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The pure avoidance paradigm: CS termination in avoidance without escape

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THE PURE AVOIDANCE PARADIGM: CS TERMINATION IN AVOIDANCE WITHOUT ESCAPE

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ABSTRACT

The traditional paradigm of avoidance conditioning allows an escape response if no avoidance response occurs. The paradigm investigated in the present experiment, the "pure" avoidance paradigm, does not contain the escape component. If no avoidance occurs, the US is delivered for a fixed duration and the trial is over.

Using the pure approach, the effect of response-termination of the CS vs non-response termination of the CS on avoidance trials was studied; of secondary interest was the effect on non-avoidance trials of an overlapping CS (overlapping the US) vs a CS that terminated contingently with US onset.

No significant differences were found with respect to any of these variables. Individual variability in learning was very marked and probably obscured any effects. The pure-avoidance paradigm appears to offer a more difficult learning problem than the traditional avoidance-escape approach.

INTRODUCTION

The Typical Avoidance Paradigm

In the usual paradigm for instrumental avoidance conditioning, S, typically an albino or hooded rat, is first confronted with some kind of signal, the conditioned stimulus (CS). This event is followed by some form of noxious stimulation, the unconditioned stimulus (US), which occurs after a certain duration of time, the CS-US interval, has elapsed. Typically, this stimulation is electric shock and it is only delivered if S does not make a prescribed correct response in the CS-US interval. The shock is then terminated when the correct response is finally elicited.

When the response is made during the critical interval, it is designated an avoidance response. Its execution permits S to avoid the US, since no shock is programmed under these conditions. Such a trial is labeled an avoidance trial. When the response occurs after the critical interval has elapsed, it is designated an escape response, since it terminates the shock, permitting S to escape from unpleasant, painful stimulation; and this kind of trial is labeled an escape trial. During the early conditioning trials, a preponderance of escapes are made, and are reinforced in some way by the shock termination. After some number of CS-US pairings, the CS alone tends to elicit the correct response, i.e., the response proved instrumental for escaping; thus the responses become avoidance ones, and conditioning is said to have occurred. For most efficient learning, the common practice has been to terminate the CS contingently with the correct response (whether it be avoidance or escape). It is obvious then, that the determination of whether the correct response is escape or avoidance depends solely on its latency, escapes having latencies greater than the CS-US interval and avoidances having latencies less than the interval value.

Regarding theoretical implications of the paradigm, in general, the major S-R theorists hold that as a result of pairings with the noxious US, the CS also becomes noxious or aversive and eventually elicits essentially the same response elicited by the US. This avoidance response is reinforced when it is instrumental in terminating the CS just as the escape response was reinforced when it terminated the US.

Two-process theorists (Mowrer, 1947, 1950; Solomon and Wynne, 1954) more specifically maintain that fear or anxiety is classically conditioned to the CS during the CS-US pairings and hence it becomes a feared stimulus. Instrumentally-acquired responses providing escape from the CS are then reinforced via fear reduction. Alternatively, Dinsmoor (1954) describes the CS as a stimulus that becomes secondarily aversive as a result of the pairings with the aversive US, and its termination presumably constitutes a reinforcement. A similar view held by Schoenfeld (1950) depicts avoidance as a process in which the US serves as a negative primary reinforcer and the CS a negative secondary reinforcer. Any responses that terminate the CS will be strengthened just as the responses that terminate the US.

The expectancy or cognitive interpretation, in general, holds that as a result of the CS-US pairings an expectancy of shock soon develops when the CS is presented on subsequent trials. Making the correct response then leads, over trials, to the development of another expectancy that "responding-to-CS" signifies a no-shock-condition (Osgood, 1950).

The Pure Avoidance Paradigm

In the aforementioned paradigm the escape response, operationally, is not necessarily an essential component. As a matter of opinion, it can be stated that the paradigm is mislabeled. It is not really a "pure" or strict avoidance paradigm but an avoidance-escape paradigm. A so-called pure avoidance paradigm would not permit the escape response operationally if no avoidance response was initiated. Since only avoidance responses are reinforced, such a paradigm is an avoidance one in the full sense of the term. It can be argued that certain of S's responses may attenuate the intensity of the shock, e.g., jumping off the grid, or assuming certain crouching postures, and that this constitutes an escape, at least in a limited sense. Technically, this is correct; such unauthorized escapes can occur. However, the effect of such escapes is probably very small because of their fleeting, momentary nature. The pure paradigm relates operationally only to authorized escapes, and makes no authorized escape available to the subjects in any case. If the correct response does not occur during the CS-US interval, the US is delivered at the end of the interval for a certain duration, and then the trial is over. On such shock or non-avoidance trials, the situation may be regarded as one in which the Ss are punished for not making the relevant response. If the correct response is made in the safe interval, no shock occurs and the trial ends.

In terms of S-R reinforcement concepts, there are some other basic differences between the two paradigms. In the avoidance-escape situation, the Ss receive some form of reinforcement for the correct response on every trial. On the escape trials the reinforcement may stem from shock termination which occurs when the escape response is made; and on the avoidance trials, according to the major theories, the reinforcement results from the CS termination which occurs when the avoidance response is made. In the pure avoidance situation, there is no shock-termination source of reinforcement for the correct response because the correct response is by definition an avoidance response, a response that prevents the occurrence of the shock. If the S fails to make the avoidance response, he gets shocked and none of his subsequent responses can remove the shock or shorten its duration. The only potential source of reinforcement under this paradigm appears to be CS termination.

Also, on an escape trial under the traditional procedure, the last response of the trial is the escape response itself. But with the proposed pure procedure, the last response of a trial can be any response and is difficult to predict. The last response is the one fortuitously made at the end of the shock duration, and this response will probably be reinforced to some degree. Hence there is a greater opportunity for competing or interfering responses to retard the animal's performance.

It can be speculated that there are further distinctions between the two paradigms concerning the process of acquisition of the avoidance response. In the traditional situation, the correct response is probably most likely to be emitted on an escape trial in some "accidental" or unintentional fashion. For example, in the shuttlebox situation the correct response involves running, and on an escape trial the natural response to shock is, mainly, running--a very compatible reaction. When the US is response-terminated, the correct response is strongly reinforced such that repeated reinforcements of this sort increases the probability of the response. When the CS becomes tied to this process, or as some have suggested (Kamin, 1959; Solomon and Brush, 1956), when the escape response decreases in latency and "moves forward in time", becoming anticipatory, conditioning is said to have occurred. The escape trials and their reinforcement implications seem to have "guided" S into behavior channels that prove instrumental for avoidance. Anthropomorphically, one may say the S discovers the relevant response that removes the shock because the shock termination itself acts as primary feedback, and this informs the S of what the relevant behavior is. One can further speculate that in the traditional situation the S learns immediately what response is relevant even if the CS is not yet viewed as noxious i.e., the CS is still "neutral." Whether the CS has become aversive on the early escape trials may not have any bearing on the occurrence of escapes. When it does become aversive to the S, as a result of the pairing procedure, then it is expected that the correct response will become anticipatory or avoidant.

Turning now to the pure paradigm, no such escape events occur and thus no escape "guidance" as to what is the relevant response occurs. The onset of the CS and not the onset of the US must motivate S to respond. The overt learning behavior in a strict sense does not begin until the CS becomes aversive. (In the avoidance-escape situation, the conditioning process may be initiated with the first escape). The CS hence is a crucial stimulus event and may be more important in the pure paradigm than in the traditional paradigm. Intuitively, it would seem that the task of avoidance under the pure approach is more difficult for the S to learn.

In consideration of the various models or theoretical accounts of avoidance behavior, none of the S-R theories should have much difficulty in explaining the pure paradigm and incorporating it into their frameworks. The validity of these theories does not seem to hinge on the inclusion of an escape in the conditioning procedure. For instance, two-process theories do not need the escape response. The conditioned fear or anxiety process is one developing from the contiguous association of CS and US. The instrumental process is one involving an emitted response and reinforcement for the response. The requirements of both processes can be satisfied in the pure approach. There is contiguous association between the CS and US from which the fear or anxiety can develop; and there is an instrumental avoidance response that can be emitted by the CS and reinforced by its termination. The uniqueness or significance of the pure paradigm relative to the traditional paradigm at this time appears to be related to the operational differences between the two and not so much to any strong theoretical differences. The paradigm does not seem to lend greater support to one particular model over another.

There may be a theoretical difference concerning the status of the CS, one not specifically related to any theory though. Under the pure approach, the CS can be postulated to be a more powerful or important reinforcer relative to the traditional approach. In fact, it may be better described in this context as more "primary" than "secondary" (although such an interpretation is not really correct) in view of the fact that there is no direct primary reinforcement for the correct response stemming from shock termination. Therefore, its role in the paradigm may be enhanced, and there may be differences in status or potency of the CS in the two paradigms in terms of such phenomena as extinction or reward gradients.

