DOCUMENT RESUME

ED 347 184 TM 018 634

AUTHOR Backer, Patricia Ryaby; Orasanu, Judith M.
TITLE Stress and Performance Training: A Review of the Literature with Respect to Military Applications.
PUB DATE Apr 92
NOTE 38p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 20-24, 1992).
PUB TYPE Information Analyses (070) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Adjustment (to Environment); Adults; *Coping; Evaluation Methods; Job Performance; *Job Skills; *Job Training; Literature Reviews; *Military Personnel; Occupational Tests; *Stress Management; Stress Variables
IDENTIFIERS Cockpit Resource Management

ABSTRACT

A previous review of the effects of stressors on military performance shows that different stressors have different effects, the effects of stress vary with the type of skill being measured, the presence of certain stressors leads to decrements in performance, and incident-related stress accompanying these stressors can further impair performance. In addition, significant variations exist in the effects of stress on different individuals. This paper summarizes some of the effects by stressor. Physical, environmental, psychological, and social factors of stressors are discussed. Three approaches to training people to perform under stressful conditions are described. The first approach involves focusing on the stress itself and assumes that if individuals can be taught to manage the stress, their performance will improve. The second approach assumes that stress is the inevitable result of exposure to stressors and that the focus should be on skill training. If individuals can achieve automaticity on certain tasks, stress will impair performance less. The third approach is the Cockpit Resource Management approach in which participants are taught effective interpersonal skills to deal with any potential stressor. Results show that these approaches can improve the performance of individuals and crews. However, most of the evaluative measures did not assess task performance, rather they assessed affective or physiological indicators of individual stress. There is a 167-it m list of references. (SLD)

Stress and Performance Training: A review of the literature with respect to military applications

Patricia Ryaby Backer

San Jose State University

and

Judith M. Orasanu

NASA-Ames Research Center

Paper presented at the American Educational Research Association annual meeting, San Francisco, CA

April 23, 1992

Abstract

Military training aims to prepare personnel to perform under high stress, high risk conditions. In order to design training programs to enhance performance under these conditions, it is necessary to understand the effects of stressors on various types of performance. While a large literature exists on stress effects, not all of it is relevant to training and performance. Often, effects of stressors are measured through self-report or physiological indicators rather than by e\‿umining the effects on performance. Unfortunately, the correlations among the three types of measures is far from perfect. A review of the literature on the effects of stressors on miliary-relevant performance by Backer and Orasanu (1992) found that (a) different stressors have different effects, (b) the effects of stress vary depending upon the type of skill being measured, c) that the presence of certain stressors leads to decrements in performance, and d) that the incident-related stress which accompanies these stressors can further impair performance. In addition, there seems to be significant variations in the effects of stress on different individuals. The focus of the Backer and Orasanu review was cognitively complex skills rather than basic cognitive processes (such as tone discrimination or reaction time) or psychomotor skills. While large holes exist in the literature, certain effects are robust. This paper will summarize some of those effects by stressor and describe three approaches to training people to perform under stressful conditions. The first involves focusing exclusively on the stress itself, with the assumption being that if individuals can be taught to manage that stress effectively, performance will improve. The second approach assumes that stress is the inevitable result of exposure to stressors and that the focus should be on skill training. If individuals can achieve automaticity on certain tasks, stress will impair performance considerably less. A third approach is seen in the Cockpit Resource Management approach in which the participants are taught effective interpersonal skills in order to deal with any potential stressor. Results of this review indicate that each of these three methods of reducing stress can cause improvements in the performance of individuals and crews. However, in each of these three strategies, most of the measures involved were not of task performance, but were affective or physiological indicators of individual stress. Therefore, much research still needs to be done evaluating each of these techniques utilizing realistic tasks.

Stress and Performance Training: A review of the literature with respect to military applications

Patricia Ryaby Backer

San Jose State University

and

Judith M. Orasanu

NASA-Ames Research Center

Military training aims to prepare personnel to perform under high stress, high risk conditions. In order to design training programs to enhance performance under these conditions, it is necessary to understand the effects of stressors on various types of performance. While a large literature exists on stress effects, not all of it is relevant to training and performance. Often, effects of stressors are measured through self-report or physiological indicators rather than by examining the effects on performance. Unfortunately, the correlations among the three types of measures is far from perfect. A review of the literature on the effects of stressors on miliary-relevant performance by Backer and Orasanu (1992) found that (a) different stressors have different effects, and (b) the effects vary depending upon the type of skill being measured. The focus of the Backer and Orasanu review was cognitively complex skills rather than basic cognitive processes (such as tone discrimination or reaction time) or psychomotor skills. While large holes exist in the literature, certain effects are robust. This paper will summarize some of those effects and describe three approaches to training people to perform under stressful conditions. The limits of the research base for such training will be addressed.

The first issue that must be addressed is the definition of **stress**. Every researcher in the field appears to have a particular definition of stress that reflects the author's orientation or purpose. For example, Selye (1973, 1977) saw the "nonspecificity" of a response pattern as the essence of stress, with the overall process characterized by alarm, resistance, and exhaustion. Selye's paradigm provides a causal basis for the development of various illnesses. In contrast, Lazarus and Monat (1977) divide stress into three types: physiological, psychological, and social. Instead of regarding stress simply as a response to a stimulus, they relate stress to the concept of coping and suggest that the degree to which an event is stressful depends on a complex interaction of factors. McGrath (1970) defines stress as "a substantial imbalance between demand and response capability, under conditions where failure to meet demand has important consequences" (p.20).

Stress also has been defined in term of the "person-environment fit" (Campbell, 1974; Caplan, 1972; French & Kahn, 1962; French, Rogers, & Cobb, 1974). Under this conceptualization of stress, Harrison (1978, p. 178) indicates that a

> job is stressful to the extent that it does not provide supplies to meet the individual's motives and to the extent that the abilities of the individual fall below demands of the job which are prerequisite to receiving supplies.

In general, many researchers conceptualize stress as an <u>intervening</u> variable that occurs sometime after the presentation of an environmental stimulus and either before, during, or after, an organism's response. Such a conceptualization makes clear the difficulty involved in pinpointing the nature and extent of stress in a particular situation. It also may explain why, although a small amount of research actually attempts to control for, manipulate, and measure stress, the great majority of studies focus exclusively on a stimulus-response process and examine stress only superficially, if at all. Measuring stress is seen as less relevant than examining the relation between <u>stressors</u> and their various effects.

Variables are not considered stressors unless they produce (1) a decrement in performance, (2) a self-report of stress by the subject, or (3) physiological change. At moderate levels, these same variables may in fact enhance performance by increasing alertness, arousal, or motivation (Poulton, 1976; Smart & Vertinsky, 1977; Streufert & Streufert, 1981a, Streufert, Streufert, & Gorson, 1981; West & Parker, 1975). In addition, performance decrements observed under stressor conditions may be reduced through stress training (Schuler, Gilner, Austrian, & Davenport, 1982), performance training (Jenson & Adrion, 1988), or other interventions that render the stressor ineffective (Freeh, 1988). Finally, effects of stressors vary across individuals, often reflecting the interpretation of events or situations by the subject, in addition to any learning effects or differential sensitivities (Streufert, Streufert, & Denson, 1982; Gaume & White, 1975).

Backer and Orasanu (1992) reviewed research on stressors that affect complex cognitive performance relevant to the military. Studies have examined a large number of different stressors that can be divided into three major categories. **Physical and environmental factors** include sleep deprivation/fatigue, noise, temperature, and altitude. **Psychological factors** include combat stress, danger/threat, information load and control, workload, and time pressure. And, **social factors** include cohesion, family stress, and individual/group interactions.

Stressors

Physical Factors

Fatigue

One of the most researched stressor is fatigue and its variants (Sustained Operations--SUSOPS, Continuous operations--CONOPS, and sleep deprivation). Mackie, Wylie, and Evans (in press) completed a review of over 500 articles on the effect of fatigue and/or sleep deprivation on the performance of military personnel. Overall, they identified the following general problems with the existing research: performance tests were too short and infrequently administered, administration of the performance tests was displaced from the fatiguing events, results of performance tests can not be applied to operational tasks in the military, and relatively few studies have involved continuous work on complex tasks. Because of the methodological problems with many of the studies that Mackie et al reviewed, they could not offer any generalized findings from the sleep deprivation literature.

Because of the intent of our research, our review addresses two specific research areas in the field of fatigue: the effect of sleep deprivation on performance and the effect of continuous or sustained operations on performance. We differentiate sleep deprivation from CONOPS and SUSOPS: In sleep deprivation, the subject is not required to perform a continuous task(s) during the period of sleep deprivation. In CONOPS and SUSOPS, the subject is both sleep deprived and fatigued from performing a task over a long period of time. Effects of sleep deprivation appear to depend upon the type of task (more interesting tasks are more resilient to sleep deprivation, Wilkinson, 1964, 1965), the length of rest preceding sleep deprivation (Rutenfranz, Aschoff, & Mann, 1972), and the circadian rhythms of subjects (see Winget, DeRoshia, Markley, & Holley, 1984 for review). Also, research indicates that decrements in performance due to sleep deprivation occur sooner (as early as 24 hours) than previously reported (Williams et al, 1959; Wilkinson, 1971).

For this paper, Continuous land operations (CONOPS) refers to continuous combat situations and work tasks with short periods of rest. Sustained operations (SUSOPS) "is used when the same soldiers and small units engage in continuous operations with no opportunity for the unit to stand down and very little opportunity for soldiers to catch more than a few minutes of sleep" (Department of the Army, 1983, p. 1-2). Belenky, Balkin, Krueger, Headley, and Solick (1986, 1987), among others (Dewulf, 1978; Siegel, Pfeiffer, Kopstein, Wilson, & Ozkaptan, 1979; Siegel, Pfeiffer, Kopstein, Wolf, & Ozkaptan, 1980), have completed reviews of the effects of continuous operations on soldier and unit performance. Their findings indicate the following effects of fatigue: tasks which primarily require physical performance are relatively immune to sleep loss; there is a positive correlation between the length of a task and its sensitivity to sleep loss; the more cognitively demanding a task, the greater is its sensitivity to sleep loss; and workload interacts with sleep deprivation, producing more severe effects. With continuous work, degradation in cognitive performance can be seen as early as 18 hours into a SUSOP, and after 48-72 hours without sleep, soldiers become militarily ineffective.

Of the studies discussed in these reviews and in the literature, there are few that included performance measures similar to actual military tasks. For this paper, we will discuss some individual studies on sleