Does Stress Training Generalize to Novel Settings?

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Many high-stress task environments are complex and dynamic, and it is often difficult during training to anticipate the exact conditions that may be encountered in these settings. We conducted an empirical study to examine whether the positive effects of stress training that addressed one specific type of stressor and task would remain when trainees performed under a novel stressor or performed a novel task. Participants performed a laboratory task under stress conditions. Measures of task performance and self-reported stress were obtained at three performance trials: (a) prior to stress training, (b) after a stress training intervention targeted to that specific task environment, and (c) under novel stressor/task conditions. Results indicated that the beneficial effects of stress training were retained when participants performed under a novel stressor and performed a novel task. We discuss the implications of this study with regard to their application in the design of stress training and the transfer of learning to complex, dynamic task environments.

INTRODUCTION

The impact of stress on the individual is a primary concern in industry (Spettell & Liebert, 1986), the military (Driskell & Olmstead, 1989), aviation (Kanki, 1996), and other applied settings in which effective performance under stress is required. Accordingly, the development of effective training interventions to reduce the negative effects of stress on performance has taken on increased importance in the training community (see Driskell & Salas, 1991, 1996; Ivancevich, Matteson, Freedman, & Phillips, 1990).

A primary goal of stress training is to provide practice under conditions similar to those likely to be encountered in the real-world setting, but, paradoxically, it is often hard to anticipate specific to-be-encountered events in training. For example, Sagan (1993) examined accidents in high-technology industries (e.g., nuclear, space, and aviation) and noted that in these complex environments it is difficult to provide effective practice and training for potential accident scenarios that are themselves unpredictable or unanticipated. Thus, on one hand, there is the general prescription that stress training should anticipate the conditions of the operational environment. On the other hand, many real-world environments of interest are "dynamic, ambiguous, and emergent; they cannot be completely defined in advance; and they can shift dramatically and unexpectedly" (Kozlowski, 1998, p. 116). Therefore, one question that has considerable applied consequences as well as theoretical implications is the extent to which stress training generalizes to novel task conditions. The purpose of this study is to examine the extent to which the beneficial effects of stress training are maintained when trainees perform under a novel stressor and when they perform a novel task.

STRESS AND PERFORMANCE

The research on stress is somewhat ill-defined

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and amorphous, with various literatures, perspectives, and terminologies offered by those who study job stress, coping behaviors, health and well-being, stressful life events, and other topics. This state of affairs can be daunting even to the most well-intentioned reader and suggests the value of delimiting briefly what it means to examine stress and performance. According to Salas, Driskell, and Hughes (1996), *stress* is defined as a process by which certain environmental demands evoke an appraisal process in which perceived demand exceeds resources and that results in undesirable physiological, psychological, behavioral, or social outcomes. Salas et al. offered an input-process-output model of stress in which *input* refers to environmental stressors such as noise, time pressure, task load, threat, and other stressors; the *appraisal process* refers to the evaluation of the extent of demand and available resources; and the *outputs* include physiological, emotional, cognitive, social, and behavioral effects.

A sound body of literature exists on the effects of stress on performance (Cannon-Bowers & Salas, 1998; Driskell, Salas, & Johnston, 1999; Huey & Wickens, 1993). Although there are various explanations for how stress degrades performance, two major theories are that stress restricts attentional capacity (Combs & Taylor, 1952; Easterbrook, 1959) and distracts from the task (Teichner, Arees, & Reilly, 1963). Evidence indicates that the effects of stress are costly in terms of individual performance and organizational productivity, and considerable effort has been devoted to developing stress training interventions to overcome these effects.

One crucial component of stress training is the practice and exercise of tasks under operational conditions similar to those likely to be encountered in the real-world setting. Training that allows some degree of preexposure to the stress operational environment should reduce the extent of performance decrement encountered in the actual operational setting. Driskell and colleagues (Driskell & Johnston, 1998; Inzana, Driskell, Salas, & Johnston, 1996; Johnston & Cannon-Bowers, 1996) have developed and tested a stress training approach, termed *stress exposure training* (SET), that is an extension of the stress inoculation training model and adapted for applied training environments. Stress exposure training is a three-phase training intervention that includes preparatory information, skills acquisition and rehearsal, and the practice of skills under simulated stress conditions (Driskell & Johnston, 1998). This stress training approach has been shown to be an effective method to reduce anxiety and enhance performance under stress (see Saunders, Driskell, Johnston, & Salas, 1996).

One principle underlying this approach is that training must be situation-specific; that is, training must be designed to address the specific stress and task components that are likely to be encountered by the trainee. Accordingly, Johnston and Cannon-Bowers (1996) have noted the importance of designing stress training based on an analysis of the task environment. This analysis becomes the basis for the development of training content, including the specific task to be practiced and the type of stress to which trainees are exposed in training. However, many real-world environments that are of interest to the training researcher are dynamic; they involve rapidly changing conditions and a high degree of unpredictability and novelty (see Johnston, Driskell, & Salas, 1997). In fact, one discernable trend in recent research on training is a broadening of interest from tasks that are well structured to those that are dynamic and ill-defined (Gist & Stevens, 1998; Smith, Ford, & Kozlowski, 1997). Thus one current emphasis in applied training research is on transfer of learning to dynamic, complex task environments in which tasks are relatively unstructured and undefined and that involve novel and changing demands. In this type of environment, as Smith et al. (1997) noted, "The transfer environment in which work tasks are performed is rarely the same as the training environment" (p. 111).

Therefore, the dilemma is that events that are encountered in stress training may not correspond to events encountered in the operational environment. To illustrate this problem, consider that the task to be trained is an aviation task – an electrical malfunction during initial climb. Based on an analysis of the task environment, the training objective is to prepare the aircrew to respond to an electrical malfunction during initial climb under extreme time pressure. In a stress exposure training protocol, trainees first receive specific information regarding the stress environment (e.g., trainees may receive information on the effects of time pressure on task performance). Trainees are then taught skills that will allow them to maintain effective performance under stress (e.g., they may be taught how to maintain task-focused attention under time pressure). Finally, they are given the opportunity to practice the task under simulated stress conditions (e.g., they may practice attention-focusing strategies while performing the task under time pressure). However, imagine that the operational environment the aircrew faces when the trained-for event occurs is one in which time pressure is not salient but which is instead characterized by noise stress (such as high ambient noise and multiple channels of communication). A critical question is whether the positive effects of training that address one type of stressor (e.g., time pressure) generalize to a task situation involving a novel stressor (e.g., noise).

A related question is whether stress training generalizes from a trained task to a novel task. Consider again the aircrew that receives training on responding to an electrical malfunction during initial climb under time pressure. They receive training that provides (a) preparatory information, (b) skills training, and (c) practice of the task under simulated time pressure conditions. However, the emergency that occurs on a subsequent flight is not an electrical malfunction but, instead, a landing gear problem. The question here is whether the benefits gained in stress training generalize when the trainees face not Task A (the training task) but a novel task, Task B.

These questions have practical consequences for stress training in that the exact types of stress inherent in many real-world settings (e.g., the threat, noise, and time pressure present in a flight emergency) and the specific task events to be encountered are often difficult to anticipate during training. If it is tenable to assume that stress training is generalizable, then it is reasonable to pursue the development of stress training techniques or procedures that have application for a wide range of settings. Furthermore, one would assume that the positive effects of stress training that incorporates skills practice and application under a particular stressor and for a particular task may generalize to novel stressor or task conditions. However, if the skills learned in stress training are particular to the specific stressor and task environment encountered in training, what the trainee learns is not a generalizable skill but, rather, a skill that is conceptually welded to the particular set of conditions that were addressed during training. In other words, do trainees learn a specific skill in training (how to focus attention under time pressure), or do they learn a more generalizable stress-adaptive skill (how to focus attention under stress)?

Although these questions have critical implications for the design of training (see Driskell & Salas, 1991), there is little available research that has addressed this topic. Both Terris and Rahhal (1969) and Vossel and Laux (1978) found that those who performed a task in the presence of one stressor performed more effectively when exposed to a novel stressor than did those who received no stress exposure. These results suggest that stress training may generalize to novel settings; however, other results have shown negative results (Klepac, Hauge, Dowling, & McDonald, 1981). Therefore, the present study had two primary goals: The first was to determine whether stress training generalizes from stressor to stressor – that is, whether the beneficial effect of stress training is retained when trainees perform under a novel stressor. The second goal of the study was to determine whether stress training generalizes from task to task – that is, whether the beneficial effect of stress training is retained when trainees perform a novel task.

STUDY 1: GENERALIZATION FROM STRESSOR TO STRESSOR

Study 1 was designed to examine whether the benefits of stress training generalize from the stressor experienced in training to a novel stressor. Given that time pressure and noise stress are arguably two of the most heavily researched environmental stressors, we chose these two types of stress for our experimental manipulations.

Noise is unwanted sound – sound that is unpleasant, bothersome, interferes with task activity, or is perceived as being potentially harmful (Cohen & Weinstein, 1981; Kryter, 1985). Various explanations for the effects of noise on performance have been offered, centering on the notions that noise increases arousal and reduces attention and that noise masks inner speech such that people cannot hear themselves think (see Poulton, 1978). Noise stress was induced in the present study by presenting variable and continuous chatter over headphones as the participants performed the task.

Time pressure is a restriction in time required to perform a task. Researchers suggest that time pressure impairs performance because of the increased cognitive load imposed by the demand to process a given amount of information in a limited amount of time (Wright, 1974). Time pressure has been manipulated in various studies by internal means (such as increasing the pace of the task) or by external means (through the imposition of deadlines and the experimenter's exhortations to work quickly). We adopted the latter method (see Bingham & Hailey, 1989; Kelly, Jackson, & Hutson-Comeaux, 1997) by urging the participants prior to the task and at 30-s intervals to "work quickly" or "hurry up." These time pressure and noise stress manipulations have been successfully implemented by the authors in previous research (Driskell et al., 1999; Inzana et al., 1996; Johnson et al., 1997).

Study 1 was a 2 (stressor sequence: train with time pressure and test with auditory distraction vs. train with auditory distraction and test with time pressure) × 3 (trials: pretraining performance, posttraining performance, and performance with a novel stressor) design, with repeated measures on the second factor. There were three performance trials for each participant: (a) performance was assessed before training, when participants performed a task under either time pressure or noise; (b) performance was assessed after training, when participants who received noise stress training performed under noise stress and participants who received time pressure training performed under time pressure; and (c) performance was assessed under novel stressor conditions, in which the participants who received noise stress training now performed under time pressure and the participants who received time pressure training now performed under noise stress. Both performance scores and self-reported stress measures were collected at the end of each trial.

All participants received stress exposure training that included three phases: (a) preparatory information, (b) skills training, and (c) task practice with the stressor. The effect of training was assessed by comparing performance scores and subjective stress ratings after the first trial (performance prior to stress training) with scores and ratings after the second trial (directly after stress training). Note that this design was intended not to test the efficacy of the stress exposure training per se but to test whether the gains realized from pre- to posttraining were retained under the novel stressor conditions in the third testing trial.

Note that during Trial 3 the participants who were trained under conditions of time pressure were tested under noise stress and those who were trained under noise stress were tested under time pressure. Generalization of stress training was assessed by comparing the performance at Trial 2 (performance after receiving stress training and practice with Stressor A) with that at Trial 3 (performance with Stressor B). If the stress training does generalize, then we would expect that the enhancement in performance gained at Trial 2 would be maintained when participants faced a novel stressor at Trial 3. That is, we would predict no significant difference in scores from Trial 2 to Trial 3. These predictions are captured in the following hypotheses:

Hypothesis 1. We predict that performance on Trial 1 < Trial 2 = Trial 3. That is, we predict that performance accuracy will increase from Trial 1 to Trial 2 and that this performance gain will be sustained from Trial 2 to Trial 3.

Hypothesis 2. We predict that self-reported stress on Trial 1 > Trial 2 = Trial 3. That is, we predict that self-reported stress will decrease from Trial 1 to Trial 2 and that the reduction in subjective stress will be sustained from Trial 2 to Trial 3.

We make no specific predictions regarding the effects of stressor sequence (training with time pressure and testing with auditory distraction vs. training with auditory distraction and testing with time pressure). That is, we have no theoretical basis to predict whether training will generalize more readily from noise to time pressure conditions or from time pressure to noise conditions.

Method

Participants. Participants in this study were 79 U.S. Navy technical school trainees (41 women and 38 men) between the ages of 18 and 30 years who volunteered to take part in a study on decision making.

Procedure. The participants arrived at the experimental laboratory and were seated in front of a video monitor. The study consisted of three phases, each lasting approximately 25 min. In the first phase of the study, all participants were given initial training and practice in performing a computer-based task. Following the initial task training, participants performed the task under conditions of either auditory distraction or time pressure. Time pressure was induced by the experimenters verbally urging the participants to hurry. These urges were administered at the onset of task performance and every 30 s thereafter. Auditory distraction was delivered via an audiotape that was played over the participants' headphones. The tape was composed of a variety of types of continuous conversations and chatter. Task performance scores were recorded (Trial 1), and participants completed an experimental questionnaire containing a subjective stress scale.

In Phase 2, participants received a brief stress exposure training (SET) intervention. The intervention consisted of three stages: (a) preparatory information, (b) skills training, and (c) application and practice. Those participants who performed the task in Phase 1 under noise stress received information on noise stress, were given information on how to maintain task-focused attention under noise stress, and practiced performing the task under noise stress. Those participants who performed the task in Phase 1 under time pressure received information on time pressure, were given information on how to maintain task-focused attention under time pressure, and practiced performing the task under time pressure. Following this training intervention, participants performed the task again under the stressor conditions for which they were trained. That is, the SET-noise trained participants performed the task under noise stress and the SET-time pressure trained participants performed the task under time pressure. Task performance scores were recorded (Trial 2), and participants again completed the experimental questionnaire.

In Phase 3, all participants performed the task under a novel stressor. Thus participants who had received the SET-time pressure training performed the task under noise stress and participants who had received the SET-noise training performed the task under time pressure. Performance scores were again recorded (Trial 3), and the questionnaire was completed.

Stress exposure training intervention. The training intervention consisted of three phases: preparatory information, skills training, and application and practice. In the preparatory information phase, participants were given (a) descriptive information on the type of stressor that they would encounter in performing the task, (b) sensory information on typical physical and emotional reactions they were likely to feel when under stress, and (c) procedural information on how stress may affect task performance. For example, those who received SET-noise training were given information on the types of noise they would encounter and how it would be presented, were told how noise can lead to frustration and distraction, and were told that noise can lead to increased errors because task performers have to allocate attention to the noise and the task. Those who received SET-time pressure training received similar information regarding time pressure. In a recent study, Inzana et al. (1996) found preparatory information to be effective in reducing anxiety and enhancing performance under stress.

The purpose of the second phase of training, skills training, was to teach skills to counter the negative effects of stress. We implemented a brief attentional training intervention (see Singer, Cauraugh, Murphey, Chen, & Lidor, 1991) that focused on three points: (a) stress can be distracting; (b) to counter the distraction, individuals should selectively attend to task-relevant stimuli; and (c) the key to effective performance is to ignore distracting stimuli and maintain focus on the task. For the SET-noise training, we described how noise can be distracting and discussed the importance of ignoring noise stimuli. For the SET-time pressure training, we described how time pressure can be distracting and discussed the importance of ignoring time pressure stimuli.

In the third phase of training, participants applied these skills while performing the task. Participants first practiced the task under either noise stress or time pressure for 30 s. The experimenter then discussed with each participant whether he or she was able to apply the skills learned and reemphasized the key points presented in training. Participants again practiced the task under stress for a 30-s period, after which the experimenter again discussed application of skills and key training points. Participants then performed the task for 3 min, again followed by refresher training.

Experimental tasks. Two standard computer-based experimental tasks were used in this study. In the spatial orientation task, participants viewed a series of histograms or four-bar graphs, presented in sets of two. Each pair of bar graphs included a target graph and a comparison graph that was rotated to a 90° or 270° orientation. The participant's task was to determine whether the second graph in each set of two was identical to the first. This task is a version of the Fitts Histograph task (Fitts, Weinstein, Rappaport, Anderson, & Leonard, 1952).

In the memory search task, participants viewed a target or memory set of four alphabet letters. After the memory set was removed a single letter was displayed, and the participant's task was to decide whether that letter belonged to the memory set. This task is a version of the Sternberg (1969) memory search task.

Note that in Study 2 we will examine generalization from task to task but that task type is not pertinent to the Study 1 predictions. Although we used these two types of laboratory tasks in Study 1 to increase generalizability, there were no significant or meaningful main effects or interactions for type of task. Therefore, for simplicity, we collapsed across this factor in the Study 1 analysis.

Measures. The two primary dependent variables were accuracy of performance and self-reported stress. The measure of performance accuracy, provided by the self-scoring computer tasks, was the percentage correct over the 3-min performance period. Self-reported stress was assessed via a 6-point scale designed to measure perceived anxiety (with 6 representing *high stress* and 1 representing *low stress*) that was presented in the experimental questionnaire.

Results

The mean scores and standard deviations for performance accuracy and self-reported stress are shown in Table 1. The columns in Table 1 represent the specific test conditions; for example, the participants who were tested at Trial 1 under Stressor 1 (e.g., noise stress) were also tested at Trial 2 under Stressor 1 (e.g., noise stress) and then tested at Trial 3 under a novel stressor, Stressor 2 (e.g., time pressure).

For each of the measures reported, an a priori theoretical test (Kirk, 1982) was conducted. These a priori tests are F tests on one degree of freedom in the numerator where the relevant means are weighted by orthogonal polynomial contrast weights. These weights must sum to zero and capture the theoretically predicted variation across predictions. Specifically, in the following a priori tests, the mean of Trial 1 is weighted +2, the mean of Trial 2 is weighted –1, and the mean of Trial 3 is weighted –1.

Accuracy. The F testing the overall pattern of results for performance accuracy (that Trial 1 < Trial 2 = Trial 3) was significant, $F(1, 154) = 59.48$, $p < .001$, indicating that Hypothesis 1 was supported. Thus the improvement in performance realized from pre- to posttraining was sustained when participants performed under a novel stressor at Trial 3.

There was no significant main effect of stressor sequence, $F(1, 77) = 0.78$, $p > .1$, nor was there a significant interaction, $p > .1$. Thus the data indicate that the performance effects did not depend on the sequence in which the stressors were presented.

Self-reported stress. An F test of the overall pattern of results for self-reported stress (that

TABLE 1: Generalization of Training from Stressor to Stressor

		Test Conditions		
Measure	*n*	Trial 1: Stressor 1	Trial 2: Stressor 1	Trial3: Stressor 2
		Noise Stress-Time Pressure		
Performance accuracy	41			
M		80.18	94.33	93.21
SD		25.91	8.17	8.28
Self-reported stress	41			
M		2.60	2.27	2.7
SD		0.95	0.92	1.08
		Time Pressure-Noise Stress		
Performance accuracy	38			
M		77.69	90.59	93.27
SD		18.24	10.02	8.76
Self-reported stress	38			
M		3.13	2.79	2.44
SD		0.99	0.94	0.95

Trial 1 > Trial 2 = Trial 3) indicates that Hypothesis 2 was supported, $F(1, 154) = 10.89$, $p < .001$. That is, the reduction in subjective stress that was realized from pre- to posttraining was sustained when participants performed under a novel stressor at Trial 3.

Again, there was no significant main effect of stressor sequence, $F(1, 77) = 2.11$, $p > .1$. However, the analysis revealed a significant Trials × Stressor Sequence interaction, $F(2, 154) = 8.92$, $p < .1$, indicating that stress training generalized more readily when the sequence of training was from time pressure to noise stress than when the sequence was from noise stress to time pressure. Thus the pattern of results for those who were trained under time pressure and tested under noise stress suggests that the reduction in self-reported stress was maintained when a novel stressor was introduced. The pattern of results for the noise stress-time pressure sequence does not support this claim.

STUDY 2: GENERALIZATION FROM TASK TO TASK

Study 2 was similar in design to Study 1. However, Study 2 was undertaken in order to test the generalizability of stress training from one *task* to another. Considerable effort has been devoted to defining the universe of human abilities (see Fleishman & Quaintance, 1984). Two types of abilities that are consistently distinguished across most major taxonomic efforts (see Dunnette, 1973; Hogan, Broach, & Salas, 1987; Peterson & Bownas, 1982) are spatial orientation and memory. *Spatial orientation* refers to the ability to perceive spatial patterns or maintain orientation with respect to objects in space. *Memory* refers to the ability to recall previously presented information. Therefore, for the purposes of this study, we chose marker tasks of these two distinct abilities. The Fitts Histograph task and the Sternberg memory search task were previously described in Study 1.

Study 2 was a 2 (task sequence: train with memory task and test with spatial task vs. train with spatial task and test with memory task) × 3 (trials: pretraining performance, posttraining performance, and performance with a novel task) design, with repeated measures on the second factor. There were three performance trials for each participant: (a) performance was assessed before training, when participants performed either Task A or Task B under stress; (b), performance was assessed after training, when participants who received stress training and practice for Task A then performed Task A under stress and those who received stress training and practice for Task B then performed Task B under stress; and (c) performance was assessed under novel task conditions, in which the participants who received stress training for Task A now performed Task B under stress and those who received stress training for Task B now performed Task A under stress. Both performance scores and self-reported stress measures were collected at the end of each trial.

Predictions were similar to those of Study 1. The primary focus of Study 2 was whether the benefits of training would generalize from the trained task to a novel task. Recall that during Trial 3, the participants who received stress training for Task A performed Task B and those who received stress training for Task B performed Task A. Generalization of stress training can be assessed by comparing the performance at Trial 2 (performance after receiving stress training and practice with Task A) with that at Trial 3 (performance with Task B). If the stress training does generalize, then we would expect that the enhancement in performance gained at Trial 2 would be maintained when participants faced a novel task at Trial 3. That is, we would predict no significant difference in scores from Trial 2 to Trial 3.

Hypothesis 1. We predict that performance in Trial 1 < Trial 2 = Trial 3. That is, we predict that performance accuracy will increase from Trial 1 to Trial 2 and that this performance gain will be sustained from Trial 2 to Trial 3.

Hypothesis 2. We predict that self-reported stress in Trial 1 > Trial 2 = Trial 3. That is, we predict that self-reported stress will decrease from Trial 1 to Trial 2 and that the reduction in subjective stress will be sustained from Trial 2 to Trial 3.

We make no specific predictions regarding the effect of task sequence (training with a memory task and testing with a spatial task vs. training with a spatial task and testing with a memory task) on the effectiveness or generalizability of the SET intervention.

Method

Participants. Participants in this study were 83 U.S. Navy technical school trainees (38 women and 45 men) who volunteered to take part in a study on decision making. Participants were drawn from the same student population as those in Study 1.

Procedure. The procedure for Study 2 was similar to that for Study 1. In Phase 1 of the study, participants were provided initial training on both the memory task and the spatial orientation task. Following the initial task training, participants performed either the memory task or the spatial orientation task under stress conditions. Task scores and questionnaire responses were collected.

For purposes of generalizability, half of the participants in Study 2 performed under time pressure and half of the participants performed under noise stress. The results indicated no significant or meaningful main effects or interactions for type of stressor. Given that type of stressor was not pertinent to the Study 2 predictions, we collapsed across this factor in the analysis.

In Phase 2, participants received the SET intervention, consisting of three stages: (a) preparatory information, (b) skills training, and (c) practice. Those participants who performed the memory task in Phase 1 were trained on the memory task during the SET intervention. Those participants who performed the spatial orientation task in Phase 1 were trained on the spatial orientation task during the SET intervention. Following this training intervention, participants performed the same task for which they had been trained. Task performance scores and questionnaire responses were recorded.

In Phase 3, all participants performed a novel task under stress: Participants who received training with the memory task performed the spatial orientation task, and participants who received training with the spatial orientation task performed the memory task. Performance scores were again recorded, and the questionnaire was completed.

Stress exposure training intervention. Participants received the same three-phase SET intervention as in Study 1. In the initial phase, participants received preparatory information regarding the stress conditions they would encounter. The second phase of training consisted of an attentional training intervention in which participants were taught to ignore distracting stimuli and maintain attentional focus on the task. In the third phase of training, participants practiced applying these skills while performing either the memory search or spatial orientation task.

Experimental tasks. The spatial orientation and memory tasks were as described in the Study 1 section.