Previous Research Employing The Pure Avoidance Paradigm

A survey of the literature revealed only two occasions when the pure avoidance paradigm was used in avoidance experimentation. The first occasion found was in research conducted by Mowrer and his group in 1947 (Mowrer, 1950, Chapter 10). Mowrer's purpose was to muster evidence for a two-process conception of learning; specifically, the attempt was to better define the role of Miller's hypothesized fear response (Miller, 1948) in avoidance conditioning and determine how it becomes connected to the CS.

The Hullian redintegrative conception maintained that fear would most readily become connected to a CS when it is contiguous with drive reduction, or when the US is terminated. The "one-process" view predicted that if a CS was not coterminous with the drive-reduction event, it would not function very effectively as a conditioned stimulus.

However, if the components of the fear response were classically conditioned to the CS, the view favored by Mowrer, there is no need theoretically for a drive reduction event--all that is necessary is that the CS be contiguous with US onset. Accordingly then, in order for the CS to become fear-arousing, the CS-US pairings are sufficient.

Mowrer and Suter (Mowrer, 1950) devised an experiment to resolve the two contrasting predictions, employing the pure avoidance approach as the vehicle of solution. Two groups of rats were run in a shuttlebox; CS-US interval was 5 seconds; and shock duration was 10 seconds. If no avoidance response was made, shock was delivered, no escape being possible. On such non-avoidance trials, the CS duration overlapped with shock and was terminated with the shock offset for one group of Ss. In the other group, the CS did not overlap but was terminated with shock onset. On avoidance trials, the CS was response-terminated for both groups.

Hullian theory would predict that better learning would occur with the former group while the Pavlovian interpretation, predicts that there should be no differences in learning between the two groups.

No significant differences in total number of avoidance responses were found, and the learning curves paralleled each other quite closely. Mowrer and Suter interpreted the results as favoring the two-process conception of avoidance learning.

It should be pointed out that Mowrer and Suter probably were not aware that they were using a unique paradigm. They omitted the escape response out of experimental necessity: in order to hold the US duration constant so that the only difference between the two groups was in CS termination.

In a similar experiment Traum and Horton (Mowrer, 1950), also members of the Mowrer group, utilized a factorial design in which one of the dimensions concerned the comparison of the pure avoidance procedure against the avoidance-escape-procedure, or what they referred to as an invariable US vs a variable US. Significant differences in learning were reported; the avoidance-escape group was superior to the pure group. Another dimension of the design was concerned with the CS termination problem previously investigated by Mowrer and Suter, and was an attempt to replicate the Mowrer and Suter findings. Once again, no difference was found between the two procedures.

The results of the Traum-Horton experiment may not really be convincing since the shock duration for the invariable US (or pure avoidance) group was only 2 sec. whereas the shock duration for the variable US (or avoidance-escape group) was determined by the escape latency. Consequently, there was a difference in the total amount of shock experienced by the groups and this could have influenced the experimental outcome.

These studies exemplify the use of the pure paradigm by Mowrer and his colleagues. As was stated earlier the employment of the paradigm was dictated by the logic of their hypotheses and experimental purposes; they were not interested in the paradigm itself. It should be mentioned that their logic did not appeal to all readers (see Miller, 1951; Kendler, 1951; and Sheffield, 1951).

The second instance of utilization of the pure avoidance paradigm was in an experiment by Marx and Hellwig (1964). Their purpose was to investigate the nature of the paradigm in itself, recognizing its uniqueness as an avoidance procedure. Their approach like that in the Traum-Horton study involved the comparison of the pure avoidance procedure with the avoidance-escape procedure in terms of acquisition and extinction. The details of the experiment are as follows:

> The apparatus was a shuttlebox containing a shock compartment and a "safe" compartment interjoined by a guillotine door. The raising of the door served as the CS. CS-US interval was set at 3 seconds; shock duration was 15 seconds. In the experimental procedure an S̲ was placed in the shock compartment and upon raising of the door, had 3 seconds to run into the safe compartment in order to avoid the US, electric shock. For one group of animals, if no avoidance response was made, an escape response was available (the door remained open at the end of the CS-US interval allowing S̲ to enter the safe chamber and flee the shock). For the other group, no escape was possible (the door closed at the end of the CS-US interval and S̲ had to endure 15 seconds of shock). After the acquisition series, each of these two groups were divided into two subgroups for the extinction series of trials. One subgroup continued in the acquisition condition (except for the omission of shock) while the other subgroup was switched to the opposite procedure (with shock omitted), making a 2 x 2 factorial design for the extinction trials.

For the acquisition trials, the results indicated no significant difference in mean number of avoidance responses between the two groups. For the extinction series, S̲s whose acquisition training was under the no-escape condition (the pure procedure) were significantly more resistant to extinction than the S̲s trained under the escape-allowed condition. On the average the former S̲s made over twice as many avoidance responses as the latter Ss. The results suggest that pure avoidance procedure leads to greater resistance to extinction. Marx and Hellwig interpreted this to mean that animals trained without escape become more strongly motivated and therefore more persistent during extinction.

Evaluation

To date, these aforementioned studies are the only instances found by the author where the pure paradigm has been employed and/or investigated. As a result the status of the pure approach is largely undefined, and the paradigm, if it is unique, remains to be proven so. It should be of interest, both practical and theoretical, to examine the pure avoidance situation further and in a more comprehensive manner, and to establish whether the results from parametric experimentation utilizing the pure paradigm would generalize to results obtained from comparable avoidance-escape parametric research.

Because of its characteristics the paradigm should be useful in certain experimental contexts particularly where a non-correction learning situation is needed, or as another instance, where the duration of the primary reinforcement must be kept constant over trials. To take a specific example, in Estes' (1959) statistical learning theory an intriguing problem concerns the effect of unreinforced trials such as those which occur in learning tasks involving a non-correction procedure. The predicted effect of such trials depends on the kind of mathematical assumptions or "operators" used in accounting for the situation. The adequacy of these operators have been assessed in various kinds of non-corrective situations. The pure avoidance approach being the non-corrective counterpart in avoidance conditioning could be used for further evaluation of these operators. Some other examples of applications of the paradigm will be discussed later.

This then is the state of affairs with respect to the pure approach. To recapitulate, it has largely been unexplored. There are some indications that pure avoidance learning is slower but more resistant to extinction. However, research investigations are limited to two instances, and so there is a need for parametric data on the paradigm. The purpose of the present research is to attempt to acquire parametric information that may help in better defining the status of the pure scheme.

The CS Termination Parameter*

One parameter of significance for instrumental avoidance conditioning and the one investigated in the present experiment is the CS-termination event. This event enjoys a particularly important theoretical role in avoidance conditioning. The contemporary status of CS termination is that of a secondary reward that produces the bridge between the stimulus events and subsequent responses on avoidance trials. It is the reinforcer of the avoidance response.

The classic study by Mowrer and Lamoreaux (1942) was the first to emphasize strongly the importance of the CS-termination event. Prior to that time, at least from a Hullian standpoint, the identity of the reinforcer of an instrumental avoidance response was unclear. On escape trials the identity of the reinforcer was unequivocal: US-offset. But on avoidance trials the US was not present. Mowrer and Lamoreaux postulated that for avoidance trials termination of the

*All investigations reported in this section employed the traditional avoidance-escape procedure.

CS served as the reinforcer. They hypothesized that the CS becomes a fear-arousing signal whose termination leads to fear-reduction and will have reward value. And, they maintained, if this reward precedes or follows a correct response by an appreciable time delay, the rate of learning under these conditions should not be as great relative to a situation in which the reward or termination occurs simultaneously with the correct response. The results of their investigation indicated that response-termination of the CS was related to faster learning while the non-response termination conditions proved to be less efficacious. The findings were interpreted as support for the fear-reduction formulation.

In a similar analysis of the role of CS termination, Wickens and Platt (1954) examined the effects of differential CS-offset in both an instrumental and a classical avoidance situation. Human Ss learned a finger-withdrawal response to a tone-CS and a shock-US. The CS either terminated instantly upon the occurrence of the withdrawal response or the offset was delayed. They failed to verify Mowrer and Lamoreaux's findings in full, however. The difference between the two termination procedures was non-significant for the classical situation. For the instrumental situation, in an analysis of trial blocks, a significant difference was found only for the first trial block.

Brody (1957), also utilizing a human avoidance learning situation, was able to corroborate Mowrer and Lamoreaux's findings. The Ss were given a continuous tracking task in which a single light illuminated the target to be tracked. The CS, a tone 1.8 sec. in duration, preceded a US which consisted of the condition of darkness, i.e., the target illumination was shut off. The Ss were asked to keep a pointer affixed on the target; during tracking, the CS came on, and in order to avoid or escape the US (the darkness) and continue the tracking operation, the correct response, turning of a knob, was required. For an acquisition series of trials, Brody reported the contingent or response-termination procedure to be superior to a delayed-termination one.

