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Avoidance learning of anxiety : an application of signal detection theory

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AN APPLICATION OF SIGNAL DETECTION THEORY

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RUNNING HEAD: AVOIDANCE LEARNING

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Abstract

The purpose of the present study was to test the application of Signal Detection Theory to a model for the development of anxiety. An attempt was made to condition anxiety responses to decreasing magnitudes of a noxious stimulus through the negative reinforcement of avoidance behavior. An analogue based on Mandler and Watson's (1966) interruption theory was designed. Data from 32 male and female volunteers from the University of Richmond subject pool were used in the final analysis. All students were pretested with Sarason's (1972) Test Anxiety Scale and placed in high- and low-anxiety groups according to their scores on the Scale. An audiometer was used in pre- and posttests to determine sound detection and discomfort levels of each student. After the pretests, all students computed five sets of math problems. The 16 students in the experimental group heard a gradually increasing sound as they worked the problems. The sound was terminated when a student reported distraction. The 16 control students worked the same math problems without the interfering sound. In a 2 X 2 X 2 ANOVA design, pre- and posttest

detection and discomfort levels of high- and low-anxious experimental and control groups were compared. Analysis of the data did not support the notion that the negative reinforcement of terminating a noxious stimulus had significantly lowered the experimental group's detection of the stimulus. Since the results of this preliminary experiment were not significant, an experiment intended to test the effects of a deliberated versus an automatic decision to terminate the sound was not conducted.

Avoidance Learning of Anxiety: An Application of Signal Detection Theory

With the development of instruments to measure anxiety in the 1950's (notably the Taylor Manifest Anxiety Scale), systematic experimentation with the anxiety response began. Since then diverse conceptual and theoretical approaches to the study of anxiety have been proposed. Researchers have been criticized, however, for their lack of integration in the field of anxiety. Lazarus and Averill (1972), acknowledging the importance of integration, nonetheless warn against "premature attempts to assimilate wide ranging phenomena" (p. 263). Lazarus and Opton (1966) call for the formulation of rules with regard to the specific eliciting stimuli and consequences of anxiety. Jaremko (Note 1) also stresses the need to know the conditions through which anxiety evolves: "Understanding how anxiety is learned is the next step in controlling it" (p. 155).

Studies examining the development of anxiety suggest that there is both an innate and a learned component to anxiety. The innate component of anxiety refers to an organism's genetic predisposition to respond anxiously to environmental stimuli. There are certain fear responses--activations of the autonomic nervous system (ANS)--necessary to the survival of the organism or species. Watson and Rayner (1920) showed how a startle response, an innate activation of the ANS by a loud noise, can be conditioned to a neutral stimulus. Thus a learned component to anxiety was demonstrated. A loud sound caused an infant to startle. After repeated pairings of the loud sound--unconditioned stimulus (UCS)--with a rabbit--conditioned stimulus (CS)--the rabbit alone came to elicit the startle response from the child. Such "classical conditioning" of anxiety may account for the learning of many phobias (Wolpe, 1958).

The learning, maintenance, and generalization of anxiety is more fruitfully conceived of, however, in terms of avoidance (Bandura, 1969; Mischel, 1971; Jaremko, Note 1). Krasner and Ullmann (1973) state that anxiety is aversive and that people will act to avoid it. If one avoids an anxiety-eliciting situation, an immediate reduction of tension occurs, and thus one is negatively reinforced for avoidance behavior. It may also be that one is negatively reinforced for detecting anxiety cues. Longterm results, however, are not so favorable. Through the negative reinforcement of avoidance, anxiety is seen to be even more firmly conditioned to the anxiety-eliciting stimulus and to generalize to similar stimuli.

Other authors suggest that anxiety is learned through the negative reinforcement of tension reduction. Tension reduction is commonly believed to be the chief factor in maintaining speech blocks or stuttering. Wischner (1950) proposes that stuttering is initiated by anxiety-eliciting cues in the environment and is maintained by the tension reduction which occurs when the word is finally completed. The reinforcing effects of tension reduction are assumed to be even stronger than the negative effects of stuttering. An experiment by Sheehan (1958) supports tension reduction as a reinforcer of stuttering. Subjects read two passages aloud in each of two conditions in counterbalanced order. In the control condition, subjects read the passages six times without any intervention. In the experimental condition, subjects were required to repeat the stuttered word until they pronounced the word fluently. Thus instead of reducing the tension, stuttering came to exaggerate the tension. On test trials following each of the conditions, stuttering was found to have significantly decreased following the punishing condition.

Krasner and Ullmann (1973) cite case studies which demonstrate how the negative reinforcer of tension reduction increases detection of anxiety cues and serves to maintain clients' avoidance behavior. Clients beginning a task which offers no immediate reward experience ANS arousal (frustration, anxiety). They soon break from their work. The break terminates the tension and negatively reinforces the taking of the break and the detection of ANS cues. Since the detection of anxiety has been rewarded by the termination of anxiety, it is probable that anxiety will be more easily detected in the future.

Studies dealing with unlearning of anxiety further support the fact that anxiety is learned through avoidance. Jaremko (Note 1) describes the unlearning of anxiety through precluding avoidance:

> By making the person confront the feared object, the fear will extinguish as the person becomes

more confident in dealing with the situation (p. 162).

Bandura and Adams (1978) have found that the best way to reduce anxiety is to preclude avoidance of the anxiety-eliciting stimulus. Jaremko considers this to be a logical finding given that anxiety is largely learned through avoidance.

Systematic desensitization, first introduced by Wolpe (1958), is an effective treatment for anxiety. In the systematic desensitization procedure, a client is led to confront imaginally each successive stimulus of a gradually increasing hierarchy of anxiety-eliciting stimuli. The hierarchy concludes with the anxiety-eliciting stimulus for which the client is being treated. As the client's anxiety response is desensitized at each level, he/she is then ready to confront the next higher level in the hierarchy. Thus anxiety is gradually unlearned. The effectiveness of systematic desensitization as a treatment for anxiety indicates that anxiety may be learned in reverse fashion. A person reacts anxiously to a stimulus of relatively high magnitude, avoids the stimulus, and learns through the negative reinforcement of avoidance to respond anxiously to stimuli of gradually decreasing magnitudes.

Krasner and Ullmann (1973) also describe the spread of anxiety along a generalization gradient: "To reduce or avoid these stimuli, the individual withdraws from the situation and avoids anything resembling aspects of the situation" (p. 163).

One model for explaining how anxiety is conditioned to gradually decreasing magnitudes of stimuli through the negative reinforcement of avoidance calls for an application of signal detection theory to the study of the development of anxiety. Signal detection theory (Tanner & Swets, 1954) maintains that an individual's perception of a given stimulus depends upon two factors: the sensitivity of his/her central nervous system and the reinforcement contingent upon the perception. Signal detection is further described as the probability that a stimulus will be detected based on the history of reinforcement of the detecting organism (Jaremko, Note 1). Applied to the study of anxiety, signal detection theory indicates that if a person has been negatively reinforced for detecting sympathetic nervous system arousal, he/she will be more likely to detect the arousal (anxiety response) in the future. This may be what happens in the learning of anxiety.

Bruner (1957) and Solomon and Wynne (1954) support the use of signal detection in explaining the learning of anxiety. Bruner states that there is

> . . . evidence that the recognition threshold for noxious objects about which one can do something is lower than normal, whereas for ones about which nothing instrumental can be done, the threshold is higher (p. 148).

Solomon and Wynne note the peculiar resistance of avoidance behavior to extinction. A conditioned anxiety stimulus can be presented countless times to an organism without the original unconditioned stimulus, and the organism will continue to avoid the conditioned stimulus. The experimenters suggest that this resistance to extinction cannot be explained adequately by the processes of classical conditioning (through which a neutral stimulus comes to evoke a fear response) and instrumental conditioning (through which avoidance behavior is negatively reinforced by tension reduction). To explain the resistance of avoidance behavior to extinction, Solomon and Wynne apply the principle of partial irreversibility of classical conditioning to the learning of anxiety responses. They propose that where traumatic avoidance learning has occurred, the responses are not capable of being completely extinguished. Their conception has similarity to the signal detection model being described here:

> . . . a "traumatic" or very intense "pain-fear" reaction taking place in the presence of some conditioned stimulus pattern will result in a _permanent_ increase in the probability of occurrence of an anxiety reaction in the presence of the conditioned stimulus pattern (whenever it recurs). This permanent change can be thought of as a decreased threshold phenomenon. . . . (p. 361).

Jaremko summarizes the application of signal detection theory to the avoidance learning of anxiety:

> An event leads to the unpleasant responses of the sympathetic nervous system, which is then avoided. The avoidance behavior is negatively reinforced by escape from the unpleasant physical feelings and the _detection threshold_ of anxiety is decreased so that the next time it takes less of

> the original event to set off the cycle. Generalization quickly occurs because the misperceived anxiety-provoking events occur frequently. Anxiety is learned and spread by avoiding it (p. 158).

The purpose of the present study is to test the application of signal detection theory to the learning of anxiety. Can an anxiety response be conditioned through the negative reinforcement of avoidance behavior to systematically decreasing magnitudes of a given stimulus?

To test this question, an analogue which allows for repeated exposure of a subject to a series of gradually increasing amounts of a potentially anxiety-eliciting stimulus must be designed. Although Izard (1972) indicates the near impossibility of adequately representing valid anxiety-eliciting conditions in the laboratory, several studies have suggested methods for experimentally inducing anxiety. The anxiety-eliciting situation hypothesized for this experiment will be based on Mandler and Watson's (1966) assertion: ". . . the interruption of an organized behavioral sequence will, under certain specifiable conditions, serve as a condition sufficient to evoke anxiety" (p. 263). The specifiable conditions include: skill instructions (Butterfield, 1964), ease of organization and over-learning of the behavioral or cognitive sequence, irrelevance of the interruptions, subjects' restricted choice in the task and lack of alternatives, and pressure toward completion of the sequence.

Accordingly, the analogue will be as follows. College students will engage in a series of five numerical computation tasks in which they will work eight mathematical problems. Since the problems involve basic arithmetic, the computation task can be considered to be easily organized and overlearned by the students. Skill instructions will be administered (Appendix E). The test-like characteristics of this situation (Spence & Spence, 1966), coupled with the skill instructions, are expected to make the task ego-involving to the subjects and to motivate pressure toward completion of and success in the task. A time limit as well as a prescribed order for working the problems will restrict students' sense of choice in the task. Finally, students will wear headphones through which gradually increasing noise will be heard.

The noise will be switched from ear to ear and irrelevant to the task. Points will be given to each student for a combination of accurate computation and noise level toleration.

The gradually increasing noise is intended to serve as a distraction which will interrupt the student's cognitive goal for earning a maximum number of points. Thus according to Mandler and Watson's assertion, the point at which distraction is reported will be operationally defined as the anxiety response. The termination of the noise will negatively reinforce the student's report of distraction. It is hypothesized that the student's detection of distraction and of anxiety cues accompanying distraction will also be negatively reinforced and that, as a result of this negative reinforcement, the student's sensitivity to or detection threshold of the sound will lower.

Method

Subjects

Subjects were 40 male and female undergraduate students from the subject pool of the psychology department of the University of Richmond who volunteered to participate in the experiment. The experimenter obtained permission from professors to solicit volunteers from classes. Information about the experiment was also posted in the students' classroom.

Students were divided into two groups of 20 subjects each. The first 20 subjects were administered the experimental manipulation. The second 20 subjects were administered the control conditions. Subjects were further divided into high- and low-anxiety groups according to their pretest scores on the Test Anxiety Scale (TAS). The high-anxiety experimental and control groups consisted of students receiving scores of 16 and above on the TAS. Low-anxiety groups were made up of students scoring 15 and below. When subjects were placed in high- and low-anxiety groups according to the above criteria, group sizes were as follows: experimental high, 10; experimental low, 10; control high, 8; and, control low, 12. Subjects were randomly deleted to form equal group sizes of eight subjects each.

Subjects were informed of the general purpose and mechanics of the experiment from the beginning. As the final step in the session, each subject was debriefed.

Apparatus

A Lafayette Instruments--Model 10 D--audiometer was used in the pretest, posttest, and experimental manipulation phases of the experiment. The TAS (Appendix A) was used to pretest subjects. The TAS served as a trait anxiety test, while a short posttest questionnaire (Appendix B) was intended to serve as a state anxiety check. Two stop watches, data sheets (Appendix C), five sets of eight math problems each (Appendix D), and written instructions (Appendix E) were also used.

<u>Procedure</u>

<u>Pretest period</u>. At the beginning of the pretest period, the experimenter gave the following instructions to each student:

> This is an experiment involving cognitive tasks and distraction. We want to determine the role of distraction in cognitive activity. You will engage in a number of phases in this experiment. First, you will take a short paper-pencil test. In the second step of the experiment, you will be given a sound discrimination task. In the third step of the experiment, you will be given a series of math problems to compute. You will be given instructions for this step at the beginning of the math

work. In the fourth step we will repeat the sound discrimination task. Finally, you will be given a short questionnaire which will permit you to share your reactions to the experiment with me. Then I will debrief you, so I would appreciate it if you would not discuss the experiment with anyone until all data have been collected.

The TAS was then administered to each subject. (Sometimes it was necessary to administer the TAS to a student prior to the above instructions. This often occurred when two students were scheduled in overlapping time segments.) The following instructions were given to students prior to the administration of the TAS:

Put your name here (indicating the blank at the top of the sheet). Then write "true" or "false" at the end of each sentence. Work as quickly and as honestly as possible--first impressions are usually best.

Students were then told to put on headphones with the blue headphone over the left ear. Sound discrimination tasks were conducted through each subject's left ear. The audiometer was set at a frequency of 1500 cycles per second (CPS) and at 30 decibels (DB).

The experimenter then turned on the audiometer and said:

> Do you hear a sound? (Yes.) In a moment I will discontinue the sound. Then I want you to listen carefully and tell me when you first hear a sound. The sound for which you will be listening will be of the same nature--frequency--as the sound you are now hearing, only not as loud. Say, "Stop," when you first detect the sound. Are there any questions?

After completing the instructions, the experimenter turned off the audiometer and set it at zero DB. Then the experimenter turned on the audiometer again and asked, "Do you hear a sound?" No student detected sound at zero DB, so the experimenter replied, "O.K., tell me when you first detect the sound." Sound was increased at the rate of one DB per five seconds until the subject reported discrimination.

When the subject reported discrimination, the experimenter turned off the audiometer again and said:

> Now I want you to listen and tell me when the sound becomes uncomfortable. The sound will not harm you, but it will become uncomfortable. Say,

"Stop," when the sound first becomes uncomfortable.

Are there any questions?

Next the experimenter turned on the audiometer with decibels set at the subject's discrimination level, asking, "Is the sound uncomfortable?" Each subject answered, "No," and the experimenter replied, "O.K., tell me when the sound first becomes uncomfortable." The sound was increased at the rate of three DB per five seconds until the student reported discomfort.

After the initial detection and discomfort pretests were completed, the experimenter said, "We will repeat that task four more times." For each of the four subsequent detection tests, the experimenter set the audiometer at 30 DB and repeated an abbreviated form of the above instructions: "Do you hear a sound? (Yes.) O.K.--listen for a sound of that same frequency." For the discomfort threshold tasks the experimenter again set the audiometer at each student's discrimination level and said: "Is the sound uncomfortable? (No.) O.K.--tell me when it first becomes uncomfortable."

Experimental manipulation. Written instructions (Appendix E) were placed face down in front of each student. The experimenter orally instructed the student as follows:

> In a moment I will have you turn over the instructions. As you read the instructions, you will hear gradually increasing sound through the headphones. When the noise distracts you--slows down your reading and comprehension of the instructions--say, "Stop," and I will discontinue the noise. This is to acclimate you to the conditions under which you will be working in the real math task. After you report distraction, we will read over the instructions together.

Then the experimenter turned on the audiometer at 30 DB and said, "Do you hear a sound? (Yes.) Ready? Begin." The student turned the instructions over and began to read while the experimenter began to increase the sound at the rate of two DB per three seconds. In addition, an aide was alternating the sound continuously from left to right ear as the student read the instructions. When the student cued her, the experimenter turned off the audiometer and quickly read through the instructions with the student.

After all questions were answered, the experimenter handed each student the first set of arithmetic problems and turned on the audiometer at 30 DB, saying, "Do you hear a sound? (Yes.) Ready? Begin." The student began work on the math problems as the experimenter began two stop watches simultaneously. Decibels were increased at the rate of two per three seconds, and sound was alternated between left and right headphones continuously for as long as the student tolerated the noise. When the student said, "Stop," the experimenter stopped one of the stop watches and turned off the audiometer. After a total of two minutes, if the student had not finished early, the experimenter said, "Stop. Put your pencil down. Place your paper face down off to the side where it will not distract you." Immediately following each math set, the experimenter recorded the amount of time during which the student had tolerated noise as well as the number of decibels tolerated on a data sheet (Appendix C). The amount of time required to complete the problems and, if noise was tolerated up to completion of the problems, the number of decibels tolerated at completion were also recorded. This basic procedure was repeated for the four additional math tasks.

Control group. This group performed exactly as the experimental group with one exception. The students took off the headphones and heard no gradually increasing sound while reading instructions for the math tasks or while computing the math problems. Instructions were adjusted accordingly.

Posttest period. The sound discrimination and discomfort threshold tasks were repeated according to pretest administration instructions. Abbreviated instructions were used with all of the posttests. Then the posttest questionnaire was filled out by each subject. Finally the experimenter debriefed each subject immediately after he/she had completed the experiment.

Data analysis. The design for this experiment was a 2 X 2 X 2 analysis of variance (ANOVA). The factors consisted of groups (experimental and control), anxiety levels (high and low), and trials (pretest and posttest), with repeated measures on the trials factor. The dependent variables were the measures of detection (discrimination) and discomfort levels. The unit of measure for data analysis was decibels.

Results

Table 1 lists the means and standard deviations of the discrimination and discomfort levels for the high- and low-anxious experimental and control groups at pretest and posttest. The 3-way analysis of variance of the discrimination data yielded a main effect for groups ($F[1,28] = 6.3$, $p < .025$). Inspection of Table 1 shows that the control group had consistently higher discrimination levels than did the experimental group. This result (a main effect) occurred across trials and anxiety levels. As will be seen in the discussion, it was possibly due to the fact that experimental subjects were seen first and control subjects were seen second, closer to the university's final exam period. A trials main effect was also obtained on the discrimination data ($F[1,28] = 7.9$, $p < .01$). Inspection of Table 1 shows that posttest scores are consistently lower than pretest scores. No other significant effects were found in the discrimination data. (A copy of the analysis of variance table for the discrimination data is contained in Appendix F.) There were no significant effects in the discomfort data, although the groups main effect approached significance

($F=[1,28] = 2.7$, $p < .12$). Inspection of Table 1 reveals the trend toward a groups main effect in that the control group discomfort levels are consistently higher than the experimental group levels. The large variances probably prevented the difference from attaining a significant level. (Appendix G contains the analysis of variance level for the discomfort data.)

Insert Table 1 about here

Table 2 lists the means and standard deviations of the TAS and posttest questionnaire scores. The means and standard deviations of the performance scores of the experimental group on the math tasks are also presented. It was predetermined that the mean of the TAS scores in the high-anxious group would have to be at least three standard errors of measurement greater than the mean of the TAS scores in the low-anxious group in order to test for an anxiety interaction. The standard error of measurement, averaged for males and females, was calculated to be 2.5 points. The experimental high- and low-anxious group means were separated by 11.4 points. The control group means were separated by 7.6 points. Thus the criterion of a minimum 7.5 point difference between the means was met, and the anxiety factor was included in the data analysis. Table 2 also shows that the TAS data are parallel to the posttest questionnaire data. High- and low-anxiety groups as defined by the TAS scores are also seen to be high- and low-anxiety groups using the posttest questionnaire data. In addition, as with the TAS data, the spread between high- and low-anxiety groups for the posttest questionnaire data was greater between the experimental groups than between the control groups. Although the average within group variance was greater for the posttest questionnaire scores than for the TAS scores, the distinction between high- and low-anxiety groups was less for the posttest questionnaire data in both the experimental and control groups. Finally, the points earned by the experimental subjects on the math tasks were tabulated. Table 2 shows that the mean score of the low-anxiety group was 3.7 points higher than the mean score of the high-anxiety group. Although this difference was in the expected direction, a t-test for the comparison of two independent means yielded no significant difference between the means ($t[14] = 2.145$, $p < .05$).