Measures. The primary dependent variables, performance accuracy and self-reported stress, were identical for Studies 1 and 2.

Results

The mean scores and standard deviations for performance accuracy and self-reported stress are shown in Table 2. The columns in Table 2 represent the specific test conditions; for example, the participants who were tested at Trial 1 on Task 1 (e.g., memory search) were also tested at Trial 2 on Task 1 (e.g., memory search) and then tested at Trial 3 on a novel task, Task 2 (e.g., spatial orientation). The overall analytic strategy reported is similar to that described in Study 1.

Accuracy. An F test of the overall pattern of results for performance (that Trial 1 < Trial 2 = Trial 3) indicates that Hypothesis 1 was supported, $F(1, 162) = 41.57$, $p < .001$. Thus the improvement in performance realized from pre- to posttraining was sustained when participants performed a novel task at Trial 3. There was no significant main effect of task sequence, $F(1, 81) = 3.51$, $p > .05$, nor was there a significant interaction, $p > .1$.

Self-reported stress. An F test of the overall pattern of results for self-reported stress (that Trial 1 > Trial 2 = Trial 3) indicates that Hypothesis 2 was supported, $F(1, 162) = 16.12$, $p < .001$. That is, the reduction in subjective stress that was realized from pre- to posttraining was sustained when participants performed a novel task at Trial 3. Again, there was no significant main effect of task sequence, $F(1, 81) = 3.79$, $p > .05$, or significant interaction, $p > .1$. Although we found no significant effect of task sequence, Table 2 shows that the spatial orientation-memory search sequence is more clearly supportive of the predicted 1 > 2 = 3 ordering than is the memory search-spatial orientation sequence.

DISCUSSION

The purpose of this study was to examine the extent to which stress training generalizes to novel stressors and novel tasks. The results indicated that the beneficial effects of stress

TABLE 2: Generalization of Training from Task to Task

		Test Conditions		
Measure	*n*	Trial 1: Task 1	Trial 2: Task 1	Trial3: Task 2
		Memory Search-Spatial Orientation		
Performance accuracy	42			
M		81.49	92.91	89.68
SD		23.06	6.42	8.49
Self-reported stress	42			
M		3.22	2.67	2.92
SD		0.61	1.06	1.08
		Spatial Orientation-Memory Search		
Performance accuracy	41			
M		86.77	92.72	94.84
SD		8.05	6.67	5.62
Self-reported stress	41			
M		2.80	2.47	2.50
SD		0.95	0.95	1.15

training on performance were maintained when participants performed under a novel stressor and when they performed a novel task. The results for self-reported stress, although supportive, were not as unequivocal: Under some circumstances, the observed reduction in self-reported stress was clearly maintained under novel stress and task conditions, and in other cases these results were more ambiguous. Nevertheless, the overall pattern of results obtained is compelling and strongly supports the predictions.

In discussing the results of this study, it may be prudent to rephrase the question originally posed at the beginning, "Does stress training generalize to novel settings?" as a more appropriate question: "Can stress training generalize to novel settings?" Our results indicate that under certain conditions, the positive gains from stress training can indeed generalize to novel settings. In the remainder of this paper we discuss how we account for the positive transfer of stress exposure training to novel environments and examine some limitations of this study.

Stress exposure training is an integrated approach to stress training that includes three phases: (a) preparatory information, (b) skills training, and (c) application and practice. The objective of the initial phase of training is to provide information on the nature of the stress environment and on stress effects. The preparatory information presented in this study described the stressors that would be encountered in the task situation, provided information on how these stressors may make the participants feel, and provided information on how these stressors may affect performance. In the second phase of stress exposure training, trainees acquire stress management skills to enhance the capability to respond effectively in the stress environment. The attentional training intervention presented in the present study focused on training participants to disregard irrelevant off-task stimuli that draw attentional resources from the task (Kanfer & Ackerman, 1989). The final phase of training provides the opportunity to practice and apply these skills in a setting that approximates the operational environment.