A series of experiments by Kamin (1956) has helped to define the role of the CS in a most comprehensive fashion. In the first investigation, Kamin maintained that if the reinforcement for the avoidance response is CS termination as espoused by the S-R theorists, then a strict or literal interpretation of their views suggests that omitting shock on avoidance trials is not crucial, since the sine qua non is the CS-offset event. Thus, according to Kamin's logic, a response that terminates the CS without resulting in US avoidance should be reinforced as much as one that does both, CS termination and US avoidance. Also, a response that is instrumental in avoidance of the US but doesn't alter the CS should be reinforced no more than one that does neither. In a factorially-designed experiment containing conditions of response termination and delayed termination of the CS on avoidance trials vs conditions where US avoidance is possible and where it is not possible on avoidance trials, Kamin attempted to answer these questions.

The data indicated that when the avoidance response was accompanied by US avoidance, as well as a response-terminated CS, the Ss learned better. No significant interaction was found. Kamin concluded that US avoidance is important in the conditioning of avoidance responses, and that any S-R interpretation relying only on the CS-offset event to account for avoidant responding is inadequate.

After examining the relative effects of different CS and US events on avoidance trials, Kamin, Campbell, Judd, Ryan, and Walker (1959) focused their attention on escape trials ~~and conducted~~ a similar analysis. The issue to be resolved was, that given the efficacy of a response-terminated CS on avoidance trials, is such a condition necessary during escape for the subsequent emergence of avoidance responding; or is it the case that the determinant of avoidance responding is tied up solely with response termination of the US. Once again, S-R theory does not specifically state whether CS-termination contingent with the escape response is important.

Kamin et al. found that response termination of the CS as well as the US produced a greater number of avoidance responses with a combination of both factors producing the highest level of responding. They concluded that the emergence of avoidant behavior depends in part on prompt CS-offset and that CS-offset may be at least as powerful a reinforcer on escape trials as US-offset. A follow-up study (Kamin, 1959) suggested that prompt CS-offset was facilitative because it contributed "positively" to avoidance responding, rather than having a "negative" or inhibitory effect due to a delayed CS-offset.

If CS termination serves as a valid secondary reinforcer, there should be a gradient of delay of this secondary reward that corresponds to the primary delay-of-reward gradient. Using the following delay intervals of CS-offset, zero-delay (response-termination condition), 2.5 sec. delay, 5 sec. delay, and 10 sec. delay, Kamin (1957 a) showed that such a gradient does in fact exist. Acquisition of a shuttlebox avoidance response was found to be a negatively monotonic function of delay of CS-offset.

Kamin also noted from the data that the trial of the first avoidance was not equal across the experimental groups. There was a tendency for the first avoidance to occur later in the long delay groups. Kamin attributed this to the fact that the delay treatments were administered not only on avoidance trials but on escapes as well, suggesting that the delays on escape trials may have influenced the trial of the first avoidance response. Kamin contended that there appeared to be a gradient effect, but its meaning was muddled. Empirically, the gradient should reveal the effect of varying intervals of delay of CS-offset on avoidance responding. Theoretically, it should reveal the effect of delay of secondary reward on avoidance responding. However, since there were indications that escape delays may have influenced the emergence of the first avoidance, the gradient may be due in part or wholly to escape treatments, i.e., escape events determine to some degree the future frequency of avoidance responding. Hence, if the empirical interpretation of the gradient is ambiguous, so must be the theoretical interpretation. For a secondary reward interpretation, the gradient must be related to avoidance trial treatments only, since secondary reward is presumably a relevant concept for avoidance and not escape behavior. Kamin pointed out that a new experiment was needed, one in which the different delays occur only on avoidance trials with escape events kept as invariant as possible across groups. Such a study would establish the secondary reward gradient less ambiguously. It should be noted that another way to keep escape treatment constant is not to permit escape at all as advocated by the pure avoidance procedure. The pure paradigm would be especially useful here.

In a suceeding replication Kamin (1957 b) varied the delay intervals only on avoidance trials. On escape trials, the CS was response-terminated for all groups.

The resulting gradient was similar to the first one except that its terminal portion was not as steep. Also, no significant differences were found among groups for the trial on which the first avoidance occurred. The secondary reward interpretation was supported.

In the second part of the same experiment Kamin provided an even more convincing argument for the gradient. It was noted that there was a fundamental difficulty with parametric studies of avoidance, viz., when the independent variable under study affects the frequency of the avoidance responding, the experimental groups differ in respect to certain variables such as CS-US pairings, amount of exposure to US, amount of escape practice, etc. The independent variable effect may be contaminated by all of these. But with a large number of Ss and identical escape treatments for all groups, it is possible to rid the main effect of such confounded variables. Under these conditions, the trial of the first avoidance response should not differ across groups except for chance fluctuations. Then, on the first avoidance trial, the delays of CS-offset can be administered, the experiment stopped on the next (second) avoidance, and the number of intervening escapes tallied. All groups would have been treated alike except for the varying delays of CS termination on the first avoidance, and any gradient effect that results will be relatively free of confounded variables. Again, Kamin's data revealed no significant trial differences for first avoidance. A trend test of frequency of intervening escape responses was significant in the predicted direction; there were more intervening escapes the longer the interval of delay.

In conclusion, Kamin interestingly remarked that the secondary-reward interpretation is not the only one possible here. Delay of CS termination could reasonably be regarded as lengthening of secondary punishment. No-delay Ss are not punished while the delay groups are punished via continued exposure to the aversive CS.

Another correlate of primary reinforcement that has been investigated in terms of CS-offset is amount of reward. Bower, Starr, and Lazarovitz (1965) hypothesized that if the CS has a reinforcement connotation, then amount of response-produced change in the CS should correspond to this variable. They proposed that variations in reduction of CS intensity contingent with the correct response should be related to variations in level of avoidance learning.

The paradigm for the experiment consisted of the following events: (1) tone onset; (2) shuttle response, either escape or avoidance; and (3) immediate reduction of tone intensity followed by cessation 10 sec. later. Three experimental groups were formed: (1) a 100% reduction group (2) a 57% reduction group, and (3) a zero-reduction group.

All group differences as measured by mean number of avoidances were significant. A gradient effect was found; the level of avoidance conditioning was an increasing function of the amount of change in the CS following the correct response. Thus, a reinforcement definition of CS termination received additional support. The self-criticism Kamin made of his first gradient may apply in this "amount of reward" context also, since the CS reduction treatments were given on escape trials. Kamin would probably prefer to hold escape treatments constant, depending on whether the trial differences of the first avoidance occurred. Again, the pure avoidance paradigm is applicable to meet such needs.

Two other experiments in the same report by Bower et al. revealed that the amount of change in CS intensity per se is more important than the direction of change, and that the addition of a safety signal presented contingently with a response-terminated CS facilitates learning.

Recently, some very important work on the role of CS-termination in extinction of avoidance responses has been reported. The most definitive investigation was that by Katzev (1965). In a paradigm for extinction, the essential operation is the omission of reinforcement source (s) available during the acquisition process. In the extinction of an avoidance response, the source typically omitted is the US. However, as Katzev emphasized, no thought has been given to CS-termination which prior research has depicted as a powerful secondary reinforcer. Under the usual avoidance extinction procedure the S's avoidance responses continue to terminate the CS. For example, in the shuttlebox situation no shock is delivered if S fails to make an avoidance, but if the avoidance is made, the CS is contingently terminated. And, presumably, these responses are reinforced! Small wonder that extinction has been reported to proceed quite slowly (cf. Solomon and Wynne, 1954).

Katzev's approach was so designed that the relative effects of withholding both shock and response-termination of the CS could be assessed. During extinction the CS was either, response-terminated, prior-terminated (terminated before the correct response), or terminated in a delayed fashion. Shock was omitted for some groups and not others. One group was given continued acquisition training to establish a baseline to which the performance of the other groups could be compared.

Katzev's results were quite startling. He found that it was neither necessary nor sufficient to omit the shock for extinction to take place. As long as the CS was not response-terminated, extinction occurred even if shock was presented for failure to make the avoidance response. Non-response-termination of the CS, either the prior or delayed version, was found to be a necessary and sufficient condition for extinction behavior. As long as the CS was not promptly terminated, the rate of extinction was marked. And in groups in which the CS-offset was prompt or contingent upon the response, the rate of extinction did not differ appreciably from the baseline group.

