition criterion and extinction test trials). Yet the differences among these groups are all significant. The ITI for the Medium Criterion group was changed from 150 sec. to 20 sec. immediately after the medium criterion was reached and Ss in this group were most resistant to extinction. The Ss in the High Criterion group received 11 long ITI trials after the medium criterion had been met and before the ITI was reduced to 20 sec. for the extinction test. These additional long ITI trials reduced resistance to extinction. The Highest Criterion groups received 28 long ITI trials before the extinction test began and resistance to extinction was reduced to less than one-fourth the level of the Medium Criterion group or almost to the overall Change Shock level. All these differences remain large even if the acquisition criterion trials are added to trials to the extinction criterion. Apparently, the short ITI used during the extinction test protected the avoidance response from extinction. According to elicitation theory, the extinction of these avoidance responses is the result of conditioned relaxation backchaining into the shock area. When there is not sufficient time for the long latency unconditioned response of relaxation to occur, almost no relaxation can be conditioned to compete with fear and avoidance. Also the shorter latency relief, which may be elicited after a primary aversive stimulus is terminated, is apparently not elicited or conditioned after a fear-CS alone is escaped.

SUMMARY AND CONCLUSIONS

Some of the most important features of the active-passive avoidance procedure are represented schematically in Figure 4. The sequence of training and testing events, repeated trial after trial, is represented by a circle. The time required for a particular trial is considered to flow clockwise around the circumference of this circle. The upper-right quadrant stands for the latency of escape from the shock area or the time S is in the presence of shock area stimuli. The lower-right quadrant represents the duration of the SAC or the time S is in the presence of safe area stimuli. The left quadrants represent the duration of the ITI or the time S is confined in the holding bucket. The dashed line inside the circle stands for the latency of the optional punished response of entering the shock area on a passive avoidance trial.

Shock and safe area stimuli were made distinct to reduce stimulus generalization and to facilitate the formation of a conditioned discrimination. After a period of habituation to all stimuli, discrimination training began with the presentation of an escapable shock. Shock area stimuli became elicitors of conditioned fear and withdrawal responses. Because Ss were fearful while they were withdrawing, fear-produced stimuli also became conditioned elicitors of withdrawal.

Shock and shock area stimuli were escaped when S entered the safe area. These events elicited the long latency response of relax-

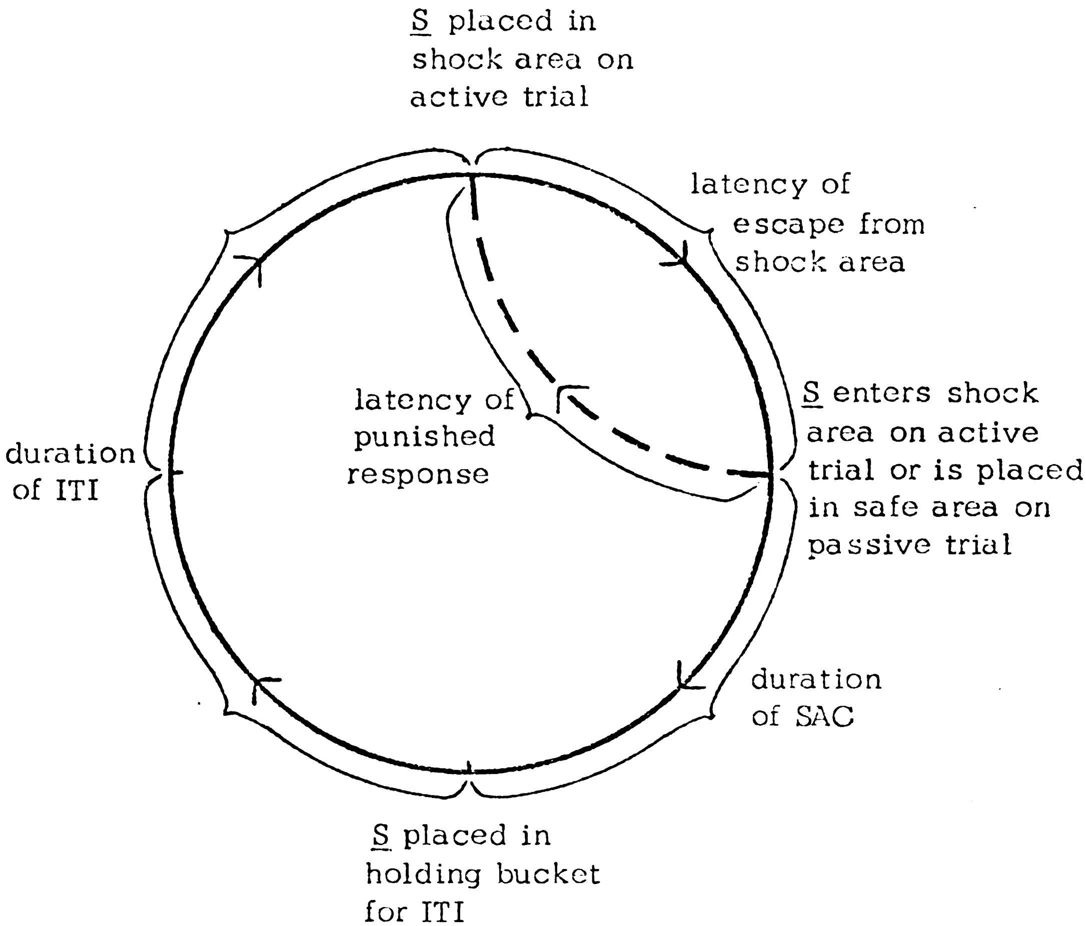

Figure 4. Schematic representation of the active-avoidance, passive-avoidance procedure.

ation which could occur in the safe area, the holding bucket, or both. Stimuli present while S relaxed became conditioned elicitors of relaxation. Approach responses to the safe area, which at first were merely the consequence of withdrawal from the shock area, were presumably conditioned to safe area and relaxation-produced stimuli. In this way, discriminated avoidance responses were taken to be a measure of both fear-withdrawal responses conditioned to shock area stimuli and relaxation-approach responses conditioned to safe area stimuli.

The acquisition and extinction of instrumental avoidance responses may be explained in terms of processes that resemble classical conditioning when it is realized that stimulus presentation and stimulus termination are distinct events that can elicit distinct responses and that certain responses can have a long latency.

Relaxation is a long latency response elicited by the termination of an aversive stimulus. Experiment I was conducted to assess the effects of ITI, a measure of relaxation time, on avoidance acquisition and extinction. Only the 150 sec. ITI was long enough for the relaxation response to fully occur. Although the Long and the Short ITI groups did not differ on most measures of pre-criterial acquisition performance, the Long ITI groups were more resistant to extinction than the Short ITI groups. Figure 4 can be used to clarify the way in which different amounts of relaxation, originally occurring in the holding bucket, could affect avoidance performance.

Stimuli that consistently precede a response can become conditioned elicitors of the response. Through conditioning, responses move forward through a repeated sequence of events or counterclockwise around the circle in Figure 4. This process has been called backchaining.

During the acquisition trials of Experiment I, unconditioned relaxation presumably occurred primarily in the holding bucket and thus had little effect on pre-criterial acquisition performance. During the seven criterial trials, relaxation backchained to the extent that it became an effective mediator of approach to the safe area. The effectiveness of relaxation-mediated approach in sustaining avoidance responses is presumably related to the strength of the unconditioned relaxation response. Thus, the Long ITI No Change group was far more resistant to extinction than the Short ITI No Change group. This interpretation of the large ITI effect on extinction performance is compatible with the data provided by the Change Shock and the Change Safe groups. There was no evidence that the Long ITI enhanced fear conditioning. Durable avoidance responses are not necessarily mediated primarily by fear although the Change Shock groups indicate that some fear is necessary in order for the relaxation-approach component to function effectively.

Experiment II can be interpreted as a parametric study of the backchaining process. The large effect of acquisition criterion on the resistance to extinction of the No Change groups cannot be explained in terms of shock history or the more direct measures of conditioned fear. Instead, the criterion effect is explained in terms of the extent to which relaxation had backchained at the beginning of the extinction test. The low criterion did not permit relaxation to backchain far enough to maximally facilitate avoidance behavior. The medium criterion permited relaxation to backchain far enough to mediate strong approach responses to the safe area and produce a very high resistance to extinction. But additional criterial trials permitted relaxation to backchain into the shock area and progressively reduce resistance to extinction.

Thus, the fear-withdrawal relaxation-approach model of avoidance behavior was strongly supported by these experiments. Experiment I demonstrated that an increase in the absolute amount of relaxation can increase the resistance to extinction of an avoidance response when acquisition criterion was constant and shock histories were similar. Experiment II demonstrated that the contribution of relaxation-approach to avoidance responding becomes relatively more important than the fear-withdrawal component before it causes avoidance behavior to extinguish.

LIST OF REFERENCES

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Bagne, C. A. Escape variables and avoidance conditioning: Two extinction processes. Unpublished M. A. thesis, Michigan State University, 1968.

Black, A. H. Heart rate changes during avoidance learning in dogs. Canadian Journal of Psychology, 1959, 13, 229-242.

Black, A. H., Carlson, N. J. and Solomon, R. L. Exploratory studies of the conditioning of autonomic responses in curarized dogs. Psychological Monographs, 1962, 76(29, Whole No. 548).

Bolles, R. C. Species-specific defense reactions and avoidance learning. Psychological Review, 1970, 77, 32-48.

Braud, W. G. Diminution of suppression by stimuli associated with the offset of fear-arousing cues. Journal of Comparative and Physiological Psychology, 1968, 65, 356-358.

Brown, J. S. Factors affecting self-punitive locomotor behavior. In B. A. Campbell and R. M. Church (Ed.), Punishment and Aversive Behavior. New York: Appleton-Century-Crofts, 1969.

Brush, F. R., Myer, J. S., and Palmer, M. E. Joint effects of intertrial and intersession interval upon avoidance learning. Psychological Reports, 1964, 14, 31-37.

Church, R. M., LoLordo, V., Overmier, J. B., Solomon, R. L. and Turner, L. H. Cardiac responses to shock in curarized dogs: Effects of shock intensity and duration, warning signal, and prior experience with shock. Journal of Comparative and Physiological Psychology, 1966, 62, 1-7.

Denny, M. R. A theoretical analysis and its application to training the mentally retarded. In N. R. Ellis (Ed.), International review of research in mental retardation. Vol. 2, New York: Academic Press, 1966.

Denny, M. R. A learning model. In W. C. Corning and S. C. Ratner (Eds.), The chemistry of learning. New York: Plenum Press, 1967.

Denny, M. R. Relaxation theory and experiments. In F. R. Brush (Ed.), Aversive conditioning and learning. New York: Academic Press, 1971.

Denny, M. R. and Adelman, H. M. Elicitation theory: I. An analysis of two typical learning situations. Psychological Review, 1955, 62, 290-296.

Denny, M. R. and Dmitruk, V. M. Effect of punishing a single failure to avoid. Journal of Comparative and Physiological Psychology, 1967, 63, 277-281.

Denny, M. R., Koons, P. B., and Mason, J. E. Extinction of avoidance as a function of the escape situation. Journal of Comparative and Physiological Psychology, 1959, 52, 212-214.

Denny, M. R. and Ratner, S. C. Comparative psychology: Research in animal behavior. (Rev. ed.) Homewood, Ill.: Dorsey Press, 1970.

Denny, M. R. and Weisman, R. G. Avoidance behavior as a function of the length of nonshock confinement. Journal of Comparative and Physiological Psychology, 1964, 58, 252-257.

Dinsmoor, J. A. Punishment: II. An interpretation of empirical findings. Psychological Review, 1955, 62, 96-105.

Hammond, L. J. A traditional demonstration of the properties of Pavlovian inhibition using different CER. Psychonomic Science, 1967, 9, 65-66.

Hammond, L. J. Retardation of fear acquisition when the CS has previously been inhibitory. Journal of Comparative and Physiological Psychology, 1968, 66, 756-759.

Kamano, D. K. Types of Pavlovian conditioning procedures used in established CS+ and their effect upon avoidance behavior. Psychonomic Science, 1970, 18, 63-64.

Kamin, L. J. The retention of an incompletely learned avoidance response. Journal of Comparative and Physiological Psychology, 1957, 50, 457-460.

Kamin, L. J., Brimer, C. J. and Black, A. H. Conditioned suppression as a monitor of fear in the course of avoidance training. Journal of Comparative and Physiological Psychology, 1963, 56, 497-501.

Kimble, G. A. Shock intensity and avoidance learning. Journal of Comparative and Physiological Psychology, 1955, 48, 281-284.

Knapp, R. K. The acquisition and extinction of instrumental avoidance as a function of the escape situation. Unpublished doctoral dissertation, Michigan State University, 1960.

Knapp, R. K. Acquisition and extinction of avoidance with similar and different shock and escape situations. Journal of Comparative and Physiological Psychology, 1965, 60, 272-273.

Maier, S. F., Seligman, M. E. P., and Solomon, R. L. Pavlovian fear conditioning and learned helplessness: Effects on escape and avoidance behavior of (a) the CS-US contingency and (b) the independence of the US and voluntary responding. In B. A. Campbell and R. M. Church (Eds.), Punishment and aversive behavior. New York: Appleton-Century-Crofts, 1969.

McAllister, W. R. and McAllister, D. E. Increase over time in the stimulus generalization of acquired fear. Journal of Experimental Psychology, 1963, 65, 576-582.

McAllister, W. R. and McAllister, D. E. Behavioral measurement of conditioned fear. In F. R. Brush (Ed.), Aversive conditioning and learning. New York: Academic Press, 1971.

Miller, N. E. Learnable drives and rewards. In S. S. Stevens (Ed.) Handbook of experimental psychology, New York: Wiley (1951).

Myers, A. K. Onset vs. termination of stimulus energy as the CS in avoidance conditioning and pseudoconditioning, Journal of Comparative and Physiological Psychology, 1960, 53, 72-78.

Pavlov, I. P. Conditioned reflexes. London: Oxford University Press, 1927.

Rescorla, R. A. Pavlovian conditioned fear in Sidman avoidance learning. Journal of Comparative and Physiological Psychology, 1968, 65, 55-60.

Rescorla, R. A. Conditioned inhibition of fear resulting from negative CS-US contingencies. Journal of Comparative and Physiological Psychology, 1969, 67, 504-509. (a)

Rescorla, R. A. Establishment of a positive reinforcer through contrast with shock. Journal of Comparative and Physiological Psychology, 1969, 67, 260-263. (b)

Rescorla, R. A. and LoLordo, V. M. Inhibition of avoidance behavior. Journal of Comparative and Physiological Psychology, 1965, 59, 406-412.

Schneirla, T. C. An evolutionary and developmental theory of biphasic processes underlying approach and withdrawal. In M. R. Jones (Ed.), Nebraska symposium on motivation. Lincoln: University of Nebraska Press, 1959.

Seward, J. P. and Raskin, D. C. The role of fear in aversive behavior. Journal of Comparative and Physiological Psychology, 1960, 53, 328-335.

Sheffield, F. D. and Temmer, H. W. Relative resistance to extinction of escape training and avoidance training. Journal of Experimental Psychology, 1950, 40, 287-298.

Sidman, M. Avoidance conditioning with brief shock and no exteroceptive warning signal. Science, 1953, 118, 157-158.

Solomon, R. L. and Turner, L. H. Discriminative classical conditioning in dogs paralyzed by curare can later control discriminative avoidance responses in the normal state. Psychological Review, 1962, 69, 202-218.

Solomon, R. L. and Wynne, L. O. Traumatic avoidance learning: Acquisition in normal dogs. Psychological Monographs, 1953, 67(4, Whole No. 354).

Trabasso, T. R. and Thompson, R. W. Shock intensity and unconditioned responding in a shuttle box. Journal of Experimental Psychology, 1962, 63, 215-216.

Weisman, R. G., Denny, M. R., Platt, S. A. and Zerbolio, D. J., Jr. Facilitation of extinction by a stimulus associated with long nonshock confinement periods. Journal of Comparative and Physiological Psychology, 1966, 62, 26-30.

Weisman, R. G., Denny, M. R. and Zerbolio, D. J. Discrimination based on differential nonshock confinement in a shuttle box. Journal of Comparative and Physiological Psychology, 1967, 63, 34-38.

Weisman, R. G. and Litner, J. S. The course of Pavlovian excitation and inhibition of fear in rats. Journal of Comparative and Physiological Psychology, 1969, 69, 667-672. (a)

Weisman, R. G. and Litner, J. S. Positive conditioned reinforcement of Sidman avoidance behavior. _Journal of Comparative and Physiological Psychology_, 1969, _68_, 597-603. (b)

Winer, B. J. _Statistical principles in experimental design_. New York: Wiley, 1962.

Woodworth, R. S. and Schlosberg, H. _Experimental psychology_, New York: Holt, 1954.

APPENDICES

APPENDIX A

EXPERIMENT I

The values of selected variables for individual Ss of Experiment I are listed in the tables of Appendix A together with group means and standard deviations. The Ss are listed in the same order on each table. Marginal means and the grand mean are also presented.

Each variable was tested with a two-way, fixed effects analysis of variance. The F-ratios for the effects of acquisition ITI (Short, 20 sec. or Long, 150 sec.), extinction stimulus condition (No Change, Change Shock, and Change Safe) and the interaction between these two variables are given together with the degrees of freedom and the probability for each F-ratio. Probabilities less than .05 are marked with "*" and probabilities less than .01 are marked with "**".

Table A1. Acquisition--Trials to criterion.

	N.C.		C. Sh.		C. Sa.		
Short ITI	18	48	15	11	13	15	
	27	21	11	16	20	11	
	9	18	8	26	30	17	
	10	11	14	7	20	18	
	$\bar{x}$ = 20.3		$\bar{x}$ = 13.5		$\bar{x}$ = 18.0		$\bar{x}$ = 17.3
	s = 12.8		s = 6.0		s = 5.8		
Long ITI	24	9	11	28	28	4	
	22	10	24	28	33	9	
	13	20	18	13	15	15	
	8	23	16	26	17	12	
	$\bar{x}$ = 16.1		$\bar{x}$ = 20.5		$\bar{x}$ = 16.6		$\bar{x}$ = 17.8
	s = 6.8		s = 6.8		s = 9.6		
	$\bar{x}$ = 18.2		$\bar{x}$ = 17.0		$\bar{x}$ = 17.0		$\bar{x}$ = 17.5

Acquisition ITI F = 0.043, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.087, df = 2/42, $p > .05$
Interaction F = 1.930, df = 2/42, $p > .05$

Table A2. Acquisition--Number of correct responses.

