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THE EFFECT OF PRIOR EXPOSURE TO A HARMFUL EVENT UPON SUBSEQUENT PERFORMANCE UNDER THREAT

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NAVAL AEROSPACE MEDICAL INSTITUTE

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SUMMARY PAGE

THE PROBLEM

The magnitude of a threat of physical harm should be controlled when measuring individual susceptibility to a given threat. Earlier researchers obtained this control by explicitly delineating the parameters of the threatening situation to each subject before testing. The delineation of one such parameter, the expected severity of the threatened event (electric shock), was established by a pretest demonstration of shock, although the subsequent effects of pretest shock were never examined. The two studies to be reported here were designed to specify these effects and to determine the feasibility of using an alternative procedure.

FINDINGS

A verbal description of shock severity proved to be a valid means for establishing effective control of threat as evidenced by significant performance differences among unshocked subjects at different threat levels. The demonstration of shock appeared to reduce these differences by increasing the perceived probability of being shocked, as indicated by lower mean performance scores; however, it did not affect measures of performance decrement (i.e., threat susceptibility). The results also suggested that if the demonstration is eliminated, perceived probabilities, as reflected in mean performance scores, may be useful individual measures independent of performance decrement scores.

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The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

INTRODUCTION

Wherry, Jr., and Curran have pointed out (7) that in combat, the threat of physical harm can cause deterioration in aviator performance. They also noted that since aviators differ in their response to combat stress, it is likely that they are not equally susceptible to the threat of harm. They suggested that if, before training, some means could be found to scale these differences, the measures might be useful for predicting a student aviator's eventual success in training, or perhaps even in combat. To measure threat susceptibility in terms of performance, they developed a laboratory test in which subjects were threatened by an electric shock while performing a standard psychomotor task.

Since the purpose of the test was to measure individual susceptibility to a given threat, the test situation had to appear equally threatening to all subjects. Wherry, Jr., and Curran believed that individual threat perception could be controlled if, prior to testing, the threatened event (shock) was explicitly defined in terms of when, where, how much, and how likely it was. Initial studies tended to confirm this belief (1, 7), and subsequent research has been concerned largely with identifying parameters of threat and with specifying how best to define a given parameter so that it is effectively controlled (4, 6).

One important parameter in any threatening situation is the expected severity of the anticipated event. Since they assumed that actual experience with the event was the most effective means for defining its severity, Wherry, Jr., and Curran chose to control this parameter by demonstrating shock to each subject before the test. Although they acknowledged that exposure to shock during the test affects subsequent performance (1), they did not investigate whether a pretest demonstration might have a similar effect. Also not investigated was the possibility that the demonstration would inadvertantly reduce the effective range of the test measures, as suggested by a study (3) in which it was shown that physiological responses to the threat of shock are much smaller if the shock has already been experienced. Since individuals do differ in pain thresholds (2), it was not reasonable to expect that threat, defined by exposure to a given level of shock, would be perfectly controlled; if for no other reason, the present investigators were led to ask whether there might be some other means for defining shock severity without actually demonstrating it.

PROBABILITY STUDY

The most easily implemented alternative to a demonstration is a verbal description of the severity of shock. This procedure had never been tried because it was anticipated that subjects would not believe that they could actually be shocked if they had not experienced it beforehand. Therefore, it was first necessary to investigate whether a verbal description was an effective means for creating a believable threat situation. In the first study to be described, the probability of receiving a verbally described shock was either very high or very low, and it was expected that if the verbal description inadequately defined threat, differences in response between the two groups would be insignificant. On

the other hand, it was hypothesized that a verbal description would actually prove to be as effective as a demonstration, so that the differences between the two groups were expected to be as great, if not greater, than those obtained earlier by Wherry, Jr., and Curran, whose subjects were all shocked prior to testing.

PROCEDURE

Subjects

Twenty naval and Marine aviation training candidates were used as subjects and were randomly assigned to one of two experimental groups. An additional ten men served as controls.

Apparatus

Each subject was tested individually in a specially constructed experimental booth (5) with his arms resting on a table-top counter on which were mounted four response keys. Various visual displays (colored lights, alpha and numeric labels) were mounted behind glass panels in front of the subject. These displays were visible only when illuminated, and all illumination was controlled by a computer by means of programmed instructions. At the appropriate time in the program, shock was administered through electrodes attached to the subject's forearm via a standard Foringer shock apparatus set at "monkey" strength.

Task

A 5-minute subject-paced, four-choice discrimination task was used as the performance measure. When a color was presented in the display, the correct response was to press a response key associated with that color. Once a response was made, whether correct or not, one of the three remaining colors was immediately displayed. So that the subject might learn the correct color-key association, the response keys were color coded during the first 3 minutes of an initial learning session. Passage of time was indicated by a series of 30 lights mounted across the display. Each of these timing lights was lit for 10 seconds, one at a time, in a series starting at the left. Performance was scored as the number of correct responses minus the number of incorrect responses for each 10-second period (the duration of each timing light), and two 10-second periods were pooled to form a trial. There were 15 trials per session.

Method

After hearing taped instructions regarding the task, both the experimental and control subjects took part in a 5-minute learning session, which was followed by a 2-minute rest period. The control group was then instructed to repeat the task for an additional 5 minutes.

The experimental subjects were also instructed to repeat the task but this time they were to be pilots on a simulated combat mission. New displays (Figure 1) now became visible: a "Probability of Hit" label with an associated decimal value; "Begin Mission" over the first timing light; "Time Zero" between the 18th and 19th light; and "End Mission" over the last light. The subject was told that during this mission, his plane could sustain damage when the timing light reached Time Zero. For the ten men in one group, the probability of sustaining damage at Time Zero was displayed as .85; for the other ten, the probability of damage was .25.

After the electrodes were attached, the subject was told that damage would be simulated by an electric shock whose severity was described as follows:

> "To give you an idea of what to expect, the shock level can be described as being just within the upper limit allowed by the Navy. This means that if your aircraft is damaged at Time Zero, the shock, while it will be harmless and brief, is expected to cause a rather violent, involuntary muscle reaction."

During testing, five men of each experimental group, or a total of ten, were shocked at Time Zero.

ANALYSIS AND RESULTS

Based on the last 2 minutes of the first session (when the response keys were not color coded), a mean score per trial was calculated for each subject as a baseline (Session I) of task ability. These mean group scores for the two experimental groups and the controls are summarized in Table I. So that the test scores would be independent of task ability, each subject's baseline was subtracted from his second session trial scores, yielding 15 possible "difference" scores per subject. To remove fatigue and learning effects from these measures, the subsequent analysis was performed upon the deviation of each of these scores from the average "difference" score per trial of the unthreatened controls.

Table I

Summary of Sessions One and Two Data from the Probability Study

	Session One Baseline (Trials 10 - 15)		Session Two Deviations (Trials 6 - 9)	
Subjects	Mean	S. D.	Mean	S. D.
Control Group	19.8	2.2		
.25 Probability Group	19.5	2.4	+1.39	1.26
.85 Probability Group	18.1	2.6	-0.78	2.04

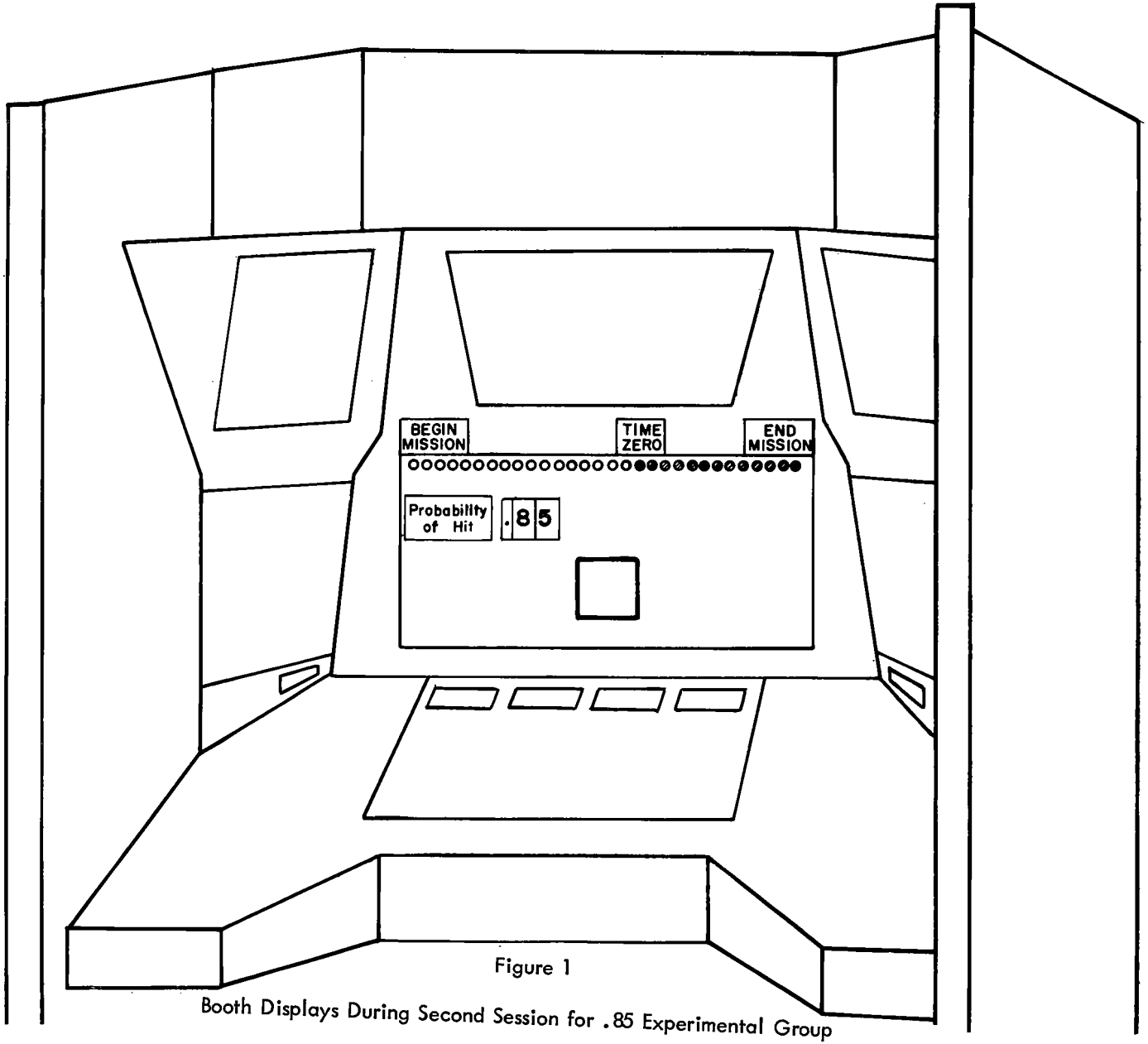

Figure 1

Booth Displays During Second Session for .85 Experimental Group

Since earlier research had indicated that the significant effects of threat occur in the trials immediately preceding Time Zero, only the last four trials before shock (Session 2, trials 6 through 9) were chosen for analysis. In Table I are listed the means and standard deviations of the experimental scores during this period. The means for each of the four trials are plotted in Figure 2. It is immediately apparent that the .85 group performed worse throughout this period than did the .25 group. A repeated-measures analysis of variance (8), summarized in Table II, indicated that although there was no significant change in performance in either group as Time Zero approached, the observed mean difference between the two groups was significant at the .05 probability level.

Table II

Summary of the Analysis of Variance Performed in the Probability Study

Source	SS	DF	MS	F	P
A (Probability)	94.61	1	94.61	7.462	< .05
Subjects within A	228.34	18	12.68		
B (Trials)	14.44	3	4.81	0.867	NS
AB	17.74	3	5.91	1.065	
Residual	299.68	54	5.55		

DISCUSSION

The difference between the two groups clearly indicates that a verbal description of shock severity does create a believable threat situation, even though the data differ considerably from those obtained by Wherry, Jr., and Curran (7). In their study significant differences in mean performance were not obtained, but rather differences in decrement as Time Zero approached. As an analogy to performance deterioration in combat, those investigators posited that performance decrement was a direct reflection of threat susceptibility and that, within certain limits, susceptibility measures should vary with changing probabilities of being harmed, or, in other words, with differing degrees of threat severity. This reasoning suggests that in the present study the limits of probability as an effective means for defining threat severity were surpassed. Without pretest shock, subjects perceived so little threat in the .25 condition that they were actually threat resistant; whereas, with the higher probability, subjects were so threatened that their performance could not reflect any further susceptibility to that threat. That these limits were not surpassed in the Wherry, Jr., and Curran study must then be attributed to the

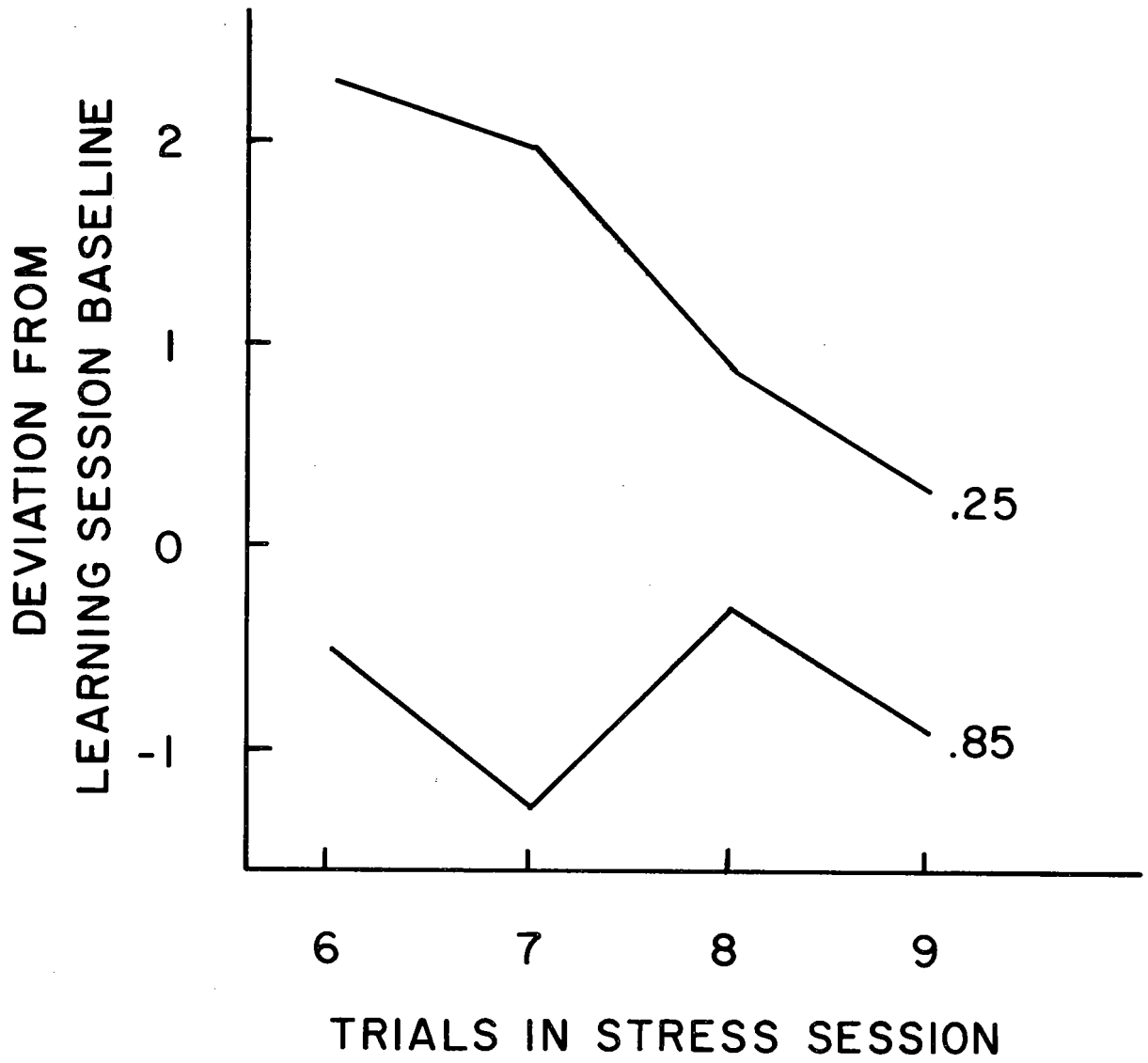

Figure 2

Mean Performance of Two Experimental Groups in Probability Study
During Four Trials Preceding Time Zero

effect of pretest shock. As suggested earlier in this report, the demonstration may either have directly suppressed performance so that real differences in performance level were obscured, or it altered the perceived probability of being harmed so that differences between probability levels were actually reduced.

DEMONSTRATION STUDY

To determine in what way the shock demonstration did affect performance, a second study was conducted to directly compare the effects of described and demonstrated pretest shock while manipulating the interval of time between shock definition and test. If a demonstration directly suppresses performance, then the longer the time between the shock and the test, the less this effect should be. On the other hand, if the perceived probability of receiving a shock is altered by the demonstration, significant differences in performance decrement (i.e., susceptibility) should occur between groups with and without the demonstration experience. The probability of being shocked was at an intermediate level so as to assure that measures of performance decrement would be obtained in all groups.

PROCEDURE

Subjects

Forty naval and marine aviation training candidates were randomly assigned to one of four experimental groups. The same control group was used as in the first study.

Apparatus, Task, and Method

The apparatus, task, and method also were the same as described in the Probability Study, with the following exceptions:

After the first session, two of the groups were told almost immediately in the instruction period, which preceded the test session, that damage was to be simulated by electric shock (Early). The other two groups were told about the shock as in the Probability Study just before the test was to begin (Late), which was 3 minutes later than in the Early groups. In one of each group of two, shock was described as in the Probability Study (No Demo), and in the other (Demo), shock was administered as an example of what might occur. All four groups were informed that the probability of being damaged was .65.

ANALYSIS AND RESULTS

"Difference" and deviation scores were calculated as before, and the four trials preceding Time Zero in the second session were again chosen for analysis. The relevant data from the first and second session for the four experimental groups and the controls are summarized in Table III. The means of the experimental scores for each of the four critical trials are plotted in Figure 3.

Table III

Summary of Sessions One and Two Data from the Demonstration Study

Subjects	Session One Baseline (Trials 10 - 15) Mean	S. D.	Session Two Deviations (Trials 6 - 9) Mean	S. D.
Control Group	19.8	2.2		
No Demo/Early Group	19.2	2.6	+0.88	1.74
No Demo/Late Group	17.9	3.3	+0.49	3.45
Demo/Early Group	19.4	2.3	-0.74	1.83
Demo/Late Group	19.1	2.4	-1.27	3.54

Figure 3 indicates that a significant decrement in performance occurred in all four experimental groups, which was confirmed by the analysis of variance summarized in Table IV. Although the graph also suggests that mean performance was affected by how and when the threat of shock was introduced, the analysis did not confirm it. Not only was the decrement similar in all four groups, but there was virtually no difference in performance level between the Early and Late subjects, although the Demo and No Demo groups did differ at a .10 probability level.

Table IV

Summary of the Analysis of Variance Performed in the Demonstration Study

Source	SS	DF	MS	F	P
A (Demo/No Demo)	114.47	1	114.47	3.190	< .10
B (Time)	8.40	1	8.40	0.234	
AB	0.18	1	0.18	0.005	
Error Between	1291.66	36	35.88		
C (Trials)	111.82	3	37.27	3.495	< .05
AC	8.55	3	2.85	0.267	
BC	9.95	3	3.32	0.311	
ABC	5.93	3	1.98	0.185	
Residual	1151.85	108	10.67		

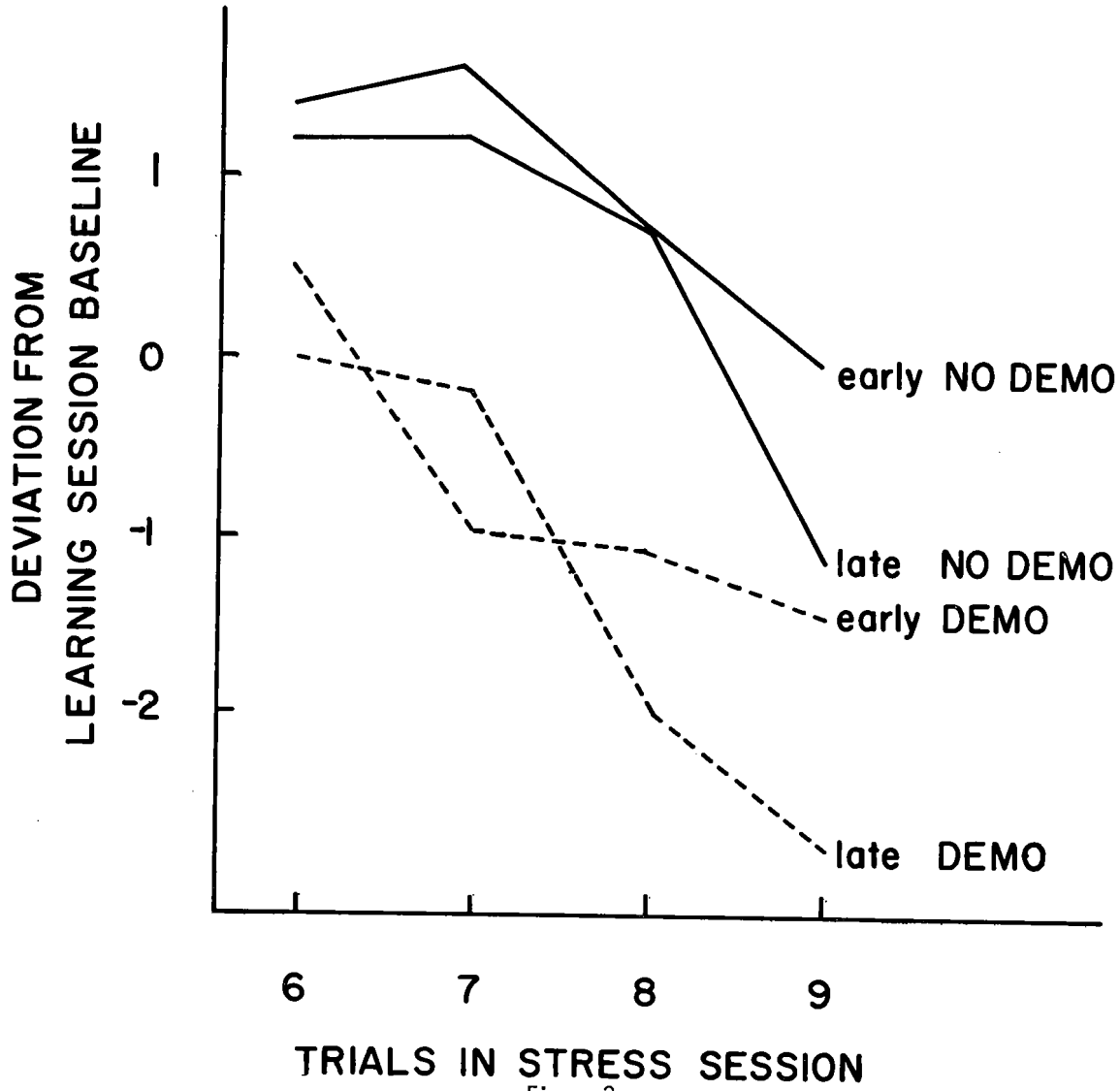

Figure 3

Mean Performance of Four Experimental Groups in Demonstration Study
During Four Trials Preceding Time Zero

DISCUSSION

Since differences in time between shock definition and test had no effect, it was apparent that the shock demonstration or description did not directly affect performance. The alternative expectation that pretest shock would increase the perceived probability of of being shocked, producing in turn measurable increases in susceptibility, was partially confirmed. The difference between the Demo and No Demo subjects suggested that shock did appear more probable to the Demo groups than to the other subjects, but it was quite surprising to obtain evidence of changes in perceived probability in terms of mean performance without corresponding variations in performance decrement. Certainly it is reasonable that susceptibility to threat might remain the same over a small range of threat severity, but previous research had not shown mean performance to be sufficiently sensitive to reflect such small effects. Since this lack of sensitivity had always occurred in connection with pretest shock, it was evident that a meaningful interpretation of performance level was now possible, at least at an intermediate level of probability, if the shock demonstration was eliminated.

If a verbal description of shock added a second measure of threat behavior to the test, it follows that such a measure could be obtained from individual as well as group performance. As long as mean performance remains independent of performance decrement, as in the present study, a two-dimensional assessment of individual threat reactivity can be made which may actually increase the relevance of the test to an aviator population. Casual observation suggests that some pilots are successful in combat because they tend to believe that the threat is less real than it actually is; in other words, they alter their perceptions of threat severity by reducing the implicit probabilities of harm, a reversal of the effect of pretest shock. If the tendency to perceptually alter probabilities could be measured apart from individual susceptibility, it might also be useful for the prediction of success in combat.

This conclusion might appear to negate the original efforts of Wherry, Jr., and Curran to hold threat perception constant so as to measure threat susceptibility alone. But it should be noted that they did not expect, nor did they obtain, independent performance measures, so that absolute control over one type of behavior was required for the assessment of the other. The results of the two studies reported here suggest that the use of a shock demonstration prior to testing may have been responsible for reducing the sensitivity of their test, but the data also make clear that an increase in sensitivity still depends upon an explicit definition of the parameters of threat, just as Wherry, Jr., and Curran first proposed. In particular, the data suggest that an optimal test of threat reactivity requires that the probability of shock be defined at an intermediate level and that the severity of shock be described verbally. In future research, investigators may find other parameters of threat that can be controlled by explicit definition so that recommendations for additional procedures may yet be forthcoming.

CONCLUSIONS

The two studies have shown that a verbal description of shock as a means for defining shock severity is sufficiently believable to be a valid alternative to a demonstration of shock. In fact, it may be a preferred procedure since it was shown to increase the range of response to various probabilities of being shocked and to allow variations in perceived probability to be measured independently of differences in susceptibility.

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13. ABSTRACT

Earlier research stressed the need for controlling magnitude of threat when measuring susceptibility to fear of harm (electric shock). Level of threat was manipulated before testing by varying the intensity of demonstrated shock and the stated probability of receiving shock at a specified point during a given experimental performance task. The present study investigated effects of 1) the stated probability at .25 versus .85 with no pretest shock demonstration and 2) pretest shock demonstration versus no demonstration with the stated probability held constant at .65. Subjects were 70 entering aviation trainees. The task was a subject-paced, four-choice discrimination task. Ten subjects were used as controls, with the remainder divided among the experimental conditions. A 5-minute practice period without threat preceded a 5-minute experimental period for all conditions. It was concluded that 1) shock demonstration is not necessary, and its elimination would provide a more useful range for individual difference measurement; 2) .65 probability is better for producing measurable performance decrement than either the lower or higher extremes of .25 and .85; 3) threat perception as measured by mean performance level across time may be as useful a parameter as performance decrement immediately preceding the anticipated harmful stimulus.

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