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Fear Reduction Following Response Prevention in the Rat

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FEAR REDUCTION FOLLOWING
RESPONSE PREVENTION
IN THE RAT

BY
DONALD P. CORRIVEAU

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS IN
PSYCHOLOGY

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1975

ABSTRACT

The purpose of this experiment was to determine whether response prevention leads to fear reduction as assessed by approach measures, and to examine the role of safety testing behavior following response prevention. The subjects were 120 experimentally naive male rats of the Sprague-Dawley strain. The apparatus consisted of a one-way platform avoidance chamber. The procedure included avoidance training, response blocking, and fear testing phases. The experiment represented a three by four factorial design. Eighty avoidance trained subjects were assigned to blocked or non-blocked conditions. The remaining control subjects were never shocked. Ten subjects from each of these treatment conditions were assigned to either a very low, low, medium, or high platform level. The results confirmed the hypothesis that response prevention does lead to a partial but incomplete reduction in fear. The results revealed that blocked subjects approached the grid sooner, spent more time on the grid before returning to the platform, spent more time on the grids during the five hour fear test, safety tested less frequently before approaching the grid, and safety tested

sooner than non-blocked subjects.. Although the blocked and control groups did not differ in total time on grid, number of approaches, first time spent on grid, and number of safety tests before first approach, the blocked group had significantly longer approach and safety test latencies than the control group. Platform height did not have a significant effect on approach latencies. Either fear elimination or fear reduction was found, depending which dependent measure was used to assess fear. The safety test data showed that safety testing behavior is clearly indicative of fear. The differential role of safety testing behavior for blocked and non-blocked subjects was discussed. Implications of the results to clinical practice and research were presented.

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INTRODUCTION

Persistent and perserverative fear-mediated avoidance behavior in animals has been consistently demonstrated (Baum, 1966, 1969a, 1969b, 1970, 1972; Levis, 1966, 1975; Page, 1955; Page and Hall, 1953; Solomon, Kamin and Wynne, 1953). Avoidance behavior is operationally defined as a learned response which terminates a previously neutral stimulus. Following Mowrer's (1950) two-factor theory, there are two components or processes thought to be involved in the learning of avoidance behavior. The first factor involves a classically conditioned fear reaction acquired by pairing a previously neutral stimulus (CS) with a primary noxious or aversive stimulus (UCS). The second component refers to the instrumental reinforcement of the avoidance response following fear reduction. As seen from the animal analogue paradigm, the animal first learns to fear a stimulus or situation and whatever the animal does to terminate that stimulus is operantly reinforced.

A proliferation of interest in methods of eliminating avoidance behavior has been attributed to both the apparent similarity of avoidance behavior in animals to anxiety-motivated phobic behavior in humans (Bandura, 1969; Baum, 1970; Baum and Poser, 1971) and empirical evidence that both animal and human avoidance behavior is highly resistant to extinction (Baum, 1965; Berman and Katsev, 1970; Hodgson and Rachman, 1970; Levis, 1966, 1970, 1975; Page and Hall, 1953; Schiff, Smith and Prochaska, 1972; Solomon and Wynne, 1954; Voss, Mejta and Reid, 1974).

The persistence of avoidance behavior is often described as being fostered by the very learning under which it is acquired. The definition of an avoidance response requires that an organism escape a warning stimulus (CS) which would otherwise terminate in the presentation of a noxious stimulus (UCS). In the laboratory, the usual extinction procedure is to remove the UCS (shock) while trials (CSs) continue to be presented. Consequently, since the organism is already avoiding consistently, the extinction procedure does not introduce a discriminate change. In essence, the animal has learned to avoid the very situation where re-learning could take place. A similar process has been attributed to human neurotic behavior which is also defined by its self-defeating and self-perpetuating nature (Mowrer, 1950).

Among several extinction techniques used to eliminate avoidance responses in animals, the most popular (cf. Baum, 1970) appears to be a technique originally called "Forced Reality Testing" (Solomon, Kamin and Wynne, 1953) and presently called "Response Prevention" (RP). The technique has been extended to clinical application under the names of Implosive Therapy, Flooding and Response Prevention (Ayer, 1972; Barrett, 1969; Baum and Poser, 1971; Hodgson and Rachman, 1970; Hogan, 1968, 1969; Hogan and Kirchner, 1967; Levis, 1966, 1970, 1974, 1975; Mathews and Shaw, 1973; Morganstern, 1973, 1974; Rachman, Marks and Hodgson, 1973; Rachman, 1969; Smith, Dickson and Sheppard, 1973; Stampfl, 1966; Stampfl and Levis, 1967, 1968; Staub, 1968).

Rimm and Masters (1974) have seen a need to distinguish implosive therapy from RP since implosive therapy typically incorporates psychodynamic material and RP does not. Response prevention consists of blocking the avoidance response in the presence of the feared CS. The fear response (CR) is then postulated to be classically extinguished. Baum (1966), for example, trained rats to jump onto a platform located 6 in. above a grid floor to avoid shock. When the learning criteria of 10 consecutive avoidance responses was attained, a group of subjects received a RP procedure. The conditioned avoidance response (CAR) was blocked by retracting the platform making it unavailable for an avoidance response. The results of this and other studies revealed that RP significantly facilitated extinction of the CAR (Baum, 1969, 1970; Baum and Higgins, 1971; Berman and Katsev, 1970; Coulter, Riccio and Page, 1969; Linton, Riccio, Rohrbaugh and Page, 1970; Marrazo, Riccio and Riley, 1974; Page, 1955; Page and Hall, 1953; Reynierse and Wiff, 1973; Siegeltuch and Baum, 1971; Schiff, Smith and Prochaska, 1972; Voss, Mejtal and Reid, 1974).

Similar studies have investigated the various parameters determining the efficacy of RP. Of these, the single most important variable determining the effectiveness of RP appears to be length of blocking (cf. Baum, 1970). Although RP durations of 5-10 minutes have been shown to be effective in reducing the CAR when low intensities (.5mA) of the UCS were employed, longer durations of up to 30 minutes were necessitated by use of more intense shock or

unavoidable shock. Also interesting was the finding that overtraining (Baum, 1968) facilitated or diminished the efficacy of RP depending whether errors occurred or did not occur during overtraining. After reaching criterion of avoidance learning, three groups of rats were given 0, 50, or 100 overtraining trials. The rats that received an additional shock during overtraining showed more persistent avoidance behavior following RP. This finding is particularly consistent with the two factor theory. Errorless overtraining can be seen as providing a series of extinction trials prior to RP. The effects of distributed vs massed avoidance training was also examined. Siegeltuch and Baum (1971) found that although distributed trials slowed the acquisition of the CAR, RP was equally effective in eliminating avoidance behavior.

Studies have also been conducted to assess how time is most effectively used during the blocking procedure. Shiff, Smith and Prochaska (1972) parametrically varied five RP durations with either 1, 5, or 12 trials of RP and found that total RP duration, rather than massed vs distributed RP was the fundamental variable predicating effective treatment. This finding supports Baum's contention that the length of RP is the most important variable. When time was kept constant, significant differences between massed vs distributed RP conditions in the Schiff et. al. study were not found. Inconsistent results, however, were reported by Berman and Katsev (1972) who found that distributed RP (40 CS exposures of 5 sec. each) were more effective than a single trial of equal time. Resolution of this

discrepancy may be inferred from a study by Tortora and Denny (1973). The results of this study revealed a nonmonotonic function between persistence of the CAR and RP duration when intense shock was used and a positive monotonic function when less intense shock was employed. This interesting interaction between shock level and RP duration suggests that when relatively short durations of RP follow intense levels of shock, 5 seconds of blocking may be more effective than 200 seconds of RP.

Aside from the effects of the previously mentioned parameters, other factors which facilitate the action of RP have been examined. Baum (Baum, 1969b; Lederhendler & Baum, 1970) has found that both the presence of non-fearful rats (social facilitation), and the mechanical forcing of the animal around the cage during blocking (mechanical facilitation), made the procedure more effective. Other experiments have revealed that the efficacy of RP is increased by allowing a delay of blocking following acquisition and by altering the illumination conditions during blocking (Baum, 1972). Similarly, a loud buzzer applied during blocking increased fear reduction (Baum & Gordon, 1970). Intracranial stimulation of the brain during RP has also resulted in increased effectiveness of the procedure (Gordon & Baum, 1971; Mejta, et al., 1974).

A most relevant, and problematic issue in the RP literature is whether extinction of the CAR is an appropriate measure of fear reduction. This controversy is both theoretically and empirically based. Proponents of a two-factor theory postulate that conditioned

fear (CR) to the CS is classically extinguished and no longer functions to mediate avoidance responses. Advocates of a counter-conditioning interpretation argue differently. They have charged that RP serves to instrumentally condition a new response (e.g. freezing, crouching) which is reinforced by the absence of shock. This competing response theory, first advanced by Page (1955) firmly maintains that conditioned fear has not been dissipated. Page found that although reduction of the CAR has been facilitated by blocking the response, latencies for approaching the avoidance chamber for food were significantly longer for blocked than non-blocked subjects. Consequently, Page concluded that blocked animals were more fearful than animals extinguished in a normal fashion. Similar studies (Coulter, Riccio and Page, 1969; Linton, Riccio, Rohrbaugh and Page, 1970) have found results consistent with those of Page (1955), although blocked subjects were typically less fearful than a non-blocked group which did not receive previous extinction trials (cf. Riccio and Silvestri, 1973).

Warranted criticism of these studies has been raised. Shipley, Mock and Levis (1971) contend that these studies did not control for number of responses in extinction, exposure to apparatus cues, the possible confounding effects of food deprivation during fear testing and more importantly, amount of CS exposure before RP. Bersh and Paynter (1972) note that in the Coulter et. al. study, the testing procedure followed normal extinction trials and as a result, non-blocked subjects received an average of four and one-half more CS

presentations than blocked subjects. In a sense, non-blocked subjects received more CS blocking than blocked subjects.

Because of the aforementioned methodological difficulties, the most desirable procedure would be to commence fear testing immediately following a RP treatment, eliminating extinction trials entirely. Shipley, Mock and Levis (1971) did so and found that fear reduction was evidenced following RP. This study, however, failed to present the CS complex employed in avoidance training, during fear testing. Bersh and Paynter (1972) found that subjects blocked in the presence of the CS for 5-min. while still fearful compared to non shocked control subjects, were less fearful than non-blocked subjects. Their finding of incomplete fear reduction, however, may have been a result of the relative short duration of RP (cf. Baum, 1970).

Similarly, a recent doctoral dissertation by Spring (1973) employed a platform apparatus similar to the one used by Baum (1965) and attempted to provide empirical support for the fear reduction hypothesis. Unfortunately, this study had several procedural difficulties. First, Spring used a short fear testing duration of 10 minutes. The insensitivity of this duration is reflected in the fact that only three out of a possible 60 subjects approached the grid. A more salient methodological weakness, however, was the manipulation of food deprivation as a motivation to approach. Besides the possible confounding effects of food deprivation (Shipley, Mock and Levis, 1971), Spring blocked his animals in the presence of inaccessible food. One could argue that aversive properties could be conditioned to the food and/or blocked subjects could have had a

lowered expectancy of finding food. Aside from these procedural weaknesses, Spring found some evidence for fear reduction. Interestingly, Spring conjectured that an important variable influencing approach measures was the ability to gradually approach a CS. In an earlier study using a straight alley apparatus (Spring, Smith and Prochaska, 1974), Spring observed that animals would gradually approach the CS in a series of graded or successive approximations. In the platform apparatus, Spring noted that subjects would typically reach down and frequently touch the grid with their paws before descending the platform. In a more cognitive vein, it appeared that the animals would test the safety of the grid before approaching it. This led Spring to reason that graded exposure to the CS was an important variable facilitating approach behavior. To test this hypothesis, Spring (1973, Exp. 3) trained and tested animals on a low or high platform. Complete fear reduction relative to a non-shocked control group was evidenced from the low platform only. Spring attributed these findings to the ability of low-tested subjects to safety test the grid. Unfortunately, Spring did not record these safety testing responses.

A more recent experiment (Marrazo, Riccio and Riley, 1974) employed a different paradigm to disprove the contention that facilitated extinction following RP is due primarily to Pavlovian fear reduction. This study employed an avoidance measure and examined the effects of RP when fear is maintained. In addition to a regularly blocked and non-blocked group of subjects, a third group of

animals received continuous shock during blocking. The results of this study showed that regular blocking and blocking with shock were equally effective in facilitating extinction of the CAR. Criticism of this study is obvious. First, the appropriateness of CAR measures in assessing fear is questionable. Secondly, the experimental manipulations of this study do not preclude the maintenance of similar behavior by two independent processes (e.g. fear reduction for blocked subjects and learned helplessness for blocked-with-shock animals).

Aside from the use of approach or avoidance measures to assess fear, a particularly noteworthy procedure was recently employed by Monti (1974). This method of assessing fear, typically called a conditioned emotional response (CER) paradigm, consists of presenting the formerly feared CS (e.g. tone) during the course of ongoing operant behavior (e.g. bar pressing). An index of fear is derived from the suppression of the instrumental behavior during the presentation of the CS. Greater suppression is assumed to be reflective of greater fear. The results of Monti's study showed that RP was effective in reducing fear, although complete fear reduction was not revealed. Monti suggests that earlier studies examining RP did not reveal residual fear because the techniques employed to assess fear were not sufficiently sensitive.

Monti's study also suggested that, aside from the ability of a discriminative CS (namely white noise) to elicit fear, the environmental stimuli per se become conditioned stimuli capable of eliciting

fear. Monti found that blocking in the CS environment (shuttle-box) was effective in reducing fear regardless of whether or not the discriminative CS was presented. This finding implies that discriminative CS's may be secondary to other stimuli, namely apparatus cues, in eliciting fear responses and subsequent avoidance behavior.

Possible criticism of Monti's study should be discussed. First, it could be argued that the CER technique is unduly sensitive to minute traces of residual fear. Unfortunately, the sensitivities of the avoidance, approach and CER techniques of measuring fear have not been directly compared. Secondly, Monti employed a total RP duration of 20 minutes. Baum (1970) has argued that RP of over 30 minutes is sometimes required for complete fear reduction. Lastly, the use of the CER technique in assessing the effects of RP has practical drawbacks. The technique is costly in both time and effort to the experimenter. To attain a stable and high-rate operant response (e.g. bar-pressing) the procedure necessitates training subjects over the course of 5 to 10 daily sessions. In the final analysis, the procedure may introduce an inadvertent experimental bias. Subjects who do not readily acquire the operant response are typically excluded from the experiment. A further consideration is that the assessment of fear is performed in an environment other than where fear was conditioned. In view of the conditioning of apparatus cues as fear eliciting stimuli (CS's), it would appear desirable to assess fear reduction in the same apparatus where fear was conditioned.

Although empirical evidence disproving the contention that RP procedures reduce fear is lacking, support for the fear reduction hypothesis is not entirely unequivocal. Consequently, a solution to the controversy surrounding the fear reduction hypothesis is still pending. The initial purpose of the present study was to resolve some of the methodological flaws inherent in previous fear testing studies and to test the fear reduction hypothesis.

Following the suggestions of Shipley, Mock and Levis (1971), fear testing in the present study immediately followed the RP phase of the experiment. It will be recalled that these authors failed to present the CS complex employed in avoidance training during fear testing. The present study circumvented this problem by eliminating the use of a distinctive discriminative CS, relying exclusively on apparatus cues to motivate avoidance behavior. The grid of the chamber was operationally defined as the CS. This procedure insured that the CS complex present during fear testing would be identical to the CS complex present during both avoidance training and RP.

Also, since it was argued that the results of earlier studies which showed only partial fear reduction may be attributed to insufficient RP durations, the present study employed a substantially longer duration of RP. The present experiment also improved specifically upon two of Spring's (1973) procedural difficulties. First, the fear testing phase of the experiment was lengthened from 10 min. to 5 hrs. Secondly, food deprivation and the presence of food on the grid was not manipulated in this study. This experiment relied exclusively on the animals' exploratory behavior as

motivation to approach the grid.

Aside from the possibility of resolving a theoretical issue with conclusive empirical evidence, the present study received further justification with respect to the application of RP to clinical settings. Experimental investigation of the efficacy of Implosion Therapy have led to both fear reduction and fear enhancement (Ayer, 1972; Hodgson and Rachman, 1970) and the postponement of this therapy with humans until better analogue studies are provided has been suggested (Eysenck, 1968; Morganstern, 1973, 1974).

A more important purpose of the present experiment, although novel to the literature, was to examine the safety-testing hypothesis. Briefly stated, this hypothesis predicts that the ability to test the "safety" of a CS will facilitate approaching it. The accessibility to engage in safety testing behavior was manipulated by training and testing the treatment groups on four platform heights. The present experiment represents a significant improvement over Spring's (1973) study in that safety tests were electronically quantified and recorded.

The potential knowledge of the role of safety testing behavior is essential to both theorists and clinical practitioners. First, safety testing behavior is conceivably indicative of residual fear. If this contention is supported by the results of this study, safety testing responses may henceforth be employed as an assessment of fear. Secondly, if the results show that animals, who are still fearful (as measured by approach latencies) of a CS, engage in significantly more safety testing behavior before approaching a CS, this finding would

suggest that safety testing itself may be a process by which fear is reduced. Stated more formally the safety testing hypothesis predicts that non-blocked subjects, who did not receive RP and are presumably more fearful of the CS, will engage in significantly more safety testing behavior than blocked or non-shocked control subjects.

In short, the role of the present experiment in examining the safety testing hypothesis was exploratory in nature. Aside from the more specific hypotheses predicted in this study, correlational analyses among the numerous dependent measures were performed in order to gain further knowledge about the relations of these variables.

METHOD

Subjects

The subjects for this experiment were 120 male Sprague-Dawley rats (*Rattus Norvegicus*) obtained from the Charles River Breeding Laboratories. The animals were approximately 90 days old and weighed about 300 grams at the beginning of this study. All subjects were maintained on an ad libitum food and water schedule.

Apparatus

The apparatus for this experiment was a modified one-way platform avoidance chamber manufactured by the Lafayette Instrument Co., Model #85200. This apparatus was similar to the one extensively used in the literature (Baum, 1965, 1966). Basically, a chamber with a grid floor capable of delivering shock is juxtaposed to an elevated non-shocked platform, allowing the subject to escape or avoid shock.

For this experiment, the avoidance chamber was modified to permit manipulation of the distance between the grid and the platform. The platform heights used were 15, 32, 85, and 130 mm. The UCS was a 2.0 mA scrambled shock delivered by a Lehigh Valley shock-generator/scrambler, Model #SG3003. Additionally, the apparatus was equipped with a touch sensitive relay, Model #221-05 manufactured by the Lehigh Valley Co., connected in series from the platform to the grids, which allowed for direct measurement of safety testing responses. An additional 9.5 Megaohms resistance was wired

in series to the relay to avoid accidental operation of this mechanism initiated by the rat's tail.

A Lehigh Valley white noise generator, Model #381-02 and audio amplifier, Model #382-20 were employed with an eight-Ohm speaker to supply a 90 dB white masking noise throughout the course of the experiment.

The apparatus was totally automated (with the exception of placing and removing the subjects from the apparatus) with standard mechanical and solid state programming equipment.

Procedure

The 120 subjects were randomly divided into 12 groups of 10 subjects, comprising a completely fixed 3 by 4 design. Forty subjects were employed for each experimental treatment, constituting the first factor of this experiment. These groups were assigned the names of Non-Blocked, Blocked and Control. Ten animals from each treatment group were assigned to one of four platform heights, constituting the second factor of this experiment. These heights were assigned the names of Very Low, Low, Medium and High. The outline of this design is illustrated in Table 1. After being transported from the animal colony room to the experimental research suite, each subject was retained within his "home cage" for five minutes to allow acclimation to the white noise. The first phase of this experiment, avoidance training, was begun by placing the animal on the grid of the avoidance chamber.

Table 1

Outline of the Experimental Design

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked	10*	10	10	10
Blocked	10	10	10	10
Control	10	10	10	10

* The number of subjects in each cell

Avoidance Training

Eighty subjects were avoidance trained, 20 on each platform height. Ten seconds after the subjects were placed on the grid (CS) shock was presented. The subjects were able to escape the shock only by jumping to the platform. Each subject was required to remain on the platform for 20 seconds. If an animal fell or jumped off the platform before this 20 second criterion was reached, the interval timer reset and the subject continued to receive shock until he again escaped and remained on the platform for 20 seconds. Upon completion of this platform criterion, a sliding door moved outward and pushed the animal off the platform, thereby initiating the next trial. The subjects could successfully avoid receiving further shocks by jumping on the platform within the 10 second CS-UCS interval and remaining there for 20 seconds. Avoidance training was terminated when an animal met the avoidance learning criterion of 10 consecutive avoidance trials. Total UCS time, number of trials to criterion, total number of shocks and total number of shocked trials were recorded during this training.

It was decided before the beginning of this experiment that an animal would be discarded and replaced if he failed to meet the criterion of 10 consecutive avoidance trials within 60 trials or if total UCS time exceeded 180 seconds. No subjects exceeded these criteria.

The unshocked control subjects received a mock avoidance session which is described in detail below. Differential treatment of

avoidance trained subjects was as follows:

Blocked group Immediately after the 10th consecutive avoidance, 40 avoidance trained subjects, 10 from each platform height, received a response prevention treatment. When the sliding door pushed the subject off the platform, it remained in half-cycle; that is, the door stayed closed, rendering the platform inaccessible. This response prevention was maintained for 60 minutes. The subjects were then removed from the chamber and placed in a retaining cage for one minute.

Non Blocked group The remaining 40 avoidance trained subjects, 10 from each platform height were placed in a retaining cage immediately following their 10th consecutive avoidance trial. These subjects were retained in the cage for 61 minutes; thereby equating blocked and non-blocked subjects for the passage of time between training and the subsequent fear testing phase of this experiment.

Control group The remaining 40 subjects, 10 from each platform height, were not avoidance trained. Instead, they were matched to the blocked group with respect to total time in the apparatus. Matching was accomplished from subject to subject. For example, the first control subject was placed in the chamber for the same amount of time as it took the first blocked subject to reach avoidance training criteria. The platform remained available to the control subjects during this time. Subsequently, with the platform door closed, control subjects remained in the chamber for an additional 60 minutes. At the end of this hour, the control subjects were removed from the apparatus and placed in the retaining cage for one

minute.

Fear Testing

All 120 subjects were employed for this final phase of the experiment. Each subject was removed from the retaining cage and placed on the platform, thereby initiating the fear testing procedure. The touch sensitive relay was operational at this time. The relay was operated when a subject touched the grid while being on the platform. Numerous dependent measures were recorded during this procedure, which had a total duration of five hours. These dependent variables were as follows:

Approach latency Approach latency was defined as the time in seconds it took a subject to completely leave the platform and approach the grid.

First time spent on grid Pilot work by the present writer had found that subjects typically jumped back on the platform after having approached the grid. Since this may have been suggestive of residual fear, the time spent on the grid before jumping back on the platform was recorded here.

Total grid time Since subjects invariably return to the platform after having approached the grid, the total time spent on the grid during the five hour fear testing procedure was recorded.

Total number of approaches In the event that subjects approached the grid and returned to the platform more than once during the five hour fear test, the total number of approaches to the grid was recorded.

Safety test latency This was defined as the time it took for the initial "safety test" to occur. If a subject should approach the grid without having "safety tested", this datum would be identical to approach latency.

Number of safety tests before first approach This was the total number of "safety tests" which occurred before the initial approach to the grid.

Total time spent safety testing The total amount of time engaged in "safety testing" was recorded.

Total number of safety tests This referred to the total amount of "safety tests" which occurred during the five hour fear test.

RESULTS .

Initial observation of the data revealed severe heterogeneity of variance for some of the dependent measures. Although the Analysis of Variance is insensitive to moderate departures of homogeneity of variance (cf. Winer, 1971), some of the present data represent serious violations of this assumption. Therefore, it was sometimes necessary to apply a $\log_{10}$ transformation to remove heterogeneous variance (cf. Edwards, 1972). Cochran's Test for Homogeneity of Variance with a determined alpha level of .01 was used on each dependent measure to test this assumption. The results of this test for each dependent variable is found in Appendix A.

For each analysis of variance, it was decided that an alpha level of .01 would be employed. (The rationale behind this conservative approach was governed by the theoretical nature of this investigation and will be addressed in the discussion section). Summary tables of each analysis of variance are presented in Appendix B.