	N.C.		C. Sh.		C. Sa.		
Short ITI	11	31	6	3	6	8	
	19	11	5	6	12	4	
	4	12	2	16	21	9	
	4	5	6	2	10	8	
	$\bar{x}$ = 12.1		$\bar{x}$ = 5.8		$\bar{x}$ = 9.8		$\bar{x}$ = 9.2
	s = 9.2		s = 4.5		s = 5.1		
Long ITI	13	4	4	17	16	0	
	13	4	13	16	17	3	
	6	10	9	6	7	6	
	4	12	6	18	9	5	
	$\bar{x}$ = 8.3		$\bar{x}$ = 11.1		$\bar{x}$ = 7.9		$\bar{x}$ = 9.1
	s = 4.2		s = 5.6		s = 6.0		
	$\bar{x}$ = 10.2		$\bar{x}$ = 8.4		$\bar{x}$ = 8.8		$\bar{x}$ = 9.1

Acquisition ITI F = 0.005, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.380, df = 2/42, $p > .05$
Interaction F = 2.647, df = 2/42, $p > .05$

Table A3. Acquisition--Number of active avoidances.

	N.C.		C. Sh.		C. Sa.		
Short ITI	6	9	1	1	1	2	
	6	4	4	2	5	1	
	3	6	0	10	10	3	
	1	2	2	0	5	2	
	$\bar{x}$ = 4.6		$\bar{x}$ = 2.5		$\bar{x}$ = 3.6		$\bar{x}$ = 3.6
	s = 2.6		s = 3.3		s = 3.0		
Long ITI	10	2	2	4	5	0	
	8	0	9	5	3	1	
	0	5	1	0	0	0	
	2	3	3	10	2	3	
	$\bar{x}$ = 3.8		$\bar{x}$ = 4.3		$\bar{x}$ = 1.8		$\bar{x}$ = 3.3
	s = 3.7		s = 3.6		s = 1.8		
	$\bar{x}$ = 4.2		$\bar{x}$ = 3.4		$\bar{x}$ = 2.7		$\bar{x}$ = 3.4

Acquisition ITI F = 0.141, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.957, df = 2/42, $p > .05$
Interaction F = 1.486, df = 2/42, $p > .05$

Table A4. Acquisition--Trial number of first active avoidance.

	N.C.		C. Sh.		C. Sa.		
Short ITI	7	16	13	10	7	4	
	8	15	3	10	10	10	
	3	7	10	7	3	10	
	7	7	7	8	10	3	
	$\bar{x}$ = 8.8		$\bar{x}$ = 8.5		$\bar{x}$ = 7.1		$\bar{x}$ = 8.1
	s = 4.4		s = 3.0		s = 3.3		
Long ITI	4	7	7	13	7	7	
	4	13	4	4	23	7	
	15	13	16	15	16	16	
	4	16	4	8	10	7	
	$\bar{x}$ = 9.5		$\bar{x}$ = 8.9		$\bar{x}$ = 11.6		$\bar{x}$ = 10.0
	s = 5.3		s = 5.1		s = 6.0		
	$\bar{x}$ = 9.1		$\bar{x}$ = 8.7		$\bar{x}$ = 9.4		$\bar{x}$ = 9.1

Acquisition ITI F = 1.953, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.090, df = 2/42, $p > .05$
Interaction F = 0.964, df = 2/42, $p > .05$

Table A5. Acquisition--Number of passive avoidances.

	N.C.		C. Sh.		C. Sa.		
Short ITI	5	22	5	2	5	6	
	13	7	1	4	7	3	
	1	6	2	6	11	6	
	3	3	4	2	5	6	
	$\bar{x}$ = 7.5		$\bar{x}$ = 3.3		$\bar{x}$ = 6.1		$\bar{x}$ = 5.6
	s = 6.9		s = 1.8		s = 2.3		
Long ITI	3	2	2	13	11	0	
	5	4	4	11	14	2	
	6	5	8	6	7	6	
	2	9	3	8	7	2	
	$\bar{x}$ = 4.5		$\bar{x}$ = 6.9		$\bar{x}$ = 6.1		$\bar{x}$ = 5.8
	s = 2.3		s = 3.9		s = 4.8		
	$\bar{x}$ = 6.0		$\bar{x}$ = 5.1		$\bar{x}$ = 6.1		$\bar{x}$ = 5.7

Acquisition ITI F = 0.032, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.327, df = 2/42, $p > .05$
Interaction F = 2.672, df = 2/42, $p > .05$

Table A6. Acquisition--Trial number of last error on an active avoidance trial.

	N.C.		C. Sh.		C. Sa.		
Short ITI	18	48	15	8	13	15	
	28	13	7	16	15	8	
	7	18	8	8	30	13	
	10	10	10	7	15	18	
	$\bar{x}$ = 19.0		$\bar{x}$ = 9.9		$\bar{x}$ = 15.9		$\bar{x}$ = 14.9
	s = 12.6		s = 3.4		s = 6.0		
Long ITI	14	4	10	28	28	4	
	22	10	15	28	33	8	
	13	10	18	13	15	15	
	8	23	16	7	15	4	
	$\bar{x}$ = 13.0		$\bar{x}$ = 16.9		$\bar{x}$ = 15.3		$\bar{x}$ = 15.0
	s = 6.2		s = 7.2		s = 9.9		
	$\bar{x}$ = 16.0		$\bar{x}$ = 13.4		$\bar{x}$ = 15.6		$\bar{x}$ = 15.0

Acquisition ITI F = 0.003, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.423, df = 2/42, $p > .05$
Interaction F = 2.280, df = 2/42, $p > .05$

Table A7. Acquisition--Trial number of last error on a passive avoidance trial.

	N.C.		C. Sh.		C. Sa.		
Short ITI	11	0	11	11	15	2	
	0	21	11	12	20	11	
	9	11	5	26	20	17	
	2	11	14	2	20	5	
	$\bar{x}$ =	8.1	$\bar{x}$ =	11.5	$\bar{x}$ =	13.8	$\bar{x}$ = 11.1
	s =	6.7	s =	6.6	s =	6.6	
Long ITI	24	9	11	0	11	2	
	12	0	24	12	32	9	
	0	20	0	0	0	2	
	2	2	11	26	17	12	
	$\bar{x}$ =	8.6	$\bar{x}$ =	10.5	$\bar{x}$ =	10.6	$\bar{x}$ = 9.9
	s =	8.8	s =	9.7	s =	9.8	
	$\bar{x}$ =	8.4	$\bar{x}$ =	11.0	$\bar{x}$ =	12.2	$\bar{x}$ = 10.5

Acquisition ITI F = 0.230, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.800, df = 2/42, $p > .05$
Interaction F = 0.174, df = 2/42, $p > .05$

Table A8. Acquisition--Number of shocks received on active avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	4	17	7	5	6	6	
	9	7	2	7	6	5	
	2	4	5	4	6	6	
	5	4	5	4	6	8	
	$\bar{x}$ =	6.5	$\bar{x}$ =	4.9	$\bar{x}$ =	6.1	$\bar{x}$ = 5.8
	s =	4.8	s =	1.6	s =	0.8	
Long ITI	3	3	4	10	10	3	
	4	6	4	10	15	4	
	7	6	9	7	8	8	
	3	10	6	4	7	3	
	$\bar{x}$ =	5.3	$\bar{x}$ =	6.8	$\bar{x}$ =	7.3	$\bar{x}$ = 6.4
	s =	2.5	s =	2.7	s =	4.1	
	$\bar{x}$ =	5.9	$\bar{x}$ =	5.8	$\bar{x}$ =	6.9	$\bar{x}$ = 6.1

Acquisition ITI F = 0.439, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 0.410, df = 2/42, $p > .05$
Interaction F = 1.146, df = 2/42, $p > .05$

Table A9. Acquisition--Number of shocks received on passive avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	2	0	1	2	1	1	
	0	3	3	1	1	1	
	2	1	1	3	1	1	
	1	2	1	1	3	2	
	$\bar{x}$ =	1.4	$\bar{x}$ =	1.6	$\bar{x}$ =	1.4	$\bar{x}$ = 1.5
	s =	1.1	s =	0.9	s =	0.7	
Long ITI	5	2	3	0	1	1	
	1	0	3	2	0	1	
	0	1	0	0	0	1	
	1	1	2	0	1	2	
	$\bar{x}$ =	1.4	$\bar{x}$ =	1.3	$\bar{x}$ =	0.9	$\bar{x}$ = 1.2
	s =	1.6	s =	1.4	s =	0.6	
	$\bar{x}$ =	1.4	$\bar{x}$ =	1.4	$\bar{x}$ =	1.1	$\bar{x}$ = 1.3

Acquisition ITI $F = 0.827$, $df = 1/42$, $p > .05$
Extinction Stimulus Condition $F = 0.354$, $df = 2/42$, $p > .05$
Interaction $F = 0.219$, $df = 2/42$, $p > .05$

Table A10. Acquisition--Total number of shocks.

	N.C.		C. Sh.		C. Sa.		
Short ITI	6	17	8	7	7	7	
	9	10	5	8	7	6	
	4	5	6	7	7	7	
	6	6	6	5	9	10	
	$\bar{x}$ =	7.9	$\bar{x}$ =	6.5	$\bar{x}$ =	7.5	$\bar{x}$ = 7.3
	s =	4.2	s =	1.2	x =	1.3	
Long ITI	8	5	7	10	11	4	
	5	6	7	12	15	5	
	7	7	9	7	8	9	
	4	11	8	4	8	5	
	$\bar{x}$ =	6.6	$\bar{x}$ =	8.0	$\bar{x}$ =	8.1	$\bar{x}$ = 7.6
	s =	2.2	s =	2.4	s =	3.6	
	$\bar{x}$ =	7.3	$\bar{x}$ =	7.3	$\bar{x}$ =	7.8	$\bar{x}$ = 7.4

Acquisition ITI $F = 0.138$, $df = 1/42$, $p > .05$
Extinction Stimulus Condition $F = 0.227$, $df = 2/42$, $p > .05$
Interaction $F = 1.064$, $df = 2/42$, $p > .05$

Table A11. Acquisition--Total shock in seconds.

	N.C.		C. Sh.		C. Sa.		
Short ITI	11.7	19.2	77.8	18.3	16.5	11.6	
	30.0	20.6	7.3	18.5	148.4	21.8	
	8.4	13.2	58.8	121.4	25.6	75.4	
	64.3	2.8	18.6	4.6	31.1	12.5	
	$\bar{x}$ = 21.3		$\bar{x}$ = 40.7		$\bar{x}$ = 42.8		$\bar{x}$ = 34.9
	s = 19.3		s = 41.6		s = 47.3		
Long ITI	8.7	11.3	24.4	22.4	32.5	25.2	
	9.4	26.1	8.2	26.3	88.9	9.8	
	28.1	29.6	67.4	41.9	28.3	23.6	
	11.9	71.5	12.8	19.9	46.0	2.6	
	$\bar{x}$ = 24.6		$\bar{x}$ = 27.9		$\bar{x}$ = 32.1		$\bar{x}$ = 28.2
	s = 20.9		s = 18.8		s = 26.5		
	$\bar{x}$ = 22.9		$\bar{x}$ = 34.3		$\bar{x}$ = 37.5		$\bar{x}$ = 31.6

Acquisition ITI	$F = 0.559$, $df = 1/42$, $p > .05$
Extinction Stimulus Condition	$F = 0.962$, $df = 2/42$, $p > .05$
Interaction	$F = 0.314$, $df = 2/42$, $p > .05$

Table A12. Acquisition--Mean activity in safe area per trial.

	N.C.		C. Sh.		C. Sa.		
Short ITI	5.6	5.4	5.4	4.7	6.3	4.8	
	10.9	4.7	6.9	5.5	4.4	5.0	
	5.4	5.8	3.1	5.6	5.7	4.6	
	4.9	3.7	5.5	6.3	6.5	7.2	
	$\bar{x}$ = 5.8		$\bar{x}$ = 5.4		$\bar{x}$ = 5.6		$\bar{x}$ = 5.6
	s = 2.2		s = 1.1		s = 1.0		
Long ITI	5.7	25.8	7.1	6.1	11.1	9.8	
	21.0	11.1	5.2	7.6	8.2	6.2	
	5.5	8.9	8.9	7.0	5.6	22.2	
	9.1	6.7	11.1	7.5	5.8	5.3	
	$\bar{x}$ = 11.7		$\bar{x}$ = 7.6		$\bar{x}$ = 9.2		$\bar{x}$ = 9.5
	s = 7.5		s = 1.8		s = 5.6		
	$\bar{x}$ = 8.8		$\bar{x}$ = 6.5		$\bar{x}$ = 7.4		$\bar{x}$ = 7.5

Acquisition ITI	$F = 11.121$, $df = 1/42$, $p < .01$**
Extinction Stimulus Condition	$F = 1.284$, $df = 2/42$, $p > .05$
Interaction	$F = 0.850$, $df = 2/42$, $p > .05$

Table A13. Extinction--Trials to criterion.

	N.C.		C. Sh.		C. Sa.		
Short ITI	136	97	41	9	76	13	
	168	121	15	20	88	78	
	112	101	7	8	63	142	
	33	46	7	3	39	45	
		$\bar{x}$ = 101.8		$\bar{x}$ = 13.8		$\bar{x}$ = 68.0	$\bar{x}$ = 61.2
		s = 44.6		s = 12.2		s = 38.7	
Long ITI	105	250	22	131	187	41	
	250	250	65	16	66	45	
	144	250	33	9	52	68	
	127	250	7	18	23	63	
		$\bar{x}$ = 203.3		$\bar{x}$ = 37.6		$\bar{x}$ = 68.1	$\bar{x}$ = 103.0
		s = 65.4		s = 42.0		s = 50.3	
		$\bar{x}$ = 152.5		$\bar{x}$ = 25.7		$\bar{x}$ = 68.1	$\bar{x}$ = 82.1

Acquisition ITI	$F = 10.331$, $df = 1/42$, $p < .01$**
Extinction Stimulus Condition	$F = 32.804$, $df = 2/42$, $p < .01$**
Interaction	$F = 5.531$, $df = 2/42$, $p < .01$**

Table A14. Extinction--Number of correct responses.

	N.C.		C. Sh.		C. Sa.		
Short ITI	109	69	30	4	61	2	
	138	109	8	9	68	43	
	97	95	3	5	51	124	
	27	38	3	1	24	33	
		$\bar{x}$ = 85.3		$\bar{x}$ = 7.9		$\bar{x}$ = 50.8	$\bar{x}$ = 48.0
		s = 37.9		s = 9.3		s = 36.3	
Long ITI	87	245	14	85	158	25	
	248	188	40	9	38	24	
	128	240	15	4	36	50	
	104	247	2	8	13	33	
		$\bar{x}$ = 185.9		$\bar{x}$ = 22.1		$\bar{x}$ = 47.1	$\bar{x}$ = 85.0
		s = 69.5		s = 28.0		s = 46.1	
		$\bar{x}$ = 135.6		$\bar{x}$ = 15.0		$\bar{x}$ = 48.9	$\bar{x}$ = 66.5

Acquisition ITI	$F = 9.350$, $df = 1/42$, $p < .01$**
Extinction Stimulus Condition	$F = 35.041$, $df = 2/42$, $p < .01$**
Interaction	$F = 7.044$, $df = 2/42$, $p < .01$**

Table A15. Extinction--Percentage of correct responses.

	N.C.		C. Sh.		C. Sa.		
Short ITI	80	71	73	44	80	15	
	82	90	53	45	77	55	
	87	94	43	63	81	87	
	82	83	43	33	62	73	
		$\bar{x}$ = 83.6		$\bar{x}$ = 49.6		$\bar{x}$ = 66.3	$\bar{x}$ = 66.5
		s = 6.9		s = 12.8		s = 23.2	
Long ITI	83	98	64	65	84	61	
	99	75	62	56	58	53	
	89	96	45	44	69	74	
	82	99	29	44	57	52	
		$\bar{x}$ = 90.1		$\bar{x}$ = 51.1		$\bar{x}$ = 63.5	$\bar{x}$ = 68.3
		s = 9.3		s = 12.7		s = 11.2	
		$\bar{x}$ = 86.9		$\bar{x}$ = 50.4		$\bar{x}$ = 64.9	$\bar{x}$ = 67.4

Acquisition ITI $F = 0.196$, $df = 1/42$, $p > .05$
Extinction Stimulus Condition $F = 28.829$, $df = 2/42$, $p < .01$**
Interaction $F = 0.457$, $df = 2/42$, $p > .05$

Table A16. Extinction--Number of active avoidances.

	N.C.		C. Sh.		C. Sa.		
Short ITI	60	46	20	0	34	1	
	63	56	8	5	35	41	
	53	49	3	2	27	62	
	18	23	3	0	7	19	
		$\bar{x}$ = 46.0		$\bar{x}$ = 5.1		$\bar{x}$ = 28.3	$\bar{x}$ = 26.5
		s = 16.7		s = 6.6		s = 19.5	
Long ITI	44	130	8	40	71	20	
	132	130	25	9	17	17	
	70	124	14	0	13	33	
	61	131	2	5	11	32	
		$\bar{x}$ = 102.8		$\bar{x}$ = 12.9		$\bar{x}$ = 26.8	$\bar{x}$ = 47.5
		s = 37.5		s = 13.5		s = 19.6	
		$\bar{x}$ = 74.4		$\bar{x}$ = 9.0		$\bar{x}$ = 27.5	$\bar{x}$ = 37.0

Acquisition ITI $F = 11.859$, $df = 1/42$, $p < .01$**
Extinction Stimulus Condition $F = 40.716$, $df = 2/42$, $p < .01$**
Interaction $F = 8.784$, $df = 2/42$, $p < .01$**

Table A17. Extinction--Percentage of active avoidances on active avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	82	88	91	0	83	14	
	70	86	100	45	74	98	
	88	91	75	40	79	82	
	100	92	75	0	33	79	
	$\bar{x}$ = 87.1		$\bar{x}$ = 53.3		$\bar{x}$ = 67.8		$\bar{x}$ = 69.4
	s = 8.7		s = 38.7		s = 28.6		
Long ITI	79	97	67	57	71	91	
	99	97	71	100	52	71	
	91	93	78	0	46	89	
	90	98	50	50	85	94	
	$\bar{x}$ = 93.0		$\bar{x}$ = 59.1		$\bar{x}$ = 74.9		$\bar{x}$ = 75.7
	s = 6.6		s = 29.0		s = 18.2		
	$\bar{x}$ = 90.1		$\bar{x}$ = 56.2		$\bar{x}$ = 71.3		$\bar{x}$ = 72.5

Acquisition ITI $F = 0.790$, $df = 1/42$, $p > .05$
Extinction Stimulus Condition $F = 7.664$, $df = 2/42$, $p < .01$**
Interaction $F = 0.003$, $df = 2/42$, $p > .05$

Table A18. Extinction--Two errors out of three active avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	36	93	41	0	9	0	
	52	107	15	6	0	78	
	93	17	7	0	54	114	
	33	44	7	0	9	22	
	$\bar{x}$ = 59.4		$\bar{x}$ = 9.5		$\bar{x}$ = 35.8		$\bar{x}$ = 34.9
	s = 33.5		s = 13.7		s = 42.1		
Long ITI	52	250	0	0	6	39	
	111	242	21	16	0	30	
	127	217	14	0	14	0	
	57	250	3	12	2	60	
	$\bar{x}$ = 163.3		$\bar{x}$ = 8.3		$\bar{x}$ = 18.9		$\bar{x}$ = 63.5
	s = 86.1		s = 8.5		s = 22.1		
	$\bar{x}$ = 111.3		$\bar{x}$ = 8.9		$\bar{x}$ = 27.3		$\bar{x}$ = 49.2

Acquisition ITI $F = 5.323$, $df = 1/42$, $p < .05$*
Extinction Stimulus Condition $F = 25.902$, $df = 2/42$, $p < .01$**
Interaction $F = 9.366$, $df = 2/42$, $p < .01$**

Table A19. Extinction--Number of passive avoidances.

	N.C.		C. Sh.		C. Sa.		
Short ITI	49	23	10	4	27	1	
	75	53	0	4	33	2	
	44	46	0	3	24	62	
	9	15	0	1	17	14	
		$\bar{x}$ = 39.3		$\bar{x}$ = 2.8		$\bar{x}$ = 22.5	$\bar{x}$ = 21.5
		s = 22.0		s = 3.4		s = 19.6	
Long ITI	43	115	6	45	87	5	
	116	58	15	0	21	7	
	58	116	1	4	23	17	
	43	116	0	3	2	1	
		$\bar{x}$ = 83.1		$\bar{x}$ = 9.3		$\bar{x}$ = 20.4	$\bar{x}$ = 37.6
		s = 35.3		s = 15.2		s = 28.2	
		$\bar{x}$ = 61.2		$\bar{x}$ = 6.0		$\bar{x}$ = 21.4	$\bar{x}$ = 29.5

Acquisition ITI $F = 5.896$, $df = 1/42$, $p < .05$*
Extinction Stimulus Condition $F = 24.638$, $df = 2/42$, $p < .01$**
Interaction $F = 4.543$, $df = 2/42$, $p < .05$*

Table A20. Extinction--Percentage of passive avoidances on passive avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	78	51	53	100	77	17	
	96	95	0	44	80	6	
	85	98	0	100	83	94	
	60	71	0	100	94	67	
		$\bar{x}$ = 79.3		$\bar{x}$ = 49.6		$\bar{x}$ = 64.6	$\bar{x}$ = 64.5
		s = 17.5		s = 46.4		s = 34.1	
Long ITI	88	99	60	74	100	26	
	100	50	50	0	81	33	
	87	100	7	100	96	55	
	73	100	0	38	20	3	
		$\bar{x}$ = 87.1		$\bar{x}$ = 41.1		$\bar{x}$ = 51.8	$\bar{x}$ = 60.0
		s = 17.8		s = 36.9		s = 36.9	
		$\bar{x}$ = 83.2		$\bar{x}$ = 45.4		$\bar{x}$ = 58.2	$\bar{x}$ = 62.3

Acquisition ITI $F = 0.219$, $df = 1/42$, $p > .05$
Extinction Stimulus Condition $F = 5.330$, $df = 2/42$, $p < .01$**
Interaction $F = 0.431$, $df = 2/42$, $p > .05$

Table A21. Extinction--Two errors out of three passive avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	23	46	1	9	56	4	
	166	121	1	1	35	2	
	1	101	1	8	50	136	
	10	1	1	3	39	1	
		$\bar{x}$ = 58.6		$\bar{x}$ = 3.1		$\bar{x}$ = 40.4	$\bar{x}$ = 34.0
		s = 62.8		s = 3.4		s = 44.5	
Long ITI	2	250	8	11	187	13	
	250	4	1	2	41	1	
	109	250	1	9	66	38	
	49	250	2	2	1	4	
		$\bar{x}$ = 145.5		$\bar{x}$ = 4.5		$\bar{x}$ = 43.9	$\bar{x}$ = 64.6
		s = 116.5		s = 4.1		s = 62.4	
		$\bar{x}$ = 102.1		$\bar{x}$ = 3.8		$\bar{x}$ = 42.1	$\bar{x}$ = 49.3

Acquisition ITI F = 2.877, df = 1/42, $p > .05$
Extinction Stimulus Condition F = 10.055, df = 2/42, $p < .01$**
Interaction F = 2.437, df = 2/42, $p > .05$

Table A22. Extinction--Index of discrimination.[1]

	N.C.		C. Sh.		C. Sa.		
Short ITI	49	25	12	0	34	-4	
	62	53	1	0	34	9	
	46	48	1	2	23	60	
	15	19	0	0	7	15	
		$\bar{x}$ = 39.6		$\bar{x}$ = 2.0		$\bar{x}$ = 22.3	$\bar{x}$ = 21.3
		s = 17.4		s = 4.1		s = 20.0	
Long ITI	40	129	7	32	71	8	
	132	86	12	3	17	7	
	63	124	1	0	13	21	
	52	131	-1	1	3	4	
		$\bar{x}$ = 94.6		$\bar{x}$ = 6.9		$\bar{x}$ = 18.0	$\bar{x}$ = 39.8
		s = 39.0		s = 11.0		s = 22.3	
		$\bar{x}$ = 67.1		$\bar{x}$ = 4.4		$\bar{x}$ = 20.1	$\bar{x}$ = 30.6

Acquisition ITI F = 8.633, df = 1/42, $p < .01$**
Extinction Stimulus Condition F = 35.630, df = 2/42, $p < .01$**
Interaction F = 8.519, df = 2/42, $p < .01$**

[1]For description, see page 42.

Table A23. Extinction--Mean activity per trial on which S remained in safe area for thirty seconds.

	N.C.		C. Sh.		C. Sa.		
Short ITI	9.8	6.6	7.4	5.5	7.8	10.9	
	6.4	4.6	11.6	8.3	6.0	7.3	
	4.1	6.1	9.5	6.5	6.8	4.7	
	6.8	4.2	8.0	4.0	6.0	9.5	
	$\bar{x}$ =	6.1	$\bar{x}$ =	7.6	$\bar{x}$ =	7.4	$\bar{x}$ = 7.0
	s =	1.9	s =	2.3	s =	2.0	
Long ITI	6.2	10.0	8.6	7.2	6.4	9.8	
	9.2	8.5	6.0	9.8	8.7	8.5	
	7.5	7.3	10.1	7.2	5.5	12.0	
	6.1	5.8	16.4	10.7	10.7	9.3	
	$\bar{x}$ =	7.6	$\bar{x}$ =	9.5	$\bar{x}$ =	8.9	$\bar{x}$ = 8.6
	s =	1.5	s =	3.2	s =	2.1	
	$\bar{x}$ =	6.8	$\bar{x}$ =	8.5	$\bar{x}$ =	8.1	$\bar{x}$ = 7.8

Acquisition ITI F = 6.246, df = 1/42, $p < .05$*
Extinction Stimulus Condition F = 2.579, df = 2/42, $p > .05$
Interaction F = 0.044, df = 2/42, $p > .05$

Table A24. Spontaneous recovery--Trials to extinction criterion.

	N.C.		C. Sh.		C. Sa.		
Short ITI	3	18	150	91	11	13	
	1	8	8	150	3	1	
	18	5	30	8	13	22	
	7	0	39	7	3	8	
	$\bar{x}$ =	7.5	$\bar{x}$ =	60.4	$\bar{x}$ =	9.3	$\bar{x}$ = 25.7
	s =	6.6	s =	57.8	s =	6.5	
Long ITI	13	--	48	98	18	1	
	--	--	84	41	16	13	
	2	--	13	18	7	3	
	3	--	150	28	20	3	
	$\bar{x}$ =	6.0	$\bar{x}$ =	60.0	$\bar{x}$ =	10.1	$\bar{x}$ = 30.5
	s =	5.0	s =	44.2	s =	7.0	
	$\bar{x}$ =	7.1	$\bar{x}$ =	60.2	$\bar{x}$ =	9.7	$\bar{x}$ = 27.8

Acquisition ITI F = 0.001, df = 1/37, $p > .05$
Extinction Stimulus Condition F = 9.612, df = 2/37, $p < .01$**
Interaction F = 0.004, df = 2/37, $p > .05$

Table A25. Spontaneous recovery--Number of correct responses.

	N.C.		C. Sh.		C. Sa.		
Short ITI	2	4	144	70	11	13	
	0	5	5	143	3	1	
	9	2	15	5	13	22	
	4	0	17	1	3	8	
	$\bar{x}$ =	3.3	$\bar{x}$ =	50.0	$\bar{x}$ =	3.9	$\bar{x}$ = 19.0
	s =	2.8	s =	57.7	s =	2.8	
Long ITI	6	--	31	82	10	1	
	--	--	72	16	4	4	
	0	--	6	7	7	0	
	1	--	142	13	10	2	
	$\bar{x}$ =	2.3	$\bar{x}$ =	46.1	$\bar{x}$ =	4.8	$\bar{x}$ = 21.8
	s =	2.6	s =	45.4	s =	3.6	
	$\bar{x}$ =	3.0	$\bar{x}$ =	48.1	$\bar{x}$ =	4.3	$\bar{x}$ = 20.2

Acquisition ITI F = 0.014, df = 1/37, $p > .05$
Extinction Stimulus Condition F = 7.052, df = 2/37, $p < .01$**
Interaction F = 0.015, df = 2/37, $p > .05$

Table A26. Spontaneous recovery--Percentage of correct responses.

	N.C.		C. Sh.		C. Sa.		
Short ITI	67	22	96	77	45	46	
	0	63	63	95	0	100	
	50	40	50	63	54	36	
	57	100	44	14	33	38	
	$\bar{x}$ =	49.9	$\bar{x}$ =	62.8	$\bar{x}$ =	44.0	$\bar{x}$ = 52.2
	s =	28.3	s =	25.6	s =	26.0	
Long ITI	46	--	65	84	56	100	
	--	--	86	39	25	31	
	0	--	46	39	100	0	
	33	--	95	46	50	67	
	$\bar{x}$ =	26.3	$\bar{x}$ =	62.5	$\bar{x}$ =	53.6	$\bar{x}$ = 53.1
	s =	19.4	s =	21.6	s =	33.0	
	$\bar{x}$ =	43.5	$\bar{x}$ =	62.6	$\bar{x}$ =	48.8	$\bar{x}$ = 52.6

Acquisition ITI F = 0.253, df = 1/37, $p > .05$
Extinction Stimulus Condition F = 2.289, df = 2/37, $p > .05$
Interaction F = 1.098. df = 2/37, $p > .05$

Table A27. Spontaneous recovery--Number of active avoidances.

	N.C.		C. Sh.		C. Sa.		
Short ITI	2	4	76	38	3	3	
	0	5	5	75	0	1	
	8	1	3	3	6	7	
	4	0	0	1	1	2	
	$\bar{x}$ =	3.0	$\bar{x}$ =	25.1	$\bar{x}$ =	2.9	$\bar{x}$ = 10.3
	s =	2.6	s =	31.3	s =	2.3	
Long ITI	5	--	11	39	2	1	
	--	--	33	16	0	3	
	0	--	6	0	4	0	
	1	--	74	8	5	2	
	$\bar{x}$ =	2.0	$\bar{x}$ =	23.4	$\bar{x}$ =	2.1	$\bar{x}$ = 11.1
	s =	2.2	s =	22.9	s =	1.7	
	$\bar{x}$ =	2.7	$\bar{x}$ =	24.3	$\bar{x}$ =	2.5	$\bar{x}$ = 10.6

Acquisition ITI F = 0.039, df = 1/37, $p > .05$
Extinction Stimulus Condition F = 6.006, df = 2/37, $p < .01$**
Interaction F = 0.003, df = 2/37, $p > .05$

Table A28. Spontaneous recovery--Percentage of active avoidances on active avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	100	40	95	78	50	43	
	0	100	100	94	0	100	
	80	33	19	60	86	58	
	100	100	0	25	50	40	
	$\bar{x}$ =	69.1	$\bar{x}$ =	58.9	$\bar{x}$ =	53.4	$\bar{x}$ = 60.5
	s =	36.8	s =	36.7	s =	28.3	
Long ITI	71	--	42	74	20	100	
	--	--	73	73	0	43	
	0	--	86	0	100	0	
	50	--	93	53	45	100	
	$\bar{x}$ =	40.3	$\bar{x}$ =	61.8	$\bar{x}$ =	51.0	$\bar{x}$ = 53.8
	s =	29.8	s =	27.9	s =	41.0	
	$\bar{x}$ =	61.3	$\bar{x}$ =	60.3	$\bar{x}$ =	52.2	$\bar{x}$ = 57.6

Acquisition ITI F = 0.612, df = 1/37, $p > .05$
Extinction Stimulus Condition F = 0.159, df = 2/37, $p > .05$
Interaction F = 0.661, df = 2/37, $p > .05$

Table A29. Spontaneous recovery--Number of passive avoidances.

	N.C.		C. Sh.		C. Sa.		
Short ITI	0	0	68	32	2	3	
	0	0	0	68	0	0	
	1	1	12	2	1	1	
	0	0	17	0	0	1	
	$\bar{x}$ =	0.3	$\bar{x}$ =	24.9	$\bar{x}$ =	1.0	$\bar{x}$ = 8.7
	s =	0.4	s =	26.8	s =	1.0	
Long ITI	1	--	20	43	8	0	
	--	--	39	0	4	1	
	0	--	0	7	3	0	
	0	--	68	5	5	0	
	$\bar{x}$ =	0.3	$\bar{x}$ =	22.8	$\bar{x}$ =	2.6	$\bar{x}$ = 10.7
	s =	0.5	s =	23.3	s =	2.7	
	$\bar{x}$ =	0.3	$\bar{x}$ =	23.8	$\bar{x}$ =	1.8	$\bar{x}$ = 9.6

Acquisition ITI F = 0.001, df = 1/37, p > .05
Extinction Stimulus Condition F = 7.903, df = 2/37, p < .01**
Interaction F = 0.041, df = 2/37, p > .05

Table A30. Spontaneous recovery--Percentage of passive avoidances on passive avoidance trials.

	N.C.		C. Sh.		C. Sa.		
Short ITI	0	0	97	65	40	50	
	100	0	0	97	0	100	
	17	50	86	67	17	10	
	0	100	94	0	0	33	
	$\bar{x}$ =	33.4	$\bar{x}$ =	63.3	$\bar{x}$ =	31.3	$\bar{x}$ = 42.6
	s =	41.7	s =	38.3	s =	31.2	
Long ITI	17	--	91	96	100	0	
	--	--	100	0	57	17	
	0	--	0	88	100	0	
	0	--	97	38	56	0	
	$\bar{x}$ =	5.7	$\bar{x}$ =	63.8	$\bar{x}$ =	41.3	$\bar{x}$ = 45.1
	s =	8.0	s =	41.2	s =	40.4	
	$\bar{x}$ =	25.8	$\bar{x}$ =	63.5	$\bar{x}$ =	36.3	$\bar{x}$ = 43.7

Acquisition ITI F = 0.190, df = 1/37, p > .05
Extinction Stimulus Condition F = 3.790, df = 2/37, p < .05*
Interaction F = 0.740, df = 2/37, p > .05

APPENDIX B

EXPERIMENT II

The values of selected variables for individual Ss of Experiment II are listed in the tables of Appendix B together with group means and standard deviations. The Ss are listed in the same order on each table. Marginal means and the grand mean are also presented.

Each variable was tested with a two-way, fixed effects, analysis of variance. The F-ratios for the effects of acquisition criterion (Low, Medium, High, and Highest), extinction stimulus condition (No Change, Change Shock, and Change Safe) and the interaction between these two variables are given together with the degrees of freedom and the probability for each F-ratio. Probabilities less than .05 are marked with "*" and probabilities less than .01 are marked with "**".

Table B1. Acquisition--Trials to criterion.

	N.C.		C. Sh.		C. Sa.		
Low	8	5	18	11	13	12	
	22	11	7	5	11	7	
	26	9	5	5	20	20	
	16	11	11	12	13	15	
	$\bar{x}$ = 13.5		$\bar{x}$ = 9.3		$\bar{x}$ = 13.9		$\bar{x}$ = 12.2
	s = 7.3		s = 4.6		s = 4.4		
Medium	24	9	11	28	28	4	
	22	10	24	28	33	9	
	13	20	18	13	15	15	
	8	23	16	26	17	12	
	$\bar{x}$ = 16.1		$\bar{x}$ = 20.5		$\bar{x}$ = 16.6		$\bar{x}$ = 17.8
	s = 6.8		s = 6.8		s = 9.6		
High	28	10	12	30	25	3	
	9	8	18	18	6	9	
	16	18	25	38	19	3	
	25	63	15	14	5	28	
	$\bar{x}$ = 22.1		$\bar{x}$ = 21.3		$\bar{x}$ = 12.3		$\bar{x}$ = 18.5
	s = 18.1		s = 9.0		s = 10.2		
Highest	23	30	22	8	8	5	
	17	11	20	5	11	13	
	28	4	11	6	10	6	
	4	12	6	25	15	15	
	$\bar{x}$ = 16.1		$\bar{x}$ = 12.9		$\bar{x}$ = 10.4		$\bar{x}$ = 13.1
	s = 10.1		s = 8.1		s = 3.9		
	$\bar{x}$ = 17.0		$\bar{x}$ = 16.0		$\bar{x}$ = 13.3		$\bar{x}$ = 15.4

Acquisition Criterion $F = 3.029$, $df = 3/84$, $p < .05$*
Extinction Stimulus Condition $F = 1.433$, $df = 2/84$, $p > .05$
Interaction $F = 1.181$, $df = 6/84$, $p > .05$

Table B2. Acquisition--Trials to low criterion.

	N.C.		C. Sh.		C. Sa.		
Low	8	5	18	11	13	12	
	22	11	7	5	11	7	
	26	9	5	5	20	20	
	16	11	11	12	13	15	
	$\bar{x}$ = 13.5		$\bar{x}$ = 9.3		$\bar{x}$ = 13.9		$\bar{x}$ = 12.2
	s = 7.3		s = 4.6		s = 4.4		
Medium	13	5	5	15	8	5	
	12	15	5	13	22	5	
	15	12	15	15	15	15	
	3	15	11	20	19	5	
	$\bar{x}$ = 11.3		$\bar{x}$ = 12.4		$\bar{x}$ = 11.8		$\bar{x}$ = 11.8
	s = 4.7		s = 5.2		s = 6.9		
High	16	15	8	15	16	15	
	9	15	9	18	7	9	
	16	15	15	31	7	15	
	22	8	15	3	5	11	
	$\bar{x}$ = 14.5		$\bar{x}$ = 14.3		$\bar{x}$ = 10.6		$\bar{x}$ = 13.1
	s = 4.4		s = 8.4		s = 4.3		
Highest	9	11	9	8	8	5	
	8	7	5	5	8	9	
	5	15	11	7	3	7	
	12	8	7	18	15	9	
	$\bar{x}$ = 9.4		$\bar{x}$ = 8.8		$\bar{x}$ = 8.0		$\bar{x}$ = 8.7
	s = 3.2		s = 4.2		s = 3.5		
	$\bar{x}$ = 12.2		$\bar{x}$ = 11.2		$\bar{x}$ = 11.1		$\bar{x}$ = 11.5

Acquisition Criterion	F =	3.134, df = 3/84, $p < .05$*
Extinction Stimulus Condition	F =	0.418, df = 2/84, $p > .05$
Interaction	F =	1.007, df = 6/84, $p > .05$

Table B3. Acquisition--Number of correct responses.