Appendix H lists each individual subject's discrimination and discomfort level data at pre- and posttests. Subjects' individual scores on the TAS and on the posttest questionnaire can be examined in Appendix I.

Discussion

A significant trials by groups by anxiety level interaction was predicted by the hypothesis of the present study. If the hypothesis was true and the analogue used here was a valid anxiety-eliciting procedure, it would be expected that the high-anxiety experimental group's detection and discomfort levels would decrease from pretest to posttest while the levels of the other groups would remain stable. Neither two-way nor three-way interactions were achieved. Thus a lowered signal detection threshold for noise level and, concurrently, for anxiety cues, as a function of avoidance behavior was not supported by the analysis of variance.

The anxiety-eliciting ability of the analogue was an important dimension in this study. Mandler and

Watson (1966) state that "the implications of interruption are not the same for the two groups of subjects; high anxiety subjects exhibit more success-related plans" (p. 279). Mandler and Watson further explain that "high-anxiety subjects more frequently show evidence of a plan to succeed, which is of course exactly the sequence that is interrupted by failure" (p. 279). The fact that no significant anxiety interactions were achieved in the present study may be due to the following limitations of the analogue.

First, the criterion for formation of high- and low-anxiety groups was that there be a minimal difference of 7.5 points between the mean TAS scores of the anxiety groups. This was an arbitrary criterion. In a study by Mandler and Watson, on the other hand, subjects who scored in the top and bottom 15% of the test distribution for their anxiety measure were placed in high- and low-anxiety groups, respectively. Perhaps the failure of this experiment to achieve a significant anxiety interaction was due to the fact that, in forming the anxiety groups, there was not enough actual difference between the high and low groups.

Secondly, posttest questionnaire data may indicate that subjects did not regard the analogue as a test-like situation. The posttest questionnaire was designed as a state anxiety test to assess subjects' reactions to the analogue. Although the questionnaire data are not normative and must thus be regarded tentatively, the data of the questionnaire (Table 2) show that the subjects did not perceive the procedure as very anxiety-eliciting. On a 40-point scale, the highest mean total is 21.9. The analogue may not have elicited anxiety.

The notion that the subjects may not have perceived the analogue as a test-like or anxiety-eliciting situation is further supported by the fact that there was no significant difference between the mean math scores of the high- and low-anxious experimental groups (Table 2). A study by Sarason (1972) indicates that when subjects perceive a situation to be evaluational, high-anxious subjects perform significantly more poorly than low-anxious subjects.

Finally, this study may not have represented a true anxiety condition due to the fact that subjects both expected and exercised control over the anxiety-eliciting variable (noise). Glass and Singer (1972) discuss "noise-produced stress" (p. 19) and conclude that "unpredictable noise has consequences equal to those of a higher-intensity predictable noise . . ." (p. 20). The noise presented in the present study was consistent and predictable. It may be possible for future research to make the analogue more anxiety provoking by making the noise unpredictable and uncontrollable.

The significant findings that were obtained in this experiment also failed to support the hypothesis. A groups main effect in the discrimination data indicated that subjects in the experimental group detected sound earlier than subjects in the control group regardless of test or anxiety level. Table 1 shows that the same trend was demonstrated by discomfort level data. It may also be noted in Table 2 that the mean TAS and posttest questionnaire scores of the experimental group were consistently higher than those of the control group. These systematic differences may be due to the fact that the groups were run in slightly different time segments. Experimental subjects participated in the experiment from four to seven days before the students' exam week. Control subjects participated more immediately prior to and during exam week. Thus the effects of exam week on the student were not adequately controlled for and may have influenced the groups main effect.

A significant trials main effect in the discrimination data indicated that the subjects detected sound earlier on posttests than on pretests, regardless of anxiety level or group. Negative reinforcers other than avoidance behavior could have been operating to lower subjects' response criteria for reporting detection and discrimination. Subjects were required to sit through a total of 20 pre- and posttests. It may well be that, after an average of a 40-minute experiment, students' response criteria for the posttests were lowered by the negative reinforcer of termination of a dull task. It could also be that the negative reinforcer of termination of a task which necessitated the wearing of uncomfortable headphones was operating to lower students' response criteria. The potential negatively reinforcing effects of wearing uncomfortable headphones were not adequately controlled for in this experiment. The experimental group wore the headphones throughout the math tasks. The control group neither heard distracting sound nor wore the headphones during the math tasks. Thus the two groups were different on a variable other than noise, and the results could have been affected accordingly.

To conclude, the findings of this study failed to demonstrate that the learning of anxiety through the negative reinforcer of avoidance behavior had occurred. The hypothesis would have been supported by a significant groups by anxiety interaction. No interactions were achieved. The failure to obtain a significant result may be due to any or all of the following rival hypotheses:

1) Avoidance behavior does not, in fact, negatively reinforce anxiety responses.

2) The analogue presented here did not elicit anxiety.

3) The experimental and control groups differed in that they

a) were tested at different times (final exam versus non-final exam), and,

b) one (experimental) wore headphones longer than the other (control).

Future research should be devoted to constructing an analogue that is reliably anxiety provoking. Such a result can be obtained by attending to the following procedural steps: making the noise unpredictable and uncontrollable, making the amount of separation between high- and low-anxiety groups clinically valid, and making the math tasks more personally meaningful. Common control procedures such as random order in the administration of the procedure and experimental-control group equivalence in all variables except the independent variables should also be used in future work.

If this experiment had supported the hypothesis, a second experiment was to have been conducted. The same analogue was to have been used with adaptions to test a second hypothesis--that a deliberated decision to avoid an anxiety-eliciting stimulus would lower the threshold of anxiety detection to a greater degree than an automatic decision. In the experimental manipulation of Experiment II, subjects were to have read orally a short paragraph designed to represent a deliberating condition. Research by Mann (1956) and by Janis and King (1954) indicates that under certain conditions individuals will internalize information which they present orally. Research by Rose (1978) also supports the efficacy of behavioral rehearsal in influencing attitudes. It is recommended that future researchers construct a valid anxiety-eliciting analogue by which both hypotheses can be tested.

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Reference Notes

1. Jaremko, M. E. Dimensions of personality. Book in preparation, 1978.

2. Rose, V. The use of covert reinforcement in the modification of external locus of control. Unpublished manuscript, University of Richmond, 1978.

Table 1

Means and Standard Deviations:

Discrimination and Discomfort Level Data (in Decibels)

N = 32

	Discrimination				Discomfort			
	High		Low		High		Low	
Experimental								
Pretest	9.98	(3.9)	9.4	(4.0)	65.4	(25.3)	66.6	(22.8)
Posttest	8.5	(3.8)	7.9	(3.2)	67.7	(24.1)	61.9	(25.8)
Control								
Pretest	13.0	(5.97)	13.6	(4.5)	80.5	(18.98)	81.9	(29.8)
Posttest	11.9	(5.6)	12.4	(4.1)	76.2	(29.3)	81.3	(29.96)

Table 2

Means and Standard Deviations:

TAS and Posttest Questionnaire Data

	TAS N = 32	Posttest Questionnaire N = 32	Math Scores N = 16
Experimental			
High	24.3 (5.4)	21.9 (3.1)	71.1 (18.7)
Low	12.9 (2.4)	16.8 (7.1)	74.8 (19.9)
Control			
High	19.0 (2.3)	18.4 (4.4)	
Low	11.4 (2.8)	14.4 (4.2)	

Appendix A

Name____

1. While taking an important exam I find myself thinking of how much brighter the other students are than I am.
2. If I were to take an intelligence test, I would worry a great deal before taking it.
3. If I knew I was going to take an intelligence test, I would feel confident and relaxed, beforehand.
4. While taking an important examination I perspire a great deal.
5. During course examinations I find myself thinking of things unrelated to the actual course material.
6. I get to feel very panicky when I have to take a surprise exam.
7. During tests I find myself thinking of the consequences of failing.
8. After important tests I am frequently so tense that my stomach gets upset.
9. I freeze up on things like intelligence tests and final exams.

Appendix A (Continued)

10. Getting a good grade on one test doesn't seem to increase my confidence on the second.

11. I sometimes feel my heart beating very fast during important tests.

12. After taking a test I always feel I could have done better than I actually did.

13. I usually get depressed after taking a test.

14. I have an uneasy, upset feeling before taking a final examination.

15. When taking a test my emotional feelings do not interfere with my performance.

16. During a course examination I frequently get so nervous that I forget facts I really know.

17. I seem to defeat myself while working on important tests.

18. The harder I work at taking a test or studying for one, the more confused I get.

19. As soon as an exam is over I try to stop worrying about it, but I just can't.

20. During exams I sometimes wonder if I'll ever get through college.

Appendix A (Continued)

21. I would rather write a paper than take an examination for my grade in a course.
22. I wish examinations did not bother me so much.
23. I think I could do much better on tests if I could take them alone and not feel pressured by a time limit.
24. Thinking about the grade I may get in a course interferes with my studying and my performance on tests.
25. If examinations could be done away with I think I would actually learn more.
26. On exams I take the attitude, "If I don't know it now there's no point worrying about it."
27. I really don't see why some people get so upset about tests.
28. Thoughts of doing poorly interfere with my performance on tests.
29. I don't study any harder for final exams than for the rest of my course work.
30. Even when I'm well prepared for a test, I feel very anxious about it.
31. I don't enjoy eating before an important test.

Appendix A (Continued)

32. Before an important examination I find my hands or arms trembling.

33. I seldom feel the need for "cramming" before an exam.

34. The University ought to recognize that some students are more nervous than others about tests and that this affects their performance.

35. It seems to me that examination periods ought not be made the tense situation which they are.

36. I start feeling very uneasy just before getting a test paper back.

37. I dread courses where the professor has the habit of giving "pop" quizzes.

Appendix B

Posttest Questionnaire

1. How uptight, tense or anxious did you feel during the math tasks?
    1. not at all tense or anxious
    2. a little tense or anxious
    3. quite tense or anxious
    4. very tense or anxious
    5. extremely tense or anxious
2. How often during the math task did you find yourself thinking how well, or how badly, you seemed to be doing?

    Never Constantly

3. How often during the math task did you find yourself thinking or wondering about how well other university students might perform?

    Never Constantly

Appendix B (Continued)

4. How important personally was it for you to do well on the math task?

Not Very Important   Very Important

Appendix C

Name ____________________

Date ____________________

Time ____________________

Test I

Distraction: Time __________

DB __________

Completion: Time __________

DB __________

Test II

Distraction: Time __________

DB __________

Completion: Time __________

DB __________

Test III

Distraction: Time __________

DB __________

Completion: Time __________

DB __________

Appendix C (Continued)

Test IV

Distraction: Time ____________

DB ____________

Completion: Time ____________

DB ____________

Test V

Distraction: Time ____________

DB ____________

Completion: Time ____________

DB ____________

PRETEST

I

Discrimination Threshold (DB) ____________

Discomfort Threshold (DB) ____________

II

Discrimination Threshold (DB) ____________

Discomfort Threshold (DB) ____________

III

Discrimination Threshold (DB) ____________

Discomfort Threshold (DB) ____________

Appendix C (Continued)

IV

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

V

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

POSTTEST

I

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

II

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

III

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

IV

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

V

Discrimination Threshold (DB) __________

Discomfort Threshold (DB) __________

Appendix D

I

1.	27 lb.	13 oz.	________
2.	44 min.	26 sec.	________
3.	15 ft.	3 in.	________
4.	42 min.	38 sec.	________
5.	13 lb.	15 oz.	________
6.	27 min.	57 sec.	________
7.	49 ft.	11 in.	________
8.	36 lb.	7 oz.	________

II

1.	17 lb.	12 oz.	________
2.	18 min.	36 sec.	________
3.	17 ft.	5 in.	________
4.	32 lb.	11 oz.	________
5.	41 min.	16 sec.	________
6.	48 ft.	8 in.	________
7.	27 min.	11 sec.	________
8.	45 lb.	10 oz.	________

III

1.	33 lb.	3 oz.	________
2.	46 min.	23 sec.	________
3.	26 ft.	11 in.	________

Appendix D (Continued)

4.	39 min.	31 sec.	___________
5.	29 lb.	14 oz.	___________
6.	22 min.	47 sec.	___________
7.	32 ft.	9 in.	___________
8.	38 lb.	8 oz.	___________
IV			
1.	47 lb.	13 oz.	___________
2.	36 min.	6 sec.	___________
3.	29 ft.	7 in.	___________
4.	14 min.	59 sec.	___________
5.	22 lb.	15 oz.	___________
6.	16 ft.	11 in.	___________
7.	33 min.	25 sec.	___________
8.	14 lb.	9 oz.	___________
V			
1.	13 lb.	12 oz.	___________
2.	49 min.	27 sec.	___________
3.	34 ft.	7 in.	___________
4.	17 min.	34 sec.	___________
5.	26 lb.	14 oz.	___________
6.	31 min.	48 sec.	___________
7.	52 ft.	8 in.	___________
8.	22 lb.	13 oz.	___________

Appendix E

Written Instructions Given to Experimental Group

You are about to be given the first in a series of five sets of math problems. Each of the five sets will contain eight problems. You may use the edges of the test sheets as scratch paper on which to work the problems. Record the answers in the blanks beside the problems.

You will earn points for your performance on these tests. Points will be given for the number of problems correctly solved. It is to your advantage to work as quickly and as accurately as possible. You probably will not have time to check back over the problems.

You will put on the headphones before you begin work and will hear gradually increasing sound as you solve the problems. Points will also be given for the amount of time during which you are able to tolerate sound while computing. However, the number of problems accurately solved will be more heavily weighted toward the points. Therefore, it will be advantageous to have me terminate the sound when it distracts you from the task. When you find the noise slowing down your computations, say, "Stop," and I will terminate the noise.

PLEASE DO NOT TALK TO YOURSELF, MAKE ANY VOCAL SOUNDS, OR MOVE YOUR LIPS.

The problems will be similar to the following:

1 lb. 4 oz. ____________

2 min. 5 sec. ____________

1 ft. 8 in. ____________

Each of these problems is to be converted to the smallest indicated unit: pounds to ounces; minutes to seconds; and, feet to inches. You do not need to write the unit, just the number. Do the problems in order. DO NOT SKIP ANY.

After I give you the math test, place it face down in front of you. Write your name on the blank side of the sheet. When I say, "Begin," turn over the paper and begin work. I will say "Begin," at the beginning of each math set and "Stop," after you have worked on each set for two minutes.