Some earlier but less definitive work was reported by Haruki* (1959) and Owen (1963). Both investigators found that when the avoidance response does not terminate the CS on avoidance trials the extinction process is more rapid.

In closing this section, once again it can be pointed out that Kamin's criticism, (that escape events should be held constant when avoidance variables are studied) can also be applied to this extinction research, since all three investigations permitted differential treatments for escapes as well as the avoidances. This constitutes another area where the pure paradigm can be used to an advantage.

The Present Problem

The purpose of this research is to examine the effect of differential CS termination in the context of the pure avoidance situation in which there is no authorized escape. It is hypothesized that, in the pure paradigm, CS termination contingent with the response on avoidance trials facilitates learning just as it does in the avoidance-escape paradigm. At this time, there is no evidence to suggest that the two

*Reviewed from Haruki's abstract.

paradigms are different with respect to the CS-termination parameter. However, the Marx and Hellwig finding that the pure paradigm is characterized by greater resistance to extinction suggests that there are some differences with respect to certain variables. Whether the parametric findings from avoidance-escape will hold remains to be determined.

It is further hypothesized that CS termination contingent with US-offset on non-avoidance trials facilitates avoidance responding. It is argued that CS termination with US-offset, by permitting the CS to continue during the shock interval, could enhance the development of aversive properties of the CS making it a more effective stimulus. As proposed in this study, CS termination at US-onset and US-offset corresponds to Mowrer and Suter's schema of the overlapping and non-overlapping CS discussed earlier.

METHOD

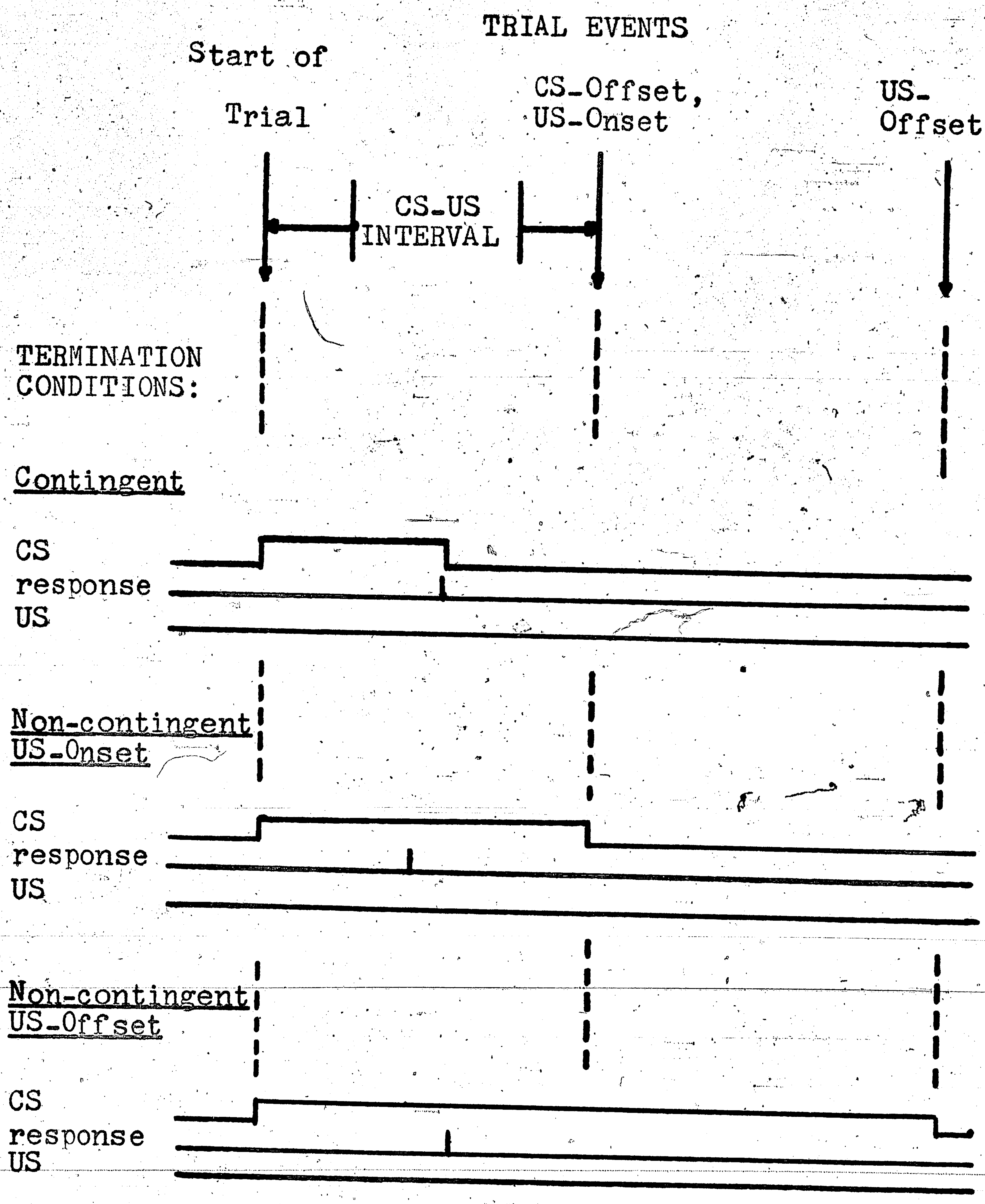
Experimental Design

A three dimension factorial design modeled after Lindquist's Type III design (Lindquist, 1953) was utilized. The design contained six experimental groups. Three conditions of CS termination on trials when the avoidance response occurred (to be called CS-T Avoid) made up one dimension of the design. They were: 1) Contingent, the response-termination condition in which the CS ended immediately or contingently with the occurrence of the avoidance response; 2) Non-Contingent, US-Onset, the non-contingent condition in which the CS was terminated at the time programmed for shock onset on non-avoidance trials; and 3) Non-Contingent, US-Offset, the non-contingent condition in which the CS terminated at the time programmed for shock offset on non-avoidance trials. See Figure 1.

A second dimension of the design was concerned with CS termination when the avoidance response was not made (to be called CS-T Non Avoid) and contained two conditions. In the first condition, US-Onset, the CS ended at the shock onset time at the end of the CS-US interval. In the other

Figure 1

Event sequences for
the CS-T Avoid conditions.



condition, US-Offset, the CS terminated with the shock offset. See Figure 2.

The last dimension of the design was trial blocks of ten trials each for 140 trials (to be called Trial Blocks) and constitutes a trend dimension.

The dependent variable was number of avoidance responses per trial block. All Ss were required to meet an acquisition criterion of at least one avoidance response in the 140 trials, the experiment being completed when each group contained eight Ss who met the criterion. All experimentation for each animal was completed in a single session. The group assignment of the Ss and order of running were determined randomly. The intertrial interval for all groups was 20 seconds.

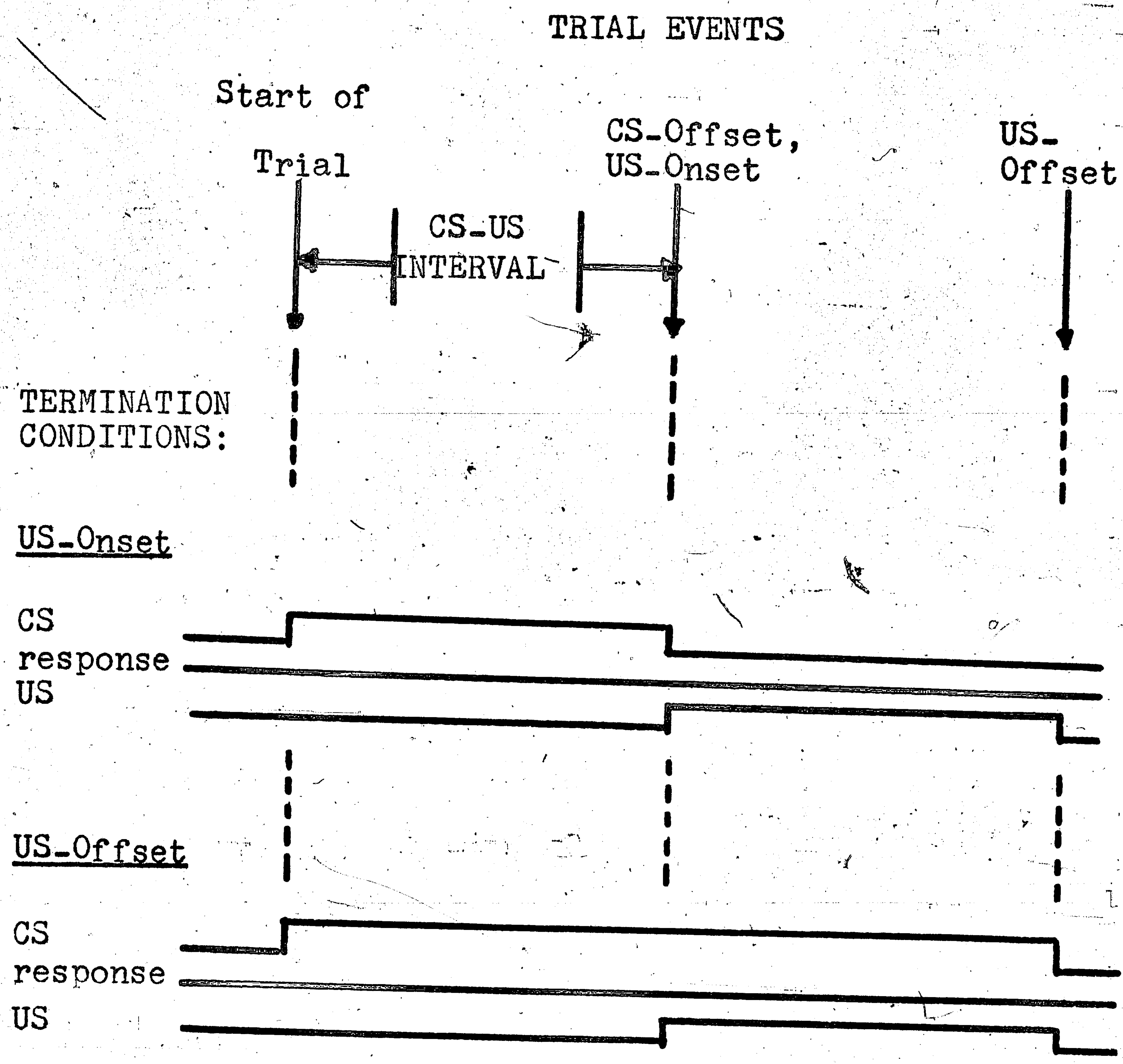
Ss and Apparatus

The Ss were naivé female, albino rats ranging in age from about 4 to 6 months. All animals were housed in pairs in single cages with free access to food and water.

The apparatus was an aluminum box 22" in length, 13" in width, and 15" in height. The box was divided into three compartments but only two were used for experimental purposes. Both experimental compartments were 5 1/2" in length by 11"

Figure 2

Event sequences for
CS-T Non-Avoid conditions.



in width by 10 1/2" in depth. One compartment, unpainted, served as the shock chamber and housed a removable grid floor constructed of brass tubing (5/8" o.d.) patterned after that developed by Dinsmoor (1958). The other compartment contained black and white striped walls and a black perforated floor. Each compartment was illuminated by a 6 watt bulb mounted beneath its floor. The two compartments were interconnected by a small guillotine door (which could also be appropriately labeled a "window") 1 1/2" x 1 1/2" located 6" above the grid floor; a perforated transparent lid served as a ceiling for both compartments.

The guillotine door, also striped in black and white, was backed by a removable transparent plexiglass barrier mounted in the striped chamber. The barrier was fixed at a distance of 3/4" from the door and controlled access from shock chamber into the striped chamber via the door. In the shock chamber, a small ledge was mounted at the bottom of the door.

The photosensitive element from a Knight-kit Photoelectronic Relay (83 Y 702) was mounted adjacent to the door opening in the striped chamber. An opaque tube 3/8" in diameter, leading into the striped chamber from a light source (a slide projector) outside the chamber, projected a small beam of light across the door opening onto the photosensitive element. A diagram of the apparatus is presented in Figure 3.

Electric shock, the US, was delivered to the grid from a matched-impedance, 60 cycle, A.C. source (Campbell and Teghtosoonian, 1958). Grid shock level averaged .2 ma., and grid shock polarity was alternated by a high-speed relay-operated scrambler (Hoffman and Fleshler, 1962). The CS, mounted under the grid on the floor of the box, was a buzzer made from a 25 Kohms D.C. relay. All CS and US onsets and offsets were controlled by Hunter timers programmed in conjunction with the photoelectronic relay to provide the appropriate stimulus events demanded by the experimental procedure. Any equipment capable of producing extraneous sound cues was sheltered in sound-deadening boxes and kept in a room adjacent to the experimental room.

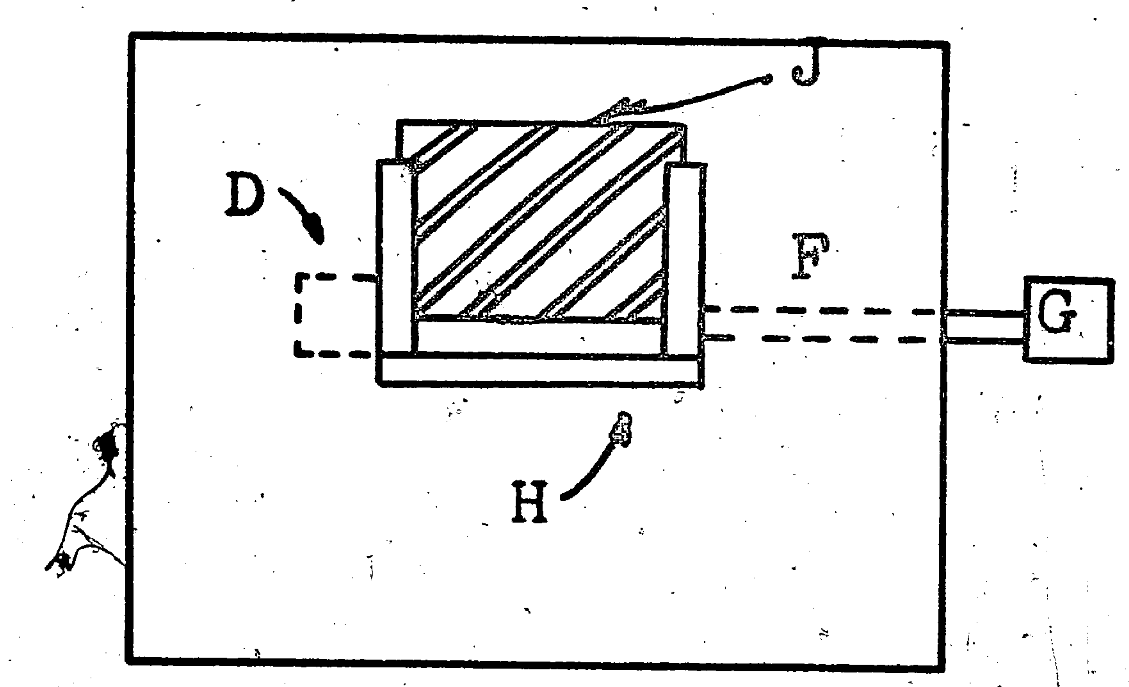
Procedure-Preliminary Training

Initially, all Ss were prehandled and given experience outside their home cages by permitting them to explore a hexagonal-shaped maze. After one week of the "gentling" process, each animal was put in the shock chamber and given

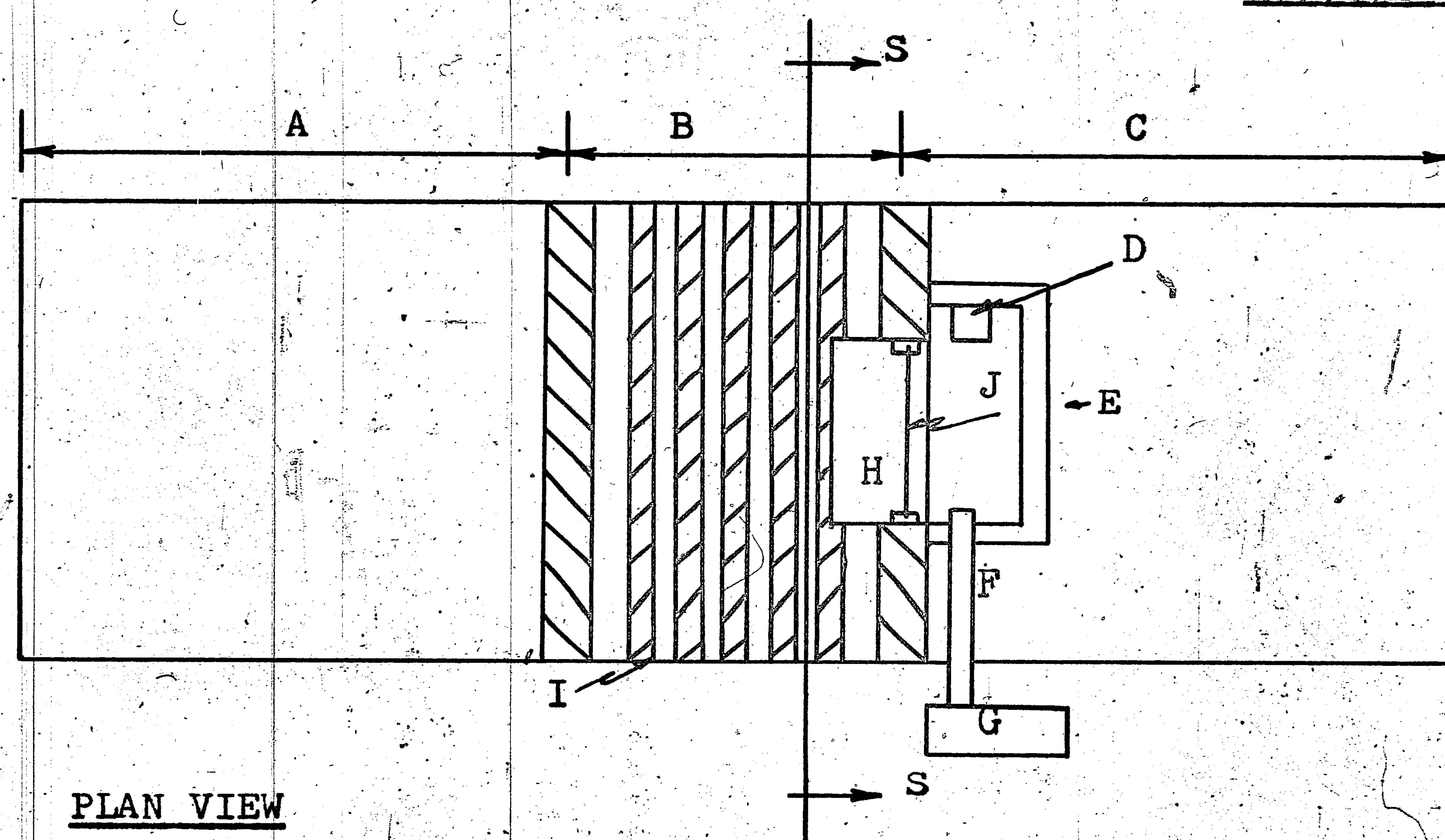
Figure 3 Diagram of apparatus.

LEGEND

A- Unused chamber
B- Shock chamber
C- Striped chamber
D- Photosensitive unit
E- Barrier
F- Light tube
G- Light source
H- Ledge
I- Shock grid bar
J- Guillotine door



Section S-S



PLAN VIEW

10 min. of adaptation or "exploration" time. During this time, the guillotine door was open and the S was required to make at least one correct response which involved inserting its head or nose into the door opening such that the light beam was interrupted and the photoelectronic relay activated, providing a response signal to E. The door barrier was not in position at this time. The size of the door opening allowed S to insert its body only up to the front shoulders, i.e., just the head portion of its body. Once inside the opening, the S could visually examine the striped chamber.

If the animal failed to make the response in the specified time, it was removed, returned to the home cage, and not put back in the box until the next day. Most of the animals, placing their front paws on the ledge provided, approached the door opening in the first or second 10 min. session, and made the relevant response. None required more than three sessions.

Procedure-Acquisition Trials

After an animal met the criterion, 2 pre-test trials were given to ascertain the neutral status of the CS. The buzzer-CS came on simultaneous with raising of the door and lasted for 6 sec., the door closing simultaneously with its offset. If S made the correct response on any of these trials, it was discarded. None made the response. The door barrier was then fixed in position and the test or acquisition trials initiated.

On any given trial, the guillotine door was raised simultaneously with the onset of the CS. If the animal failed to make a prescribed avoidance response in a 6 sec. CS-US interval, the door was lowered at the end of the interval, shock followed for a duration of 4 sec., and the trial was over. This was defined as a non-avoidance trial. The avoidance response was defined as a response, occurring in the CS-US interval, involving the insertion of the S's head (or nose) into the door opening such that the photo-electronic relay was tripped (with the door barrier in place, the S could insert its head or nose only about 3/4" in distance--an ample protrusion though, for activation of the relay). The function of the transparent door barrier was to prevent the S from obstructing the closing of the door. The barrier allowed only a limited protrusion, and hence the S could not deter the falling of the door by remaining in the opening. At most, the door could come to rest on S's snout, causing S to withdraw it from the door. The door was closed on avoidance trials at the same point in time that it was closed on non-avoidance trials (at the end of the CS-US interval) so that this event could be kept constant across trials and not be directly tied in with the CS-termination event. For all practical purposes this was achieved.

If the S made the avoidance response in the crucial interval, the door was lowered at the end of the interval, no shock followed, and the trial was ended. Such a trial was defined as an avoidance trial. In both avoidance and non-avoidance trials, the CS was terminated according to the definition of the group to which the animal belonged.

RESULTS

In order to obtain 48 Ss who met the criterion of at least one avoidance, 54 animals were used. In addition to four Ss who failed to meet the acquisition criterion, two other animals were discarded, one S because of an impairment in sense of balance (probably resulting from middle-ear disease), and the other because of a failure of the apparatus during the early trials.

The total number of avoidance responses over the 140 trials made by each S in each experimental group is shown in Table 1. The mean number of avoidance responses over the 140 trials for each experimental group is shown in Table 2. Means for the three CS-T Avoid conditions pooled over the two CS-T Non-Avoid conditions (column means), for the two CS-T Non-Avoid conditions pooled over the three CS-T Avoid conditions (row means), and for all six groups combined (grand mean) are also shown in Table 2. Mean number of avoidance responses per blocks of 10 trials for the 140 trials for each experimental group is shown in Table 3. The variance of avoidance responses over the 140 trials for each experimental group is shown in Table 4. Hartley's F-Max test (Lewis, 1960) for homogeneity of variance among these six variances was found to be significant at the 5%

Table 1

Total number of avoidance responses over 140 trials for each S in each experimental group.

		CS-T Avoid		
		Contingent	Non-Contingent US-Onset	Non-Contingent US-Offset
	US-Onset	88	20	22
		47	5	32
		120	8	8
		5	25	22
		4	3	16
		8	5	26
		42	44	24
		100	3	103
CS-T Non-Avoid				
	US-Offset	2	1	35
		43	43	5
		12	39	19
		4	5	3
		30	7	1
		2	3	8
		10	20	9
		85	12	3

Table 2

Mean number of avoidance responses over 140 trials for each experimental group.

		CS-T Avoid			
		Cont*	Non-Cont US-Onset	Non-Cont US-Offset	Row Means
CS-T Non Avoid	US Onset	51.75	14.13	31.63	32.50
	US Offset	23.50	16.25	10.38	16.71
	Column Means	37.63	15.19	21.00	24.61 Grand Mean

* Cont is the abbreviation for Contingent

Table 3
Mean number of avoidance responses per blocks of 10 trials over 140 trials for each experimental group.

Trial Blocks

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	2.13	1.13	4.25	4.62	3.50	5.13	4.39	3.13	4.00	2.88	2.38	3.38	3.50	4.50
B	1.38	1.50	1.88	0.25	0.13	0.63	0.25	0.88	1.25	1.75	3.50	3.00	3.50	3.63
C	1.13	1.63	1.25	1.25	0.25	0.75	1.50	1.50	0.50	1.50	0.50	0.75	0.88	0.75
D	2.13	2.38	1.88	1.13	1.38	1.00	1.00	1.50	1.13	1.25	0.63	0.63	0.00	0.00
E	1.38	3.38	2.63	3.25	3.00	2.63	1.50	1.38	2.13	2.88	1.75	1.50	2.00	2.13
F	1.38	1.50	2.63	1.25	0.13	0.75	0.00	0.25	0.25	0.63	1.13	0.25	0.13	0.13

		CS-Avoid		
		Contingent	Non-Contingent US-Onset	Non-Contingent US-Offset
CS-T Non-Avoid	US-Onset	A	C	E
	US-Offset	B	D	F

KEY TO GROUP LABELS

Table 4

Variance of avoidance responses over 140 trials for each experimental group.

		CS-T Avoid		
		Contingent	Non-Cont US-onset	Non-Cont US-offset
CS-T Non Avoid	US-onset	14797.50	1496.87	6171.87
	US-offset	5824.00	1885.50	913.87

$$F\text{-Max} = \frac{14797.50}{913.87} = 16.19$$

level of significance (see Table 4). Following Lindquist's suggestion (Lindquist, 1953, Chapter 3), in spite of the lack of homogeneity of variance, the originally proposed trend analysis was carried out but with an appropriate change in the level of significance to be used. Thus to compensate for the heterogeneity of variance and still maintain the original significance level, a more conservative value (making it more difficult to declare that a significant difference was found) was used.