	N.C.		C. Sh.		C. Sa.		
Low	0	1	7	4	9	4	
	9	4	2	2	6	1	
	11	3	1	2	9	11	
	6	2	5	5	5	8	
	$\bar{x}$ =	4.5	$\bar{x}$ =	3.5	$\bar{x}$ =	6.6	$\bar{x}$ = 4.9
	s =	3.9	s =	2.1	s =	3.2	
Medium	13	4	4	17	16	0	
	13	4	13	16	17	3	
	6	10	9	6	7	6	
	4	12	6	18	9	5	
	$\bar{x}$ =	8.3	$\bar{x}$ =	11.1	$\bar{x}$ =	7.9	$\bar{x}$ = 9.1
	s =	4.2	s =	5.6	s =	6.0	
High	15	5	5	17	11	1	
	2	4	11	12	1	2	
	5	11	15	21	8	1	
	15	36	9	9	3	17	
	$\bar{x}$ =	11.6	$\bar{x}$ =	12.4	$\bar{x}$ =	5.5	$\bar{x}$ = 9.8
	s =	11.1	s =	5.1	s =	6.0	
Highest	15	18	14	4	0	2	
	8	5	11	2	5	7	
	16	1	3	2	4	1	
	1	4	1	15	10	10	
	$\bar{x}$ =	8.5	$\bar{x}$ =	6.5	$\bar{x}$ =	4.9	$\bar{x}$ = 6.6
	s =	6.9	s =	5.8	s =	3.9	
	$\bar{x}$ =	8.2	$\bar{x}$ =	8.4	$\bar{x}$ =	6.2	$\bar{x}$ = 7.6

Acquisition Criterion	$F = 3.790$, $df = 3/84$, $p < .05$*
Extinction Stimulus Condition	$F = 1.408$, $df = 2/84$, $p > .05$
Interaction	$F = 1.416$, $df = 6/84$, $p > .05$

Table B4. Acquisition--Trial number of first active avoidance.

	N.C.		C. Sh.		C. Sa.		
Low	10	7	19	13	8	10	
	23	4	8	4	4	8	
	4	10	7	4	22	8	
	18	10	10	4	15	13	
	$\bar{x}$ =	10.8	$\bar{x}$ =	8.6	$\bar{x}$ =	11.0	$\bar{x}$ = 10.1
	s =	6.6	s =	5.3	s =	5.6	
Medium	4	7	7	13	7	7	
	4	13	4	4	23	7	
	15	13	16	15	16	16	
	4	16	4	8	10	7	
	$\bar{x}$ =	9.5	$\bar{x}$ =	8.9	$\bar{x}$ =	11.6	$\bar{x}$ = 10.0
	s =	5.3	s =	5.1	s =	6.0	
High	18	7	10	16	18	4	
	7	4	7	3	4	8	
	18	10	8	10	8	4	
	4	10	10	4	3	4	
	$\bar{x}$ =	9.8	$\bar{x}$ =	8.5	$\bar{x}$ =	6.6	$\bar{x}$ = 8.3
	s =	5.6	s =	4.1	s =	5.0	
Highest	7	4	7	3	10	3	
	10	7	7	4	7	7	
	4	7	8	4	4	7	
	7	10	7	10	4	3	
	$\bar{x}$ =	7.0	$\bar{x}$ =	6.2	$\bar{x}$ =	5.6	$\bar{x}$ = 6.3
	s =	2.3	s =	2.4	s =	2.5	
	$\bar{x}$ =	9.3	$\bar{x}$ =	8.1	$\bar{x}$ =	8.7	$\bar{x}$ = 8.7

Acquisition Criterion F = 3.286, df = 3/84, $p < .05$*
Extinction Stimulus Condition F = 0.480, df = 2/84, $p > .05$
Interaction F = 0.601, df = 6/84, $p > .05$

Table B5. Acquisition--Total number of shocks.

	N.C.		C. Sh.		C. Sa.		
Low	7	4	11	7	4	6	
	13	6	6	3	4	5	
	15	6	4	3	11	8	
	9	8	6	2	7	7	
	$\bar{x}$ = 8.5		$\bar{x}$ = 5.3		$\bar{x}$ = 6.5		$\bar{x}$ = 6.8
	s = 3.7		s = 2.9		s = 2.3		
Medium	8	5	7	10	11	4	
	5	6	7	12	15	5	
	7	7	9	7	8	9	
	4	11	8	4	8	5	
	$\bar{x}$ = 6.6		$\bar{x}$ = 8.0		$\bar{x}$ = 8.1		$\bar{x}$ = 7.6
	s = 2.2		s = 2.4		s = 3.6		
High	13	5	7	13	14	2	
	7	4	7	6	3	6	
	11	6	9	17	10	2	
	10	27	6	5	1	8	
	$\bar{x}$ = 10.4		$\bar{x}$ = 8.8		$\bar{x}$ = 5.8		$\bar{x}$ = 8.3
	s = 7.4		s = 4.2		s = 4.6		
Highest	8	10	8	4	7	3	
	7	4	6	3	5	5	
	11	3	4	3	6	3	
	3	6	3	10	5	2	
	$\bar{x}$ = 6.5		$\bar{x}$ = 5.1		$\bar{x}$ = 4.5		$\bar{x}$ = 5.4
	s = 3.1		s = 2.6		s = 1.7		
	$\bar{x}$ = 8.0		$\bar{x}$ = 6.8		$\bar{x}$ = 6.2		$\bar{x}$ = 7.0

Acquisition Criterion $F = 2.749$, $df = 3/84$, $p < .05$*
Extinction Stimulus Condition $F = 1.935$, $df = 2/84$, $p > .05$
Interaction $F = 1.286$, $df = 6/84$, $p > .05$

Table B6. Extinction--Trials to criterion.

	N.C.		C. Sh.		C. Sa.		
Low	155	157	202	18	45	172	
	43	69	7	7	43	48	
	38	138	22	33	99	78	
	90	91	3	7	26	76	
	$\bar{x}$ = 97.6		$\bar{x}$ = 37.4		$\bar{x}$ = 73.4		$\bar{x}$ = 69.5
	s = 47.7		s = 67.3		s = 46.3		
Medium	105	250	22	131	187	41	
	250	250	65	16	66	45	
	144	250	33	9	52	68	
	127	250	7	18	23	63	
	$\bar{x}$ =203.3		$\bar{x}$ = 37.6		$\bar{x}$ = 68.1		$\bar{x}$ =103.0
	s = 65.4		s = 50.0		s = 50.3		
High	38	88	3	250	7	23	
	153	3	45	13	22	120	
	86	250	16	7	61	250	
	120	250	7	5	3	13	
	$\bar{x}$ =123.5		$\bar{x}$ = 43.3		$\bar{x}$ = 62.4		$\bar{x}$ = 76.4
	s = 90.5		s = 84.6		s = 85.1		
Highest	45	99	7	11	15	9	
	13	113	48	3	18	0	
	45	3	8	9	24	42	
	20	1	91	26	50	5	
	$\bar{x}$ = 42.4		$\bar{x}$ = 25.4		$\bar{x}$ = 20.4		$\bar{x}$ = 29.4
	s = 42.8		s = 30.3		s = 17.6		
	$\bar{x}$ =116.7		$\bar{x}$ = 35.9		$\bar{x}$ = 56.1		$\bar{x}$ = 69.6

Acquisition Criterion $F = 6.179$, $df = 3/84$, $p < .01$**
Extinction Stimulus Condition $F = 15.721$, $df = 2/84$, $p < .01$**
Interaction $F = 2.599$, $df = 6/84$, $p < .05$*

Table B7. Extinction--Number of correct responses.

	N.C.		C. Sh.		C. Sa.		
Low	129	106	121	9	27	150	
	29	42	3	4	36	35	
	19	122	13	16	75	34	
	41	61	1	4	16	54	
	x̄ = 68.6		x̄ = 21.4		x̄ = 53.4		x̄ = 47.8
	s = 43.8		s = 40.6		s = 42.9		
Medium	87	245	14	85	158	25	
	248	188	40	9	38	24	
	128	240	15	4	36	50	
	104	247	2	8	13	33	
	x̄ =185.9		x̄ = 22.1		x̄ = 47.1		x̄ = 85.0
	s = 69.5		s = 28.0		s = 46.1		
High	23	62	1	230	4	17	
	148	1	28	6	12	60	
	70	246	10	2	44	243	
	102	242	6	0	2	5	
	x̄ =111.8		x̄ = 35.4		x̄ = 48.4		x̄ = 65.2
	s = 93.2		s = 79.1		s = 81.4		
Highest	39	61	2	1	7	4	
	8	102	17	1	10	0	
	32	1	1	2	14	19	
	7	0	47	9	23	2	
	x̄ = 31.3		x̄ = 10.0		x̄ = 9.9		x̄ = 17.0
	s = 35.8		s = 16.0		s = 8.2		
	x̄ = 99.4		x̄ = 22.2		x̄ = 39.7		x̄ = 53.8

Acquisition Criterion $F = 6.586$, $df = 3/84$, $p < .01$**
Extinction Stimulus Condition $F = 17.299$, $df = 2/84$, $p < .01$**
Interaction $F = 3.203$, $df = 6/84$, $p < .01$**

Table B8. Extinction--Percentage of correct responses.