If you finish before I say "Stop," you are to indicate this by saying, "Finished." I will make a note of the fact that you finished early.

Remember to indicate when the sound coming through the headphones distracts you--slows down your computations--by saying, "Stop," and I will terminate the sound.

Take a few moments to work the above problems according to the directions. The test problems will be harder than these.

Are there any questions?

Appendix F

Analysis of Variance:

Discrimination Level

N = 32

Source	Df	Ms	F
Total	63		
Between subjects	31		
Experimental/control	1	227.2	6.3*
Anxiety (high/low)	1	0.0	0.0
Exp-con X anxiety	1	4.8	.1
$Error_b$	28	36.3	
Within subjects	32		
Tests	1	28.3	7.9**
Tests X exp-con	1	.6	.2
Tests X anxiety	1	0.0	0.0
Tests X exp-con X anxiety	1	.1	<1
$Error_w$	28	3.6	

*$p < .025$

**$p < .01$

Appendix G

Analysis of Variance:

Discomfort Level

N = 32

Source	Df	Ms	F
Total	63		
Between subjects	31		
Experimental/control	1	3,404.8	2.7
Anxiety (high/low)	1	3.8	<1
Exp-con X anxiety	1	120.9	.1
Error$_b$	28	1,266.8	
Within subjects	32		
Tests	1	53.8	.6
Test X exp-con	1	5.4	.1
Tests X anxiety	1	11.2	.1
Tests X exp-con X anxiety	1	116.8	1.4
Error$_w$	28	85.1	

Appendix H

Raw Data:

Discrimination and Discomfort Levels (in Decibels)

N = 32

		Discrimination		Discomfort	
		Pre	Post	Pre	Post
Experimental (High)					
N = 8	S_1	5.6	3.2	84.0	86.8
	S_2	8.0	5.4	71.6	77.8
	S_3	8.4	6.2	76.0	62.6
	S_4	12.0	10.8	24.6	30.0
	S_5	10.0	6.8	54.4	48.2
	S_6	17.6	14.8	103.8	107.6
	S_7	11.8	11.8	69.4	55.6
	S_8	6.4	8.6	39.0	72.6
Experimental (Low)					
N = 8	S_9	15.2	13.0	64.4	67.8
	S_{10}	5.0	5.4	23.2	31.8
	S_{11}	13.0	11.6	78.4	84.0
	S_{12}	7.4	5.0	68.6	71.4
	S_{13}	9.6	8.8	87.2	85.6
	S_{14}	6.4	3.8	57.2	17.0

Appendix H (Continued)

		Discrimination		Discomfort	
		Pre	Post	Pre	Post
	S_{15}	13.6	8.2	97.8	84.0
	S_{16}	5.2	7.6	56.2	53.2
Control (High)					
N = 8	S_{17}	4.8	4.2	81.4	79.2
	S_{18}	12.6	12.2	104.6	97.6
	S_{19}	13.4	14.6	91.8	108.8
	S_{20}	12.2	15.8	64.8	50.8
	S_{21}	15.8	8.2	49.0	22.4
	S_{22}	9.8	11.2	71.0	81.4
	S_{23}	10.0	7.0	78.8	65.2
	S_{24}	25.4	21.8	102.4	104.2
Control (Low)					
N = 8	S_{25}	14.4	10.8	100.8	101.4
	S_{26}	13.4	12.8	51.2	52.4
	S_{27}	15.4	14.2	104.8	103.4
	S_{28}	12.6	15.6	96.8	98.2
	S_{29}	12.2	14.0	110.0	110.0
	S_{30}	13.0	8.4	92.0	87.6
	S_{31}	22.0	18.0	74.2	74.0
	S_{32}	5.6	5.4	25.0	23.4

Appendix I

Raw Data:

TAS, Posttest Questionnaire and Math Scores

	TAS N = 32	Posttest Questionnaire N = 32	Math Scores N = 16
Experimental (High)			
S_1	20	17	60
S_2	30	27	91
S_3	34	21.5	74
S_4	23	19	58
S_5	18	21.5	62
S_6	20	25	94
S_7	25	22	42
S_8	24	22.5	88
Experimental (Low)			
S_9	10	17	68
S_{10}	15	20	32
S_{11}	13	27	85
S_{12}	12	17	97
S_{13}	15	24	67
S_{14}	9	11	79

Appendix I (Continued)

		TAS N = 32	Posttest Questionnaire N = 32	Math Scores N = 16
	S_{15}	14	13	83
	S_{16}	15	5	87
Control (High)				
	S_{17}	21	22	
	S_{18}	17	14.5	
	S_{19}	20	24	
	S_{20}	21	22	
	S_{21}	21	16.5	
	S_{22}	20	12	
	S_{23}	16	15	
	S_{24}	16	21	
Control (Low)				
	S_{25}	14	18	
	S_{26}	12	12	
	S_{27}	15	9	
	S_{28}	10	14.5	
	S_{29}	8	14	
	S_{30}	10	16	
	S_{31}	14	21.5	
	S_{32}	8	10	

AVOIDANCE LEARNING OF ANXIETY:

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BY

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