Avoidance Data

Since it was important to show equitable avoidance training for the non-blocked and blocked groups, four dependent measures were recorded during this phase of the experiment. The four dependent measures were number of trials to criterion, number of shocked trials, number of shocks, and total UCS time. The means and standard deviations of these four dependent variables for each group of subjects are presented in Tables 2, 3, 4, and 5, respectively.

Table 2

Means and Standard Deviations
of Trials to Criterion

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked:				
<u>M</u>	26.9	27.6	21.0	25.8
<u>SD</u>	10.2	10.8	8.3	10.6
Blocked:				
<u>M</u>	21.8	27.6	19.2	21.2
<u>SD</u>	9.5	10.1	3.1	4.9

Table 3

Means and Standard Deviations of
Total Number of Shocked Trials

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked:				
<u>M</u>	7.6	8.7	7.1	8.0
<u>SD</u>	2.3	1.8	4.7	4.7
Blocked:				
<u>M</u>	7.3	12.3	6.0	7.7
<u>SD</u>	4.2	7.9	2.2	4.0

Table 4

Means and Standard Deviations of
Total Number of Shocks

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked:				
<u>M</u>	15.5	15.8	11.2	14.4
<u>SD</u>	7.58	4.89	8.68	8.73
Blocked:				
<u>M</u>	18.3	22.3	8.2	15.4
<u>SD</u>	9.83	14.79	2.83	8.18

Table 5

Means and Standard Deviations of
Total UCS Time

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked:				
<u>M</u>	15.88	17.50	17.86	28.60
<u>SD</u>	16.72	17.04	15.00	20.86
Blocked:				
<u>M</u>	22.07	22.06	9.84	38.26
<u>SD</u>	23.35	33.84	5.70	24.82

The four Cochran's Tests for Homogeneity of Variance applied to these data were non significant. The four Analyses of Variance performed on these data failed to reveal either a significant platform, treatment, or interaction effect, indicating that all groups received equitable avoidance training.

Fear Reduction Hypothesis

Of the remaining eight dependent variables, four were originally designed to test the fear reduction hypothesis. The rationale behind the use of these measures will be discussed separately.

Approach latency An a-priori decision was made that approach latency would be the most meaningful test of the fear reduction hypothesis. Approach latency was defined as the time it took subjects to completely depart the platform and approach the grid. Since Cochran's Test for Homogeneity of Variance was significant ($p < .01$), a $\log_{10}$ transformation was applied to the data and the transformed variable was not heterogeneous. The means and standard deviations of both the original and transformed variable are presented in Table 6. The means of the transformed variable for all groups of subjects are illustrated in Figure 1. The mean approach latencies for the blocked group appear to be shorter than for the non-blocked group but also longer than the control group. Figure 1 fails to suggest any differences due to platform height.

The results of an analysis of variance performed on these data revealed only a significant treatment effect, $F(2,108) = 58.75$, $p < .001$. To further investigate the significant Treatment effect, a Tukey Significant Gap Test was applied to the treatment means.

Table 6

Means and Standard Deviations of Approach Latency
for Original (Sec.) and Transformed (Log 10) Scale

TREATMENT	PLATFORM HEIGHT			
	VERY LOW	LOW	MEDIUM	HIGH
NON BLOCKED:				
Original Scale:	M 4632.6	5731.3	7930.8	5490.0
	S. D 5318.5	6896.9	7914.4	5964.2
Transformed Scale:	M 3.34	3.16	3.45	3.29
	S D .75	1.07	.84	.85
BLOCKED:				
Original Scale:	M 206.9	787.8	1178.2	270.6
	S D 303.2	1854.6	1424.0	269.6
Transformed Scale:	M 2.00	2.14	2.67	2.06
	S D .55	.78	.71	.71
CONTROL:				
Original Scale:	M 44.9	884.1	441.7	55.7
	S D 81.9	2620.3	44.1	38.8
Transformed Scale:	M 1.23	1.58	1.38	1.55
	S D .66	1.04	.54	.60

Figure 1

Mean approach latencies (Log 10) for
each platform group

Table 7

Tukey Significant Gap Test Applied to Treatment Means
of a Log(10) Transformation for Approach Latency

Group	NonBlocked	Blocked	Control
Means	3.308	2.219	1.437
Blocked	1.089**		
Control	1.871**	.792**	

** Significant Gap at .01 level ($df = 78$) = .4670

Table 8

Means and Standard Deviations of First Time Spent on Grid
for Original (Sec.) and Transformed (Log 10) Scale

TREATMENT	PLATFORM HEIGHT			
	VERY LOW	LOW	MEDIUM	HIGH
NON BLOCKED:				
Original Scale:	M	5.9	13.1	13.1
	S D	10.76	5.89	30.23
Transformed Scale:	M	.47	.31	.52
	S D	.48	.47	.65
BLOCKED:				
Original Scale:	M	30.3	17.9	155.9
	S D	55.11	21.24	446.73
Transformed Scale:	M	1.00	.95	1.23
	S D	.66	.61	.80
CONTROL:				
Original Scale:	M	20.1	11.5	30.3
	S D	33.21	9.13	27.75
Transformed Scale:	M	.90	.93	1.32
	S D	.62	.37	.39

found in Table 9. The control and the blocked groups were not found to differ. Both the control group and the blocked groups spent significantly more time on the grid before returning to the platform than the non blocked group. From these data, it would appear that RP was effective in completely reducing fear.

Total grid time Another method of assessing fear was to record the total amount of time spent on the grid during the five hour fear testing phase of the experiment. Since the data were found to be heterogeneous, a $\log_{10}$ transformation was applied to these data and the transformed variable was not heterogeneous. The means and standard deviations for both the original and transformed variable are presented in Table 10. The means of this transformed scale are illustrated in Figure 3. Figure 3 suggests that non-blocked subjects spent much less time on the grid than either control or blocked subjects. The control and blocked groups do not appear to differ. Figure 3 also suggests a Platform effect. For all treatment groups, the medium and high platform subjects appear to have spent more time on the grid than low and very low platform subjects.

The results of an Analysis of Variance performed on these data revealed a significant Treatment effect, $F(2,108) = 20.94$, $p < .001$; a significant Platform effect, $F(3,108) = 5.49$, $p < .005$; and a non significant interaction. Two Tukey Significant Gap Tests were employed to further analyze both significant main effects. The results of these analyses are presented in Table 11 and 12. The analysis of the treatment means revealed that the non-blocked subjects

Table 9

Tukey Significant Gap Test Applied to Treatment Means
Based on a Log(10) Transformation for First Time Spent
on Grid

Group	NonBlocked	Control	Blocked
Means	.436	.972	1.162
Control	.536**		
Blocked	.726**	.19	

** Significant Gap at .01 level ($df = 78$) = .335.

Table 10

Means and Standard Deviations of Total Grid Time
for Original (Sec.) and Transformed (Log 10) Scale

TREATMENT	PLATFORM HEIGHT			
	VERY LOW	LOW	MEDIUM	HIGH
NON BLOCKED:				
Original Scale:				
M	741.0	685.6	1407.8	6449.9
S D	1968.9	1244.1	1950.0	7025.5
Transformed Scale:				
M	1.31	1.60	1.85	2.85
S D	1.17	1.35	1.64	1.35
BLOCKED:				
Original Scale:				
M	5421.9	2275.6	3494.2	6058.5
S D	7667.0	5199.1	5412.7	5293.2
Transformed Scale:				
M	3.08	2.56	3.17	3.61
S D	.96	.94	.61	.44
CONTROL:				
Original Scale:				
M	1125.4	1646.9	6361.4	3677.8
S D	852.5	2728.0	5810.3	3072.0
Transformed Scale:				
M	2.90	2.90	3.57	3.33
S D	.42	.50	.55	.55

Table 11

Tukey Significant Gap Test Applied to Platform Means
Based on a Log(10) Transformation for Total Grid Time

Group	Low	Very Low	Medium	High
Means	2.35	2.43	2.86	3.26
Very Low	.08			
Medium	.51	.43		
High	.91**	.83**	.40	

** Significant Gap at .01 level (df = 58) = .6998

Table 12

Tukey Significant Gap Test Applied to Treatment Means
Based on a Log(10) Transformation for Total Grid Time

Group	NonBlocked	Blocked	Control
Means	1.91	3.10	3.17
Blocked	1.19**		
Control	1.26**	.07	

** Significant Gap at .01 level (df = 78) = .5937

spent significantly less time on the grid than either the blocked or control subjects. The means for the blocked and control subjects were not significantly different. The analysis of platform means indicated that the high platform group spent more time on the grid than either the very low or low platform groups. The medium platform group was not significantly different than any of the other three platform groups, nor were the very low and low groups significantly different from each other.

Number of approaches Control subjects were typically observed to frequently descend and ascend the platform. Essentially, this behavior may be characterized as normal non-fearful exploratory responses. It would follow that if fear is completely reduced, blocked animals would similarly engage in normal exploratory behavior. The means and standard deviations for each group of subjects appear in Table 13. These data were not found to be heterogeneous. The mean number of approaches for each group of subjects are illustrated in Figure 4. Figure 4 suggests that the non-blocked subjects approached the grid less often than either control or blocked subjects. Although the blocked and control subjects from the very low and low platform groups do not appear to differ, the blocked subjects from the medium and high platform heights appear to approach the grid less often than the medium and high control groups. A platform effect is also suggested by Figure 4. The high and medium platform groups appear to approach the grid more frequently than the very low and low platform groups.

Table 13
Means and Standard Deviations of
Number of Approaches

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked:				
<u>M</u>	9.10	12.70	16.80	26.90
<u>SD</u>	16.32	15.69	19.21	33.94
Blocked:				
<u>M</u>	27.40	23.80	28.40	44.60
<u>SD</u>	18.40	20.73	29.94	25.68
Control:				
<u>M</u>	32.30	21.90	51.60	54.00
<u>SD</u>	25.06	17.72	36.65	41.30

The Analysis of Variance performed on these data revealed a significant Treatment effect, $F(2,108) = 8.15$, $p < .001$; a significant Platform effect, $F(3,108) = 4.36$, $p < .01$; and a non significant interaction effect. The results of a Tukey Test applied to the platform means is found in Table 14. The results indicate that the high platform group approached the grid significantly more frequently than either the very low or low platform groups. The very low and low platform groups did not differ from other and the medium group did not differ from any of the other three groups. The results of a Tukey Test applied to Treatment means, which are presented in Table 15, revealed that the non-blocked subjects approached the grid significantly less frequently than the control subjects. The blocked groups was not found significantly different than either non-blocked or control groups.

Safety Testing Hypothesis

The remaining four dependent variables were designed to assess the safety testing hypothesis. These dependent measures were as follows: safety test latency, number of safety tests before first approach, total time spent safety testing, and total number of safety tests. Unfortunately, the electronical equipment recording total time spent safety testing frequently malfunctioned during the course of the experiment. These data were consequently omitted and will not be reported.

Safety test latency The nature of safety testing behavior was first examined by assessing latency to first safety test. (A safety

Table 14

Tukey Significant Gap Test Applied to Platform Means
for Number of Approaches

Group	High	Medium	Very Low	Low
Means	41.83	32.27	22.93	19.47
Medium	9.56			
Very Low	18.90**	9.34		
Low	22.36**	12.80	3.46	

** Significant Gap at .01 level ($df = 58$) = 18.73

Table 15

Tukey Significant Gap Test Applied to Treatment Means
for Number of Approaches

Group	NonBlocked	Blocked	Control
Means	16.38	31.05	39.95
Blocked	14.67		
Control	23.57**	8.9	

** Significant Gap at .01 level ($df = 78$) = 15.89

test was operationally defined in the Introduction and Method sections.) Since these data were found to be heterogeneous, a $\log_{10}$ transformation was applied and the resulting transformed variable was not heterogeneous. The means and standard deviations for both the original and transformed variable are presented in Table 16. The means for the transformed variable for all groups of subjects are illustrated in Figure 5. This figure suggests that the mean safety test latencies for the blocked group were appreciably shorter than those of the non-blocked group and longer than those of the control group. It also appears that safety test latencies were longer for the medium and high groups than they were for the very low and low groups.

The Analysis of Variance performed on these data revealed a significant Platform effect, $F(3,108) = 6.35$, $p < .001$; a significant Treatment effect, $F(2,108) = 37.30$, $p < .001$; and a non significant interaction. The results of a Tukey Significant Gap test employed to further analyze the significant Platform effect is presented in Table 17. Indeed, both the high and medium groups took significantly longer to safety test the grid than did both the very low and low groups. The analysis also revealed that the very low and low groups were not significantly different and the medium and high groups were also not significantly different.

The results of a Tukey Significant Gap Test applied to the Treatment means indicated that all three means were significantly different from each other. The results of this analysis are found in Table 18. The mean safety test latency for the blocked subjects

Table 16
Means and Standard Deviations of Safety Test Latency
for Original (Sec.) and Transformed (Log 10) Scale

TREATMENT	PLATFORM HEIGHT			
	VERY LOW	LOW	MEDIUM	HIGH
NON BLOCKED:				
Original Scale:	M	1059.20	5285.19	2164.40
	S D	2137.84	6666.8	3374.82
Transformed Scale:	M	2.23	3.17	2.72
	S D	1.07	.85	.78
BLOCKED:				
Original Scale:	M	175.00	538.20	230.40
	S D	479.48	982.74	233.33
Transformed Scale:	M	1.44	2.31	2.00
	S D	.71	.62	.69
CONTROL:				
Original Scale:	M	36.50	25.60	54.50
	S D	67.90	28.97	38.11
Transformed Scale:	M	1.07	1.07	1.53
	S D	.71	.63	.60

Table 17

Tukey Significant Gap Test Applied to Platform Means of a Log(10) Transformation for Safety Test Latency

Group	Very Low	Low	High	Medium
Means	1.470	1.583	2.086	2.184
Low	.113			
High	.616**	.503		
Medium	.714**	.601**	.098	

** Significant Gap at .01 level (df= 58) = .551

Table 18

Tukey Significant Gap Test Applied to Treatment Means of a Log(10) Transformation for Safety Test Latency

Group	NonBlocked	Blocked	Control
Means	2.63	1.73	1.14
Blocked	.90**		
Control	1.49**	.59**	

** Significant Gap at .01 level (df= 78) = .468

was significantly shorter than the mean for the non-blocked subjects and longer than the mean for the control subjects.

Number of safety tests before first approach To further investigate the nature of safety testing behavior, the number of safety tests recorded before a subject completely departed the platform were analyzed. Since these data were found to be heterogeneous, a $\log_{10}$ transformation was performed and the transformed variable was homogeneous. The means and standard deviations for both the original and transformed variable appear in Table 19. The means of the transformed variable, for all groups of subjects, are illustrated in Figure 6. This Figure suggests that the mean number of tests before first approach for the blocked subjects was less than the mean for the non-blocked subjects and more than the mean for the control subjects. Figure 6 also suggests that very low and low platform subjects safety tested the grid before approaching more often than the subjects from the medium and high platform heights.

An Analysis of Variance performed on these data revealed only a significant Treatment effect, $F(2,108) = 26.62, p < .001$. The Platform effect did not reach significance at the .01 level ($p < .05$). The results of a Tukey Significant Gap Test applied to the Treatment means revealed that the non-blocked group safety tested before approaching the grid significantly more frequently than both the blocked and control group. The blocked and control group were not significantly different at the .01 level ($p < .05$). These results are presented in Table 20.

Table 19
Means and Standard Deviations of Number of Safety Tests Before First Approach
for Original (Sec.) and Transformed (Log 10) Scale

TREATMENT	PLATFORM HEIGHT			
	VERY LOW	LOW	MEDIUM	HIGH
NON BLOCKED:				
Original Scale:				
M	73.10	76.70	13.00	24.60
S D	95.33	98.60	11.45	30.00
Transformed Scale:				
M	1.28	1.40	.90	.84
S D	.96	.85	.51	.84
BLOCKED:				
Original Scale:				
M	6.70	7.80	5.80	2.00
S D	7.44	9.03	4.61	1.25
Transformed Scale:				
M	.64	.63	.60	.23
S D	.42	.50	.43	.26
CONTROL:				
Original Scale:				
M	3.40	2.60	2.60	1.00
S D	2.87	2.72	4.06	.00
Transformed Scale:				
M	.39	.29	.19	.00
S D	.38	.32	.37	.00

Table 20

Tukey Significant Gap Test Applied to Treatment Means
Based on a Log(10) Transformation for Number of Safety
Tests Before First Approach

Group	NonBlocked	Blocked	Control
Means	1.107	.523	.217
Blocked	.584**		
Control	.890**	.306	

** Significant Gap at .01 level ($df = 78$) = .334

Total number of safety tests The mean number of safety tests which occurred during the five hour fear test are presented in Table 21, along with the standard deviations of these data. Cochran's Test for Homogeneity of Variance found the data to be homogeneous. The means of these data are also illustrated in Figure 7. Although a Treatment effect is not suggested by this figure, it appears that the mean number of safety tests for the lower platform heights are greater than those for the medium and high platform heights.

The Analysis of Variance applied to these data revealed a significant Platform effect, $F(3,108) = 6.62, p < .001$; and a non significant Treatment and interaction effect. To further analyze the significant Platform effect, A Tukey Significant Gap Test was applied to the Platform means. The results of this analysis, which are presented in Table 22, indicate that the low, medium and high platform subjects, although not significantly different from each other, all safety tested significantly less frequently than the very low platform subjects.

Correlational Analyses

A bivariate correlation matrix showing the correlations between each pair of dependent variables for all blocked and non-blocked subjects is presented in Table 23. The correlations among the seven fear and safety testing measures for all subjects are presented in Table 24.

Particular attention should first be given to the correlations among the four dependent measures recorded during avoidance training

Table 21

Means and Standard Deviations
of Total Number of Safety Tests

Treatment	Platform Height			
	Very Low	Low	Medium	High
Non Blocked:				
<u>M</u>	219.60	168.00	84.50	110.50
<u>SD</u>	214.14	141.37	76.66	120.42
Blocked:				
<u>M</u>	285.10	127.60	83.10	71.60
<u>SD</u>	237.92	61.33	98.37	36.51
Control:				
<u>M</u>	176.50	87.60	106.40	108.80
<u>SD</u>	141.85	40.48	54.96	121.14

Table 22

Tukey Significant Gap Test Applied to Platform Means
for Total Number of Safety Tests

Group	Means	Very Low 227.1	Low 127.7	High 97.0	Medium 91.3
Low		99.4**			
High		130.1**	30.7		
Medium		135.0**	36.4	5.7	

** Significant Gap at .01 level ($df=58$) = 72.8

(variables A,B,C,D). It is not surprising that number of shocks and number of shocked trials are highly correlated ($r = .81, p < .001$). Similarly, trials to criterion was highly correlated with both of these variables, respectively ($r = .55, p < .001$; $r = .70, p < .001$). Surprisingly, while UCS time was significantly correlated with number of shocks ($r = .32, p < .01$), it was not significantly correlated with either number of shocked trials or trials to criterion. Although it would logically follow that as number of shocks increases, UCS time would also increase, it is difficult to explain why UCS time is not related to number of shocked trials or trials to criterion. The present results would suggest that UCS time was not related to the acquisition of the avoidance response but rather to the particular typography of the training trials (e.g., a series of shocks on one learning trial).

It is also desirable to examine the correlations between the four avoidance learning measures and the seven fear and safety testing variables. Although UCS time was marginally correlated with total grid time, ($r = .25, p < .05$); all other correlations were non significant.

It is also informative to examine the correlations among the seven fear and safety testing variables. Since the correlations among these variables when derived from either the 80 avoidance trained subjects (Table 23) or all the 120 subjects (Table 24) can be seen to parallel each other, the present discussion will focus primarily on the results presented in Table 24.

Table 23

Bivariate Correlation (r) Matrix of All Dependent Variables
For All Avoidance Trained Subjects (n=80)

DEPENDENT VARIABLE	Avoidance Training Measures					Fear and Safety Test Measures						
	A	B	C	D	E	F	G	H	I	J	K	
A		.32**	.13	-.02	.12	-.09	.25*	.17	-.07	-.22	-.15	
B			.81***	.55***	-.07	.11	-.03	.20	-.12	-.04	.18	
C				.70***	-.11	.01	-.16	.06	-.06	-.00	.11	
D					-.12	.02	-.22	.03	-.11	.05	.15	
E						.18	.69***	.37**	-.34**	-.46***	-.25*	
F							.05	.03	-.22	-.03	.40***	
G								.53***	-.41***	-.60***	-.27*	
H									-.39***	-.44***	-.17	
I										.75***	.10	
J											.55***	

Key to Variable Code:

- A Total UCS Time
- B Number of Shocks
- C Number of Shocked Trials
- D Trials to Criterion
- E Number of Approaches
- F Total Number of Safety Tests
- G Total Grid Time (Log)
- H First Time Spent on Grid (Log)
- I Safety Test Latency (Log)
- J Approach Latency (Log)
- K Number of Safety Tests Before First Approach (Log)

Statistical Significance

- * $p < .05$
- ** $p < .01$
- *** $p < .001$

Table 24

Bivariate Correlation (r) Matrix
for the Seven Fear and Safety Testing Measures (n=120)

DEPENDENT VARIABLE	B	C	D	E	F	G
A	.25**	.62***	.25**	-.32***	-.43***	-.31**
B		.05	-.03	-.16	.00	.37***
C			.49***	-.42***	-.56***	-.35***
D				-.25**	-.26**	-.19*
E					.81***	.27**
F						.63***

Key to Variable Code:

- A Number of Approaches
- B Number of Safety Tests
- C Total Grid Time (Log)
- D First Time Spent on Grid (Log)
- E Safety Test Latency (Log)
- F Approach Latency (Log)
- G Number of Safety Tests Before First Approach (Log)

Statistical Significance of r:

- * $p < .05$
- ** $p < .01$
- *** $p < .001$

The correlations between the foremost measure of fear, approach latency, and the other variables deserves particular attention. The results of these correlations appear in column F of Table 24. The results show significant negative correlations between approach latency and number of approaches ($r = -.43, p < .001$), total grid time ($r = -.56, p < .001$) and duration of first time spent on grid ($r = -.26, p < .01$). These results corroborate previous assumptions made in this study; namely, that all four of these measures may be used to assess fear. Two other correlations are most important. Approach latency, the primary measure of fear, was highly correlated with safety test latency ($r = .81, p < .001$) and number of tests before first approach ($r = .63, p < .001$). These results suggest that these two safety test variables may also be employed to assess fear. It appears that animals who are more fearful take longer to safety test. Similarly, animals who are more fearful appear to engage in more safety testing behavior before finally approaching the grid.

Collectively, these results support the hypothesis that safety testing behavior is indicative of fear. Notably, both number of safety tests before first approach and safety test latency were significantly correlated with all other measures of fear. In fact, with only the exception of one variable, all the dependent measures of fear and safety testing behavior are highly related. Total number of safety tests does not appear to be functionally related to the assessment of fear, since this variable was only significantly

correlated with number of approaches ($r = .25$; $p < .01$) and number of safety tests before first approach ($r = .37$, $p < .001$).

In summary, the most fundamental conclusion generated by the present correlational analyses is that safety testing behavior is positively related to fear. The implications of this conclusion are twofold. First, it suggests that safety test measures could also be employed to assess the fear reduction hypothesis. Secondly, it appears that examining safety testing behavior as a process of fear reduction is warranted.

DISCUSSION

Before discussing the fear reduction hypothesis, brief mention should be given to the correlations between the original four dependent measures of fear and the safety test data. The findings that both safety test latency and number of safety test before first approach were significantly correlated with all other measures of fear provide strong justification for employing these dependent variables in assessing the fear reduction hypothesis. Moreover, it is notable that these six dependent variables were significantly correlated with each other.

The collective results of these variables provide forcible evidence that RP is effective in reducing fear. The results showed that blocked subjects were less fearful than non-blocked subjects--- the blocked subjects approached the grid sooner, spent more time on the grid before returning to the platform, spent more time on the grid during the five hour fear test, safety tested less frequently before approaching the grid, and safety tested sooner. Thus, five of the six measures of fear showed that RP was indeed effective in reducing fear.