The results of this trend analysis are presented in Table 5. As can be seen, none of the F's were found to be significant either at the original level of significance, 5%, or at a more conservative value. Hence none of the differences in terms of group means, learning rates, or interactions were significant. There was no significant trial block effect, indicating that no significant amount of learning occurred overall. The total number of avoidance responses made by each S for each trial block over all the trials is given in the Appendix.

Table 5

Analysis of Variance
of avoidance responses per
blocks of 10 trials

Source	df	SS	MS	F-ratio
Between Ss	47	2888.96		
CS-T Avoid	2	309.95	254.98	2.93
CST-Non Avoid	1	213.75	213.75	4.04
CS-T Avoid x CS-T Non Avoid	2	144.57	72.29	1.37
Error (b)	42	2220.69		
Within Ss	642	2569.50		
Trial-Blocks	13	66.15	5.09	1.30
Trial Blocks x CS-T Avoid	26	155.42	5.98	1.53
Trial Blocks x CS-T Non Avoid	13	86.02	6.62	1.69
Trial-Blocks x CS-T Avoid x CS-T Non Avoid	26	129.73	4.99	1.28
Error (w)	546	2132.18	3.91	
Total	671	5458.46		

DISCUSSION

From Table 1 it can be seen that inter-subject variability was quite high. For example, in the experimental group with the joint conditions CS-T Avoid, Contingent and CS-T Non Avoid, US Onset, two Ss made less than 10 avoidance responses and two made at least 100 avoidance responses in the 140 trials. This diversity appeared to hold for all the groups. In fact, some animals made a relatively large number of avoidances and showed definite learning during the acquisition trials while others stayed at a very low level never showing much change. Consequently, with such high variability, any group differences that may have resulted would be difficult to detect.

Mowrer and Suter also reported that their data was characterized by large individual difference and a low level of learning. Their two experimental groups, comparable to the two CS-T Avoid, Contingent groups in the present experiment, had a range of avoidance responses that varied from under 10 responses to as high as 90 responses in 100 trials. The mean number of avoidances for their "overlapping CS" group was 37.1, and that for their "non-overlapping CS" group was 37.9; for the comparable groups of the present experiment the means, given in Table 2, were 23.50 and 51.75 respectively. The results in the Traum-Horton investigation were essentially the same, i.e., large inter-subject variability and low levels of learning.

In the Marx and Hellwig experiment the median number of trials needed to reach the acquisition criterion by the avoidance-escape was 29 while that for the pure avoidance group was 53; only 8 out of the 12 pure avoidance Ss reached the criterion. In testing the difference between the two groups in terms of mean number of avoidances made to criterion, no significance was found. It can be inferred that if the difference between the two groups in mean number of avoidance responses was as large as the difference in median trials to reach criterion, and if such a difference was non-significant, then these data may also be marked by large inter-subject variability, although probably not as large as in the present experiment or in the Mowrer and Suter one. The extent of the variability cannot be known definitely since the information was not provided.

It should be pointed out that Marx and Hellwig used a one-way shuttlebox, providing a task generally recognized as less difficult than the two-way shuttlebox where an S is required to run into an area in which he has previously been shocked. This may account for the fact that higher levels of learning were obtained. The author used a one-way shuttlebox in some pilot work but found it unsuitable for the experimental purposes. It appeared that the learning in the one-way apparatus was too fast. That is, it was too fast in the sense that CS termination could not be varied. It was the author's observation that the shock chamber itself became so strongly aversive after several shocks that the buzzer-CS became totally irrelevant as a signal and the chamber itself became the aversive precursor. As soon as the animal discovered the correct, "exit" response, upon being replaced in the shock chamber for the next trial, it would immediately run to the exit door and await its opening without any need for a formal CS. As a result, CS termination probably could not be varied and so the one-way shuttle was not used. The two-way box, because of its conflict-producing nature (forcing the S to run into a previously noxious area) was also considered undesirable, especially with conditions of no escape. The window response appeared satisfactory because it took some advantage of one of the natural responses to shock, namely jumping.

Also, Marx and Hellwig demonstrated that guillotine door "movement" can serve as the CS and initiate avoidance behavior. In their experiment the raising of the door signalled CS-onset and the subsequent lowering of the door signalled CS-offset. In the present study the CS (buzzer) always came on simultaneously with the raising of the guillotine door, and hence, probably served as part of CS-complex. However, the lowering of the door was not correlated with the buzzer termination; it was kept constant across trials. So the situation was such that the door-raising was part of the CS but not the door-lowering. This condition could have contributed part of the inter-subject variability that occurred.

Although in the present experiment there were no significant differences among the groups, in examining the group means some appear to be in the predicted direction. The Contingent groups under CS-T Avoid made more correct responses than the two Non-contingent groups (see column means, Table 2). However, the Non-Contingent, US Offset groups averaged slightly more avoidances than the Non-Contingent, US Onset groups. Kamin's findings on gradients of delay of CS termination would lead one to expect the opposite prediction. The US Offset groups should have experienced a greater delay of CS termination, and learning should have been poorer under this condition. The larger mean for the US Offset groups was probably due, in the main, to one animal in the CS-T Non Avoid, US Onset condition who made 103 responses.

Examining the CS-T, Non Avoid dimension, the directionality of the means is rather puzzling. The means for the two conditions of the dimension are 32.50 for US Onset and 16.71 for US Offset (see row means, Table 2). Considering only the Contingent condition for this comparison, the difference is even greater (51.75 vs 23.50). The two groups at this level are of course most comparable to Mowrer's groups. It should be remembered that Mowrer's interpretation predicted no difference between the two procedures. The results here lean toward US Onset as the most facilitative condition or the non-overlapping CS group in Mowrer's terminology. The suggestion from the data, and it is only a suggestion, is that a CS that terminates with the US onset on non-avoidance trials, one that is shorter in duration and with less "association time", is more conducive for this type of learning. Interestingly enough, Mowrer commented briefly on the possibility of such an outcome in his own research. A non-overlapping CS might give better results than an overlapping one because with the overlapping case, the CS is associated with both shock onset and shock offset or in other words, with pain and with pleasure. In the non-overlapping case, the CS in only associated with shock onset (pain) and consequently may set up a stronger fear drive relative to the other case (Mowrer, 1950).

It appears, then, that the pure avoidance paradigm provides a situation much more difficult to learn. As it was pointed out earlier, the paradigm is open to fortuitous responding, i.e., the response made at the end of the shock period is reinforced by the shock termination and hence will tend to be repeated on the next trial but to no avail. Also, there may be a greater amount of fear, anxiety, or emotionality in the pure situation. The animal must make some response, unknown initially, and make it <u>in the CS-US interval</u>. Such a situation may be analogous to a very strong drive state, and according to activation-level predictions for example, performance would be retarded. Mowrer also suggests that pure avoidance learning is more difficult. He noted, "....a skeletal reaction will be acquired <u>more quickly</u> as the solution to the problem of fear if it is also the solution to the (shock) problem....the fact that there was no overt response which would solve the shock problem probably accounts for the rather low overall levels of learning....and for the high levels of inter-subject variability" (Mowrer, 1950).

In conclusion, the lack of a significant degree of learning in the present experiment proved disappointing. But some consolation, a meager amount, comes from Solomon and Brush (1956) who have stated: "....the failure of Ss to learn to avoid are not rare, but they are less apt to be reported in scientific papers than are the successes....the conditions surrounding failures to learn to avoid are instructive to the investigator.... as are the optimum conditions."

SUMMARY

In the traditional paradigm for avoidance conditioning, an escape response is permitted if no avoidance response occurs. In the "pure" avoidance paradigm proposed in the present experiment, no such authorized escape is provided. If the S fails to avoid, the US is delivered for its specified duration, and then the trial ends.

In the present problem, the effect of differential CS-termination on avoidance behavior was investigated under the conditions of the pure paradigm. On avoidance trials the CS was either response-terminated or it was terminated with US-onset of US-offset. For the non-avoidance trials the CS-termination occurred either with US-onset or US-offset.

The Ss were albino rats. CS was a buzzer, and US was electric shock. To make the avoidance response, the Ss were required to project their heads through the opening of a guillotine door located in the shock chamber, and activate a photoelectronic relay.

The results revealed no significant differences in the CS-termination treatments. Inter-subject variability was high and probably obscured any treatment effects. The overall levels of learning for all groups was low, and it was concluded that the

pure avoidance paradigm presented a rather difficult learning task to the Ss.

APPENDIX

Total number of avoidance responses for each S per trial block over 14 trial blocks for each experimental group.