	N.C.		C. Sh.		C. Sa.		
Low	83	68	60	50	60	87	
	67	61	43	57	84	73	
	50	88	59	48	76	44	
	46	67	33	57	62	71	
	$\bar{x}$ = 66.3		$\bar{x}$ = 50.9		$\bar{x}$ = 69.6		$\bar{x}$ = 62.3
	s = 14.4		s = 9.4		s = 14.0		
Medium	83	98	64	65	84	61	
	99	75	62	56	58	53	
	89	96	45	44	69	74	
	82	99	29	44	57	52	
	$\bar{x}$ = 90.1		$\bar{x}$ = 51.1		$\bar{x}$ = 63.5		$\bar{x}$ = 68.3
	s = 9.3		s = 12.7		s = 11.2		
High	61	70	33	92	57	74	
	98	33	62	46	55	50	
	81	98	63	29	72	97	
	85	97	86	0	67	38	
	$\bar{x}$ = 77.8		$\bar{x}$ = 51.4		$\bar{x}$ = 63.8		$\bar{x}$ = 64.3
	s = 22.5		s = 30.7		s = 18.0		
Highest	87	62	29	9	47	44	
	62	90	35	33	56	100	
	71	33	13	22	58	45	
	35	0	52	35	46	40	
	$\bar{x}$ = 55.0		$\bar{x}$ = 28.5		$\bar{x}$ = 54.5		$\bar{x}$ = 46.0
	s = 30.5		s = 13.7		s = 19.4		
	$\bar{x}$ = 72.3		$\bar{x}$ = 45.5		$\bar{x}$ = 62.8		$\bar{x}$ = 60.2

Acquisition Criterion $F = 6.674$, $df = 3/84$, $p < .01$**
Extinction Stimulus Condition $F = 17.183$, $df = 2/84$, $p < .01$**
Interaction $F = 1.246$, $df = 6/84$, $p > .05$

Table B9. Extinction--Number of active avoidances.

	N.C.		C. Sh.		C. Sa.		
Low	67	54	36	2	9	71	
	10	20	3	4	22	21	
	16	66	9	15	29	30	
	33	46	1	4	13	30	
	x̄ = 39.0		x̄ = 9.3		x̄ = 28.1		x̄ = 25.5
	s = 22.5		s = 11.7		s = 19.0		
Medium	44	130	8	40	71	20	
	132	130	25	9	17	17	
	70	124	14	0	13	33	
	61	131	2	5	11	32	
	x̄ =102.8		x̄ = 12.9		x̄ = 26.8		x̄ = 47.5
	s = 37.5		s = 13.5		s = 19.6		
High	8	36	1	117	2	11	
	80	0	20	1	9	55	
	33	130	6	2	24	128	
	47	126	4	0	2	5	
	x̄ = 57.5		x̄ = 18.9		x̄ = 29.5		x̄ = 35.3
	s = 49.8		s = 40.2		s = 43.5		
Highest	22	16	1	1	7	0	
	6	53	14	0	8	0	
	18	0	1	1	6	6	
	0	0	41	3	0	0	
	x̄ = 14.4		x̄ = 7.8		x̄ = 3.4		x̄ = 8.5
	s = 18.0		s = 14.2		s = 3.7		
	x̄ = 53.4		x̄ = 12.2		x̄ = 21.9		x̄ = 29.2

Acquisition Criterion $F = 8.207$, $df = 3/84$, $p < .01$**
Extinction Stimulus Condition $F = 18.738$, $df = 2/84$, $p < .01$**
Interaction $F = 3.836$, $df = 6/84$, $p < .01$**

Table B10. Extinction--Number of passive avoidances.

	N.C.		C. Sh.		C. Sa.		
Low	62	52	85	7	18	79	
	19	22	0	0	14	14	
	3	56	4	1	46	4	
	8	15	0	0	3	24	
	$\bar{x}$ = 26.6		$\bar{x}$ = 12.1		$\bar{x}$ = 25.3		$\bar{x}$ = 22.3
	s = 23.3		s = 29.6		s = 25.7		
Medium	43	115	6	45	87	5	
	116	58	15	0	21	7	
	58	116	1	4	23	17	
	43	116	0	3	2	1	
	$\bar{x}$ = 83.1		$\bar{x}$ = 9.3		$\bar{x}$ = 20.4		$\bar{x}$ = 37.6
	s = 35.3		s = 15.2		s = 28.2		
High	15	26	0	113	2	6	
	68	1	8	5	3	5	
	37	116	4	0	20	115	
	55	116	2	0	0	0	
	$\bar{x}$ = 54.3		$\bar{x}$ = 16.5		$\bar{x}$ = 18.9		$\bar{x}$ = 29.9
	s = 43.6		s = 39.1		s = 39.4		
Highest	17	45	1	0	0	4	
	2	49	3	1	2	0	
	14	1	0	1	8	13	
	7	0	6	6	23	2	
	$\bar{x}$ = 16.9		$\bar{x}$ = 2.3		$\bar{x}$ = 6.5		$\bar{x}$ = 8.5
	s = 19.6		s = 2.5		s = 8.0		
	$\bar{x}$ = 46.0		$\bar{x}$ = 10.0		$\bar{x}$ = 17.8		$\bar{x}$ = 24.6

Acquisition Criterion $F = 4.509$, df = 3/84, $p < .01$**
Extinction Stimulus Condition $F = 14.052$, df = 2/84, $p < .01$**
Interaction $F = 2.426$, df = 6/84, $p < .05$*

Table B11. Extinction--Index of discrimination.[1]

	N.C.		C. Sh.		C. Sa.		
Low	61	48	32	1	8	70	
	10	15	0	1	19	16	
	4	63	4	2	29	0	
	12	22	1	1	5	26	
		$\bar{x}$ = 29.4		$\bar{x}$ = 5.3		$\bar{x}$ = 21.6	$\bar{x}$ = 18.8
		s = 24.1		s = 10.9		s = 22.0	
Medium	40	129	7	32	71	8	
	132	86	12	3	17	7	
	63	124	1	0	13	21	
	52	131	-1	1	3	4	
		$\bar{x}$ = 94.6		$\bar{x}$ = 6.9		$\bar{x}$ = 18.0	$\bar{x}$ = 39.8
		s = 39.0		s = 11.0		s = 22.3	
High	8	25	1	114	1	7	
	77	0	14	0	8	10	
	32	130	3	-1	24	127	
	47	126	3	-2	2	-1	
		$\bar{x}$ = 55.6		$\bar{x}$ = 16.5		$\bar{x}$ = 22.3	$\bar{x}$ = 31.5
		s = 50.5		s = 39.7		s = 43.0	
Highest	22	16	-1	-1	1	0	
	3	53	-2	0	1	0	
	13	0	-2	0	6	6	
	0	0	11	-1	0	0	
		$\bar{x}$ = 13.4		$\bar{x}$ = 0.5		$\bar{x}$ = 1.8	$\bar{x}$ = 5.2
		s = 18.1		s = 4.3		s = 2.7	
		$\bar{x}$ = 48.3		$\bar{x}$ = 7.3		$\bar{x}$ = 15.9	$\bar{x}$ = 23.8

Acquisition Criterion	$F = 6.828$, $df = 3/84$, $p < .01$**
Extinction Stimulus Condition	$F = 18.550$, $df = 2/84$, $p < .01$**
Interaction	$F = 3.529$, $df = 6/84$, $p < .01$**

[1]For description, see page 42.

Table B12. Spontaneous recovery--Trials to extinction criterion.

	N.C.		C. Sh.		C. Sa.		
Low	24	8	150	5	7	23	
	8	3	150	26	7	3	
	1	8	20	31	100	7	
	3	7	150	150	150	7	
	$\bar{x}$ =	7.8	$\bar{x}$ =	85.3	$\bar{x}$ =	38.0	$\bar{x}$ = 43.7
	s =	6.7	s =	65.1	s =	52.1	
Medium	13	--	48	98	18	1	
	--	--	84	41	16	13	
	2	--	13	18	7	3	
	3	--	150	28	20	3	
	$\bar{x}$ =	6.0	$\bar{x}$ =	60.0	$\bar{x}$ =	10.1	$\bar{x}$ = 30.5
	s =	5.0	s =	44.2	s =	7.0	
High	5	8	30	--	7	15	
	18	16	50	31	7	23	
	1	--	52	57	18	--	
	13	--	150	123	1	1	
	$\bar{x}$ =	10.2	$\bar{x}$ =	70.4	$\bar{x}$ =	10.3	$\bar{x}$ = 31.3
	s =	6.0	s =	43.5	s =	7.9	
Highest	1	3	1	3	8	9	
	7	1	7	7	15	11	
	3	1	0	15	5	3	
	5	3	7	139	5	49	
	$\bar{x}$ =	3.0	$\bar{x}$ =	22.4	$\bar{x}$ =	12.0	$\bar{x}$ = 12.5
	s =	2.0	s =	44.3	s =	11.2	
	$\bar{x}$ =	6.6	$\bar{x}$ =	59.2	$\bar{x}$ =	17.8	$\bar{x}$ = 29.3

Acquisition Criterion	$F = 2.450$, $df = 3/75$, $p > .05$
Extinction Stimulus Condition	$F = 15.255$, $df = 2/75$, $p < .01$**
Interaction	$F = 1.021$, $df = 6/75$, $p > .05$