The hypothesis that RP would lead to complete fear reduction was not supported. When the results of total time on grid, number of approaches, first time spent on grid and number of safety tests before first approach were analyzed, the blocked group was not significantly different than the control group. The results of these four dependent measures are congruent with researchers who have claimed that RP leads to complete fear reduction (e.g., Baum, 1970; Shipley, Mock and Levis,

1971). Approach latency, however, the foremost measure of fear, along with safety test latency, suggested that blocked subjects were more fearful than control subjects. These later findings, suggestive of residual fear, are consistent with other studies (Linton, Riccio, Rohrbaugh, and Page, 1970; Monti, 1974; and Riccio and Silvestri, 1973) which found only partial fear reduction.

These data make an important contribution in demonstrating the differential sensitivities of various fear measures to residual fear. It is imperative to realize that since conclusions inferred from data will vary dependently upon the measure employed, the researcher has the responsibility of selecting the most sensitive measure. The results presented here show that both approach latency and safety test latency meet this criteria, albeit, CER procedures may be equally sensitive. Although the differential sensitivities of approach and CER measures of fear have not been formally investigated, the present data are totally consistent with CER results (e.g., Monti & Smith, in press). The desirability of the approach procedure, however, deserves both practical and methodological considerations. As previously mentioned, the CER paradigm is more costly in time and effort: It necessitates training subjects over the course of several daily sessions. Subjects who do not readily learn the operant response are typically excluded from the experiment, conceivably introducing biasing subject selection. The entire procedure of the present experiment required only one experimental session and no subject was excluded for failure to meet the avoidance criteria. The CER paradigm may be inferior to the present procedure in yet another respect. In the CER procedure, a distinctive

discriminative CS is employed during avoidance training. Fear testing only examines the ability of this CS to suppress ongoing operant behavior. This procedure fails to examine fear associated with the environmental stimuli of the avoidance apparatus. Unlike the CER procedure, the present study relied exclusively on environmental stimuli as CS's, and subsequent fear to the entire CS complex was assessed.

Although the present study showed that residual fear was still present following RP, a remaining issue is whether RP can conceivably lead to complete elimination of fear. Perhaps this would be demonstrated if RP durations longer than the one hour used in this study were employed. This would not be suggested by Baum's (1969) results which showed 30 minutes of RP effective in completely reducing fear conditioned with 2.0 mA shock. Baum, however, used the less sensitive avoidance measures to assess fear. Another interesting speculation is whether RP, coupled with other techniques designed to facilitate fear reduction, could completely eliminate residual fear. Spring (1973), for example, suggested that chain flooding facilitates fear reduction. During the RP phase of his experiment, Spring's chain-flooded-subjects were placed on the platform which was then retracted. This procedure, which was repeated five times, was shown to decrease the subjects' latencies to approach the grids during the subsequent fear test. Although a considerable body of research (see introduction) has revealed methods to increase the efficacy of RP, the studies invariably relied on the problematic extinction-trial-avoidance measure of fear. This issue, then, must remain unresolved, pending further empirical research. Nonetheless, the results of this study provide forcible evidence that RP

is effective in reducing, but not eliminating fear. The foregoing results are best interpreted as follows: Response prevention is an efficacious treatment resulting in partial but incomplete fear reduction.

Perhaps the most interesting focus of this experiment, completely novel to the literature, is the investigation of safety testing behavior. The first hypothesis of this part of the investigation stated that safety testing behavior is indicative of fear. Ostensibly, an animal would not be testing the safety of a CS if it were completely free from fear. This hypothesis was unequivocally supported. The correlational analyses demonstrated significantly high correlations between safety test latency, number of safety tests before first approach, and the original four measures of fear. Another interesting observation is the high degree of parallelism between the dependent variables of fear and safety test behavior when the collective results of the analyses of variance are viewed. Consequently, these two safety test variables were used to test the fear reduction hypothesis, addressed in an earlier section of this discussion.

In a different, more important, vein the safety test results are quite striking. Non-blocked subjects took longer to test the safety of the grid and required more safety tests to approach it than blocked subjects. Blocked animals took longer to approach the grid but were not found to test the safety of the grid significantly more often before approaching it than controls. These results lead to intriguing speculation regarding the role of safety test responses. It is notable that safety test responses resemble a graded exposure or successive approximation to the CS which is regulated and self-imposed by the

animal itself. One could conceptualize this successive approximation of approaching a feared CS akin to the process of desensitization (Wolpe, 1973), or self-imposed extinction trials. Safety testing behavior, then, may be conceived to represent a "self-governed" process of desensitization. This conjecture would follow the previously supported argument that non-blocked subjects were more fearful than blocked or control subjects. Consequently, significantly more safety testing behavior was required before the level of fear was appreciably lowered, allowing approaches to the grid to occur. Another method of testing the proposed fear reducing role of safety test behavior was to examine the correlations between number of safety tests before first approach and the other fear variables. This variable was significantly correlated with all measures of fear, suggesting that as fear decreases, the need to safety test the grid before approaching it decreases concomitantly.

If blocked subjects were more fearful than control subjects, why didn't the blocked subjects safety test before approaching the grid more frequently than control subjects? One viable answer to this question is that blocked subjects did safety test more frequently. It will be recalled that the conservative test of the fear reduction hypothesis necessitated an alpha level of .01. For this reason, blocked subjects were not reported significantly different than control subjects on this measure, although they were significantly different at the .05 level. Although this explanation obviously violates the a-priori alpha level of .01., the conservative approach to the fear reduction hypothesis need not be precisely applicable to the more exploratory investigation of safety test behavior.

A second explanation is equally plausible. This explanation would again follow the obvious premise that the amount of safety testing required to reduce fear is dependent upon the fear present. Since only two of the six fear variables revealed the blocked subjects more fearful than control subjects, the residual fear of blocked subjects may not have been great. It would logically follow that blocked subjects may not have required many safety tests to reduce fear if the residual fear was indeed slight. It should be stressed that the results of this study do, in fact, suggest that the difference in fear between blocked and control subjects was less than the difference in fear between blocked and non-blocked subjects. The results of all dependent measures, with the exception of total number of approaches, revealed the blocked group less fearful than the non-blocked group. The results of only two of the fear measures revealed a statistically significant difference between the control and blocked group.

The last hypothesis of the safety test investigation predicted that the accessibility of graded exposure to a CS would facilitate the efficacy of RP. In other words, the ability to test the safety of a previously feared CS should decrease the latency to approach it. The design of the present experiment attempted to manipulate the accessibility of safety testing responses by varying the height of the platform used in the apparatus. It was hoped that increasing platform height would render safety testing responses increasingly difficult to execute. In fact, subjects from the high platform level were not expected to be able to safety test at all. The rationale behind this prediction is best explained by the topography of the safety test response. A safe-

ty test was electronically recorded only when a subject was simultaneously on the platform and in contact with the grids.

To test this prediction, it was first necessary to demonstrate that safety testing behavior was affected by platform height. Quite unfortunately, the initial prediction that high platform subjects would be physically incapable of performing this response was disconfirmed by both the present results and less formal observations of the experimenter, rendering an adequate test of this safety-testing hypothesis impossible. Obviously, though, the safety test response was performed with less difficulty from lower platform levels. The results revealed that high platform subjects tested the safety of the grid before departing the platform significantly less frequently than either very low or low platform subjects. Similarly, total number of safety tests during the five hour fear test were more frequent for very low platform subjects than for higher platform subjects. Likewise, latencies to safety test were shorter for very low and low platform subjects. Thus, the results of safety test latencies, number of tests before first approach, and total number of safety tests indicate that the experimental manipulation of platform height did have the expected effect of at least rendering safety test responses increasingly difficult to execute.

An a-priori decision stated that approach latency would be the most important measure to test this last safety test hypothesis. This hypothesis would predict that approach latencies would be longer for subjects from the higher platform groups. A significant platform effect for these data was not found. Similarly, a significant platform effect

was not found when the data for first time spent on grid were analyzed. Ironically, the two dependent fear measures which revealed significant platform effects indicated significant differences contrary to those which the safety testing hypothesis would have predicted. High platform subjects spent significantly more time on the grid than either very low or low platform subjects. These results are also paralleled by the number of approaches data. High platform subjects approached the grid significantly more often than either very low or low platform subjects.