CS-T Avoid, <u>Contingent</u>
x CS-T Non-Avoid, <u>US-Onset</u> Group

<u>Trial Block</u>

Ss	1	2	3	4	5	6	7	8	9	10	11	12	13	14
# 4	0	1	10	10	4	10	8	7	8	4	6	6	5	9
16	0	1	3	1	0	0	0	0	0	0	0	0	0	0
22	1	4	1	0	0	1	0	0	0	1	0	0	0	0
34	3	0	1	0	0	0	0	0	0	0	0	0	0	0
39	5	5	4	8	8	9	9	8	10	9	3	9	6	7
40	1	0	0	0	0	7	7	0	5	0	0	3	9	10
53	3	10	10	10	9	4	1	0	0	0	0	0	0	0
54	4	8	5	10	7	10	10	10	9	9	10	9	9	10

CS-T Avoid, Contingent
x CS-T Non-Avoid, US-Offset Group

Trial Block

Ss	1	2	3	4	5	6	7	8	9	10	11	12	13	14
# 5	2	0	0	0	0	0	0	2	0	1	9	10	9	10
7	0	1	0	0	1	0	0	0	0	0	0	0	0	0
8	2	0	3	0	0	0	0	0	0	0	6	1	0	0
19	1	3	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	0	0	0	0	0	1	0	3	3	3	10	9
24	0	0	2	0	0	0	0	0	0	0	0	0	0	0
32	4	1	5	0	0	0	0	0	0	0	0	0	0	0
44	2	6	5	2	0	5	2	4	10	10	10	10	9	10

CS-T Avoid, US-Onset (Non-Contingent)
x CS-T Non-Avoid, US-Onset Group

Ss	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Trial Block													
# 3	0	1	4	0	0	0	0	0	0	0	0	0	0	0
9	0	2	0	1	1	2	6	6	0	0	0	2	0	0
21	3	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	5	4	7	0	2	1	2	1	3	0	0	0	0
29	2	2	0	1	1	0	1	0	0	0	0	0	0	1
31	4	1	0	1	0	2	4	4	3	9	4	2	5	5
45	0	2	2	0	0	0	0	0	0	0	0	0	1	0
48	0	0	0	0	0	0	0	0	0	0	0	2	1	0

CS-T Avoid, US-Onset (Non-Contingent).
x CS-T Non-Avoid, US-Offset Group.

Trial Block

Ss	1	2	3	4	5	6	7	8	9	10	11	12	13	14
# 6	0	1	0	0	0	0	0	0	0	0	0	0	0	0
11	1	6	5	9	3	6	2	1	0	3	2	1	0	0
15	0	3	3	0	0	0	0	0	1	0	0	0	0	0
17	3	2	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	2	1	0	0	0	0	0
33	2	5	3	0	3	2	0	0	0	2	1	2	0	0
43	6	0	2	0	3	0	0	0	1	0	0	0	0	0
50	5	4	2	0	2	0	6	9	6	5	2	2	0	0

CS-T Avoid, US-Offset (Non-Contingent)
x CS-T Non-Avoid, US-Onset Group.

Trial Block

Ss	1	2	3	4	5	6	7	8	9	10	11	12	13	14
# 2	1	3	3	0	0	4	0	0	1	7	1	0	0	2
14	4	6	3	5	5	5	1	1	0	0	2	0	0	0
18	0	4	0	0	0	0	0	0	0	0	1	0	0	3
41	0	0	0	4	2	2	1	0	3	3	2	3	2	4
42	0	0	2	0	0	0	0	1	5	2	5	1	2	6
52	0	0	0	7	6	0	0	0	0	0	0	3	6	0
49	4	5	4	0	1	0	0	0	1	1	0	0	0	0
51	2	9	10	10	10	10	10	9	7	10	3	5	6	2

CS-T Avoid, US-Offset (Non Contingent)
x CS-T Non-Avoid, US-Offset Group.

Trial Block

Ss	1	2	3	4	5	6	7	8	9	10	11	12	13	14
# 1	3	4	8	3	1	1	0	0	2	4	6	2	0	1
23	1	1	2	0	0	0	0	0	0	1	0	0	0	0
28	2	1	4	4	0	3	0	2	0	0	3	0	0	0
35	1	0	0	0	0	0	0	0	0	0	0	0	0	0
36	3	0	3	1	0	0	0	0	0	0	0	0	1	0
37	0	1	1	0	0	1	0	0	0	0	0	0	0	0
47	0	0	3	0	0	0	0	0	0	0	0	0	0	0
55	1	5	0	2	0	1	0	0	0	0	0	0	0	0

REFERENCES

Bower, G., Starr, R., and Lazarovitz, L. Amount of response-produced change in the CS and avoidance learning. J. comp. physiol. Psychol., 1965, 59, 13-17.

Brody, A. L. Statistical learning theory applied to an instrumental avoidance situation. J. exp. Psychol., 1957, 54, 240-245.

Campbell, B. A. Electrical and behavioral effects of different types of shock stimuli on the rat. J. comp. physiol. Psychol., 1958, 51, 185-192.

Dinsmoor, J. A. Punishment: 1. The avoidance hypothesis. Psychol. Rev. 1954, 61, 34-46.

Dinsmoor, J. A. A new shock grid for rats. J. exp. anal. Behav., 1958, 1, 182.

Estes, W. K. The statistical approach to learning. In S. Koch (ed.), Psychology: A study of a science, Vol. 2. New York: McGraw-Hill, 1959. Pp. 380-491.

Haruki, Y. A consideration of extinction procedure of avoidance response. Ann. Anim. Psychol. (Japan), 1959, 9, 53-61.

Hoffman, H. S. and Fleshler, M. A relay sequencing device for scrambling grid shock. J. exp. anal. Behav., 1962, 5, 329-330.

Kamin, L. J. The effects of termination of the CS and avoidance of US on avoidance learning. J. comp. physiol. Psychol., 1956, 49, 420-424.

Kamin, L. J. The gradient of delay of secondary reward in avoidance learning. J. comp. physiol. Psychol., 1957, 50, 445-449 (a).

Kamin, L. J. The gradient of delay of secondary reward in avoidance learning tested on avoidance trials only. J. comp. physiol. Psychol., 1957, 50, 450-456 (b).

Kamin, L. J., Judd, R., Ryan, T., and Walker, J. Two determinants of the emergence of anticipatory avoidance. J. comp. physiol. Psychol., 1959, 52, 202-205.

Kamin, L. J. CS termination as a factor in the emergence of anticipatory avoidance. Psychol. Rep., 1959, 5, 455-456.

Katzen, R. D. The extinction of avoidance responses. Unpublished Ph.D. thesis, Univ. of California, 1965.

Kendler, H. H. Reflections and confessions of a reinforcement theorist. Psychol. Rev., 1951, 58, 368-374.

Lindquist, E. F. Design and analysis of experiment in psychology and education. Boston: Houghton Mifflin Co. 1959.

Lewis, D. Quantitative methods in psychology. New York: McGraw-Hill, 1960.

Marx, M. H. and Hellwig, L. R. Acquisition and extinction of avoidance conditioning without escape responses. J. comp. physiol. Psychol., 1964, 58, 451-452.

Miller, N. E. Studies of fear as an acquirable drive: I. Fear as motivation and fear-reduction as reinforcement in learning of new responses. J. exp. Psychol., 1948, 38, 99-101.

Miller, N. E. Comments on the multiple-process conceptions of learning, Psychol. Rev., 1951, 58, 375-381.

Mowrer, O. H. On the dual nature of learning: a reinterpretation of "conditioning" and "problem-solving." Harv. educ. Rev., 1947, 17, 102-148.

Mowrer, O. H. Learning Theory and Personality dynamics, New York: Ronald, 1950.

Mowrer, O. H., and Lamoreaux, R. R. Avoidance conditioning and signal duration - A study of secondary motivation and Reward. Psychol. Monogr. 1942, 54, No. 5 (Whole No. 247).

Osgood, C. E. Can Tolman's theory of learning handle avoidance training? Psychol. Rev. 1950, 57, 133-137.

Owen, S. The effect on extinction of avoidance response in rats of CS continuation and emotional constitution. J. genet. Psychol., 1963, 103, 147-151.

Schoenfeld, W. N. An experimental approach to anxiety, escape, and avoidance behavior. In Hoch, P. H., and Zubin, J. (Eds.), Anxiety New York: Grune and Stratton, 1950.

Sheffield, F. D. The contiguity principle in learning theory. Psychol. Rev., 1951, 58, 362-367.

Solomon, R. L. and Wynne, L. C. Traumatic avoidance learning: acquisition in normal dogs. Psychol. Monog., 1953, 67, No. 4 (Whole No. 354).

Solomon, R. L., and Brush, Elinor S. Experimentally derived conceptions of anxiety and aversion. In M. R. Jones (Ed.) Nebraska symposium on motivation. Lincoln: University of Nebraska Press, 1956.

Wickens, D. D., and Platt, C. E. Response termination of the cue stimulus in classical and instrumental conditioning. J. exp. Psychol., 1954, 47, 183-186.

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