How do we account for the generalizability of stress training results demonstrated in this study? The classic view of transfer is that transfer occurs to the extent that there are identical elements in the training and transfer environments (Thorndike & Woodworth, 1901). However, in considering the extent to which training and transfer environments are similar, it is useful to distinguish between structural features and surface features of these environments (see Gick & Holyoak, 1987; Halpern, 1998). *Structural features* of training refer to the underlying principles imparted in training. *Surface features* refer to domain-specific characteristics such as the specific training examples used and the specific attributes of training content. In general, we would expect skills learned in training to transfer to a novel environment if the structural features of training – the principles or associations learned – are relevant to both environments, even if the surface features of the two settings differ.

If the structural features of the training and transfer environment are similar, then the relationships among variables that hold in one context should hold in other contexts. The SET intervention presented in this study was designed to focus on the structural features underlying the effect of stress on task performance. We adopted a distraction/overload perspective on stress effects (Baron, 1986), arguing that acute stress is distracting and leads to attentional conflict as the task performer allocates limited attentional resources between the task and the stress stimuli. To maintain effective performance, the task performer must focus attention on task-relevant stimuli and restrict attention to stimuli that are less task relevant. Therefore, the structural components of the stress-task performance relationship that were emphasized in training were that (a) stress distracts and results in attentional conflict and (b) task-relevant cognitions improve performance.

The surface components of the SET intervention that differed were that in one instance the manifestation of stress was noise stress and in the other it was time pressure. The surface features of these two manipulations differed such that in the noise stress-SET intervention the content and practice centered on noise, and in the time pressure-SET intervention the content and practice centered on time pressure. However, these stressors are similar to the extent that they both distract from task-relevant cognitions and result in attentional conflict. Likewise, the surface features of the memory task and the spatial orientation task differ in that they tap different abilities, and yet they share the structural feature that task-relevant cognitions (time-on-task) enhances performance. Therefore, although the surface features of the training and the transfer environments were different, it is likely that the stress training resulted in positive transfer to novel settings because the underlying principles presented in training were structurally consistent with the transfer environment.

Several limitations of this study are implied in the foregoing discussion. First, not all types of stressors are distractors. Salas et al. (1996) noted that some types of acute stressors, such as noise and time pressure, increase arousal and some types, such as fatigue, decrease arousal. Therefore, not all types of stress operate through a similar process, and to the extent that a particular stressor does not affect performance by distracting attentional focus and increasing cognitive load, a training intervention that has this structural process as its basis is not likely to promote positive transfer.

A second caveat relates to the types of tasks used in this study. In examining generalization of training to novel settings, it is useful to consider *near transfer* (transfer of training to similar settings) and *far transfer* (transfer to dissimilar settings). The memory search task and the spatial orientation task represent two distinct types of abilities (Fleishman & Quaintance, 1984). However, these tasks are similar in that they are both primarily cognitive tasks. Other sets of tasks are more dissimilar, such as a memory task and a physical task. Moreover, performance of some types of tasks, such as a primarily physical task, may be less determined by attentional processes and more dependent on endurance and other factors. Whether the positive results shown in this study would hold for different types of tasks that involve a greater degree of transfer is unknown. Further, the question of whether the results would hold for nonlaboratory tasks in which performance spans a longer time frame deserves further study.

Finally, the pretest/posttest design employed in this study did not allow us to test the efficacy of the SET intervention. That is, factors independent of the training, such as mere exposure, could also account for the gains observed from pretraining to posttraining (Campbell & Stanley, 1963). The primary purpose of this study was not to test a specific training intervention but to examine whether gains realized in training are retained in novel stress conditions and in novel task conditions. Further, one alternative explanation for the observed results is that learning occurred over the repeated trials, in which case the expected increment in performance in Trial 3 may have been offset by a decrement from facing a novel stressor or task, resulting in the observed pattern of results. This possibility should be examined in further research.

The ultimate goal of stress training is to transfer learned skills to the real-world or operational environment. Because many task environments of interest to the applied researcher are characterized by a high degree of uncertainty and unpredictability, it is difficult to anticipate the exact nature of the transfer environment during training. Therefore, one question that has considerable theoretical and applied import is whether the skills taught in stress training are domain specific or whether they transfer to novel stressor and task settings that differ from the exact conditions of the training environment. The present study suggests that by designing stress training to focus on the structural similarities in the training and transfer environments, skills learned can be generalized to novel settings.

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