These results are, at first, quite perplexing. A particular feature of these dependent measures is that they reflect the behavior of subjects during the entire five-hour fear test. It is quite plausible that the platform variable differentially interacted with the protracted fear testing phase of this study. The data show, for example, that nearly all subjects had engaged in approach behavior by the end of the fear test. Thus, platform height may conceivably have a different effect toward the end of fear testing, where nearly all subjects were apparently non-fearful, engaging in approach behavior, than during the beginning of the fear testing phase. Admittedly, this explanation of the platform effect is post hoc --- Further empirical investigation is required.

The contribution of the results of this study should be discussed in light of methodological improvements. First, earlier studies showing only partial fear reduction, (Bersh & Paynter, 1972; Monti, 1974) could be criticized for employing unduly short RP durations. The present study employed a RP duration which was comparatively very long.

Second, the procedure of this experiment purposefully excluded the practice of interpolating extinction trials between blocking and the procurement of approach measures, thereby removing the confounding effects of additional CS presentations. Examples of such inadvertent confounding are found in Page (1955) and Marrazo, Riccio, and Riley (1974). Third, unlike other studies, (e.g., Shipley, Mock, and Levis, 1971) this experimental method did not employ a distinctive CS, but rather relied exclusively on apparatus cues (e.g., grids). This assured identical CS exposure between fear conditioning and fear testing. Fourth, this study did not introduce the possible confounding effect of food deprivation (e.g., Spring, 1973). Lastly, this study employed a conservative statistical assessment of the fear reduction hypothesis. The hypothesis that RP is effective in reducing fear would have been rejected if the blocked group had not been found to be significantly less fearful than the non-blocked group at the .01 alpha level. Likewise, the hypothesis that RP does not lead to complete fear reduction would have been accepted only if the blocked group appeared significantly more fearful than the non-shocked control group at a .01 level.

In summary, the present experiment demonstrated conclusive evidence that RP is effective in reducing fear. The hypothesis that a relatively long duration of RP leads to complete fear elimination was rejected. The results of the safety test data showed that safety testing responses are unequivocally indicative of fear. The safety test data also suggested that safety testing behavior may represent a self-imposed process of fear reduction. The effects of manipulating platform height is best represented as only partially understood, awaiting future empirical investigations.

In closing, clinical implications of the present findings should be presented. Although great caution should be exercised in extrapolating results of animal research to a clinical setting, research with the sub-human analogue of Implosive Therapy (IT) may contribute relevant guidelines and suggestions. The relevancy of such research logically follows the pending controversy surrounding the use of IT (Morganstern, 1973, 1974; Levis, 1974, 1975). In addressing this controversy, the present author takes the following position: Animal research showing residual fear following RP should not be used as conclusive evidence against the use of IT. The convincing evidence is that RP does reduce fear, albeit not completely. A criteria of perfect and complete fear reduction may be too idealistic. The efficacy of IT relative to other available treatment procedures, along with potential contraindications of its use (e.g., hypertension) are more relevant criteria.

The results of the safety test investigation of this study make speculation concerning the role of safety test behavior in humans, particularly in relation to IT, difficult to avoid. Although anecdotal evidence will suffice to suggest that human clients do engage in gradual successive approximations to a feared stimulus, an empirical consideration of the role of human safety testing behavior, has heretofore been neglected. The results of this study provide a substantial base for generating three experimental questions involving human subjects: In what way is safety testing behavior in humans related to fear? Is safety testing behavior in humans contributory to a fear reduction process? Lastly, would the relative accessibility or non-accessibility of graded exposure to a CS following IT have an effect on removal of fear?

APPENDIX A

Results of Cochran's Test for Homogeneity of Variance

Dependent Variable	Original Variable	Transformed Variable
Total UCS Time	C(8,9) = .316; p > .01	
Number of Shocks	C(8,9) = .337; p > .01	
Number of Shocked Trials	C(8,9) = .052; p > .01	
Trials to Criterion	C(8,9) = .185; p > .01	
Approach Latency	C(12,9) = .336; p < .01	C(12,9) = .159; p > .01
First Time Spent on Grid	C(12,9) = .892; p < .01	C(12,9) = .172; p > .01
Total Grid Time	C(12,9) = .283; p < .01	C(12,9) = .230; p > .01
Total Number of Approaches	C(12,9) = .205; p > .01	
Safety Test Latency	C(12,9) = .475; p < .01	C(12,9) = .199; p > .01
Number of Tests Before Approach	C(12,9) = .454; p < .01	C(12,9) = .250; p > .01
Total Number of Tests	C(12,9) = .274; p > .01	

APPENDIX B

- . Summary Tables for the
Analysis of Variance

Table 1

Analysis of Variance Summary Table of Number of Trials
to Avoidance Criterion

Source	Sum of Squares	d.f.	Mean Square	F
Platform	15.44	3	5.15	0.065
Treatment	165.31	1	165.31	2.10
Interaction	641.14	3	213.71	2.715
Within Cells	5668.03	72	78.72	
Total	6489.91	79		

Table 2

Analysis of Variance Summary Table of Number of Trials
Where Shock Was Received

Source	Sum of Squares	d.f.	Mean Square	F
Platform	72.14	3	24.05	1.266
Treatment	4.51	1	4.51	0.238
Interaction	168.04	3	56.01	2.949
Within Cells	1367.70	72	19.00	
Total	1612.39	79		

Table 3 .

Analysis of Variance Summary Table for Number of Shocks

Source	Sum of Squares	d.f.	Mean Square	F
Platform	312.14	3	104.05	1.335
Treatment	66.61	1	66.61	0.855
Interaction	882.44	3	294.15	3.775
Within Cells	5610.23	72	77.92	
Total	6871.42	79		

Table 4

Analysis of Variance Summary Table for Total UCS Time

Source	Sum of Squares	d.f.	Mean Square	F
Platform	4247.59	3	1415.86	3.174
Treatment	191.89	1	191.89	0.430
Interaction	847.86	3	282.62	0.634
Within Cells	32122.70	72	446.15	
Total	37410.04	79		

Table 5

Analysis of Variance Summary Table of Log_{10} Transformation
for Total Grid Time

Source	Sum of Squares	d.f.	Mean Square	F
Platform	16.00	3	5.33	5.491
Treatment	40.67	2	20.34	20.943
Interaction	6.27	6	1.05	1.077
Within Cells	104.87	108	.97	
Total	167.81	119		

Table 6

Analysis of Variance Summary Table of Log_{10} Transformation
for First Time on Grid

Source	Sum of Squares	d.f.	Mean Square	F
Platform	1.45	3	.48	1.560
Treatment	11.36	2	5.68	18.326
Interaction	2.35	6	.39	1.264
Within Cells	33.48	108	.31	
Total	48.64	119		

Table 7

Analysis of Variance Summary Table for Total Number of Approaches

Source	Sum of Squares	d.f.	Mean Square	F
Platform	9089.76	3	3029.92	4.355
Treatment	11338.00	2	5668.97	8.148
Interaction	2423.69	6	403.95	0.581
Within Cells	75141.00	108	695.75	
Total	97992.45	119		

Table 8

Analysis of Variance Summary Table of $\log_{10}$ Transformation for "Safety Test" Latency

Source	Sum of Squares	d.f.	Mean Square	F
Platform	11.46	3	3.82	6.345
Treatment	44.92	2	22.46	37.296
Interaction	4.39	6	.73	1.215
Within Cells	65.04	108	.60	
Total	125.81	119		

Table 9

Analysis of Variance Summary Table of Log_{10} Transformation
for First Approach Latency

Source	Sum of Squares	d.f.	Mean Square	F
Platform	1.49	3	.50	0.827
Treatment	70.66	2	35.33	58.750
Interaction	2.49	6	.41	0.690
Within Cells	64.94	108	.60	
Total	139.58	119		

Table 10

Analysis of Variance Summary Table of Log_{10} Transformation
for Number of "Safety Tests" Before First Approach

Source	Sum of Squares	d.f.	Mean Square	F
Platform	3.52	3	1.17	3.819
Treatment	16.35	2	8.18	26.621
Interaction	.74	6	.12	0.401
Within Cells	33.17	108	.31	
Total	53.78	119		

Table 11

Summary Table of an Analysis of Variance
for Total Number of Safety Tests

Source	Sum of Squares	d.f.	Mean Square	F
Platform	356399.5	3	118799.8	6.620
Treatment	15553.0	2	7776.5	.433
Interaction	89654.9	6	14942.5	.832
Within Cells	1939270.0	108	17956.2	
Total	2500877.4	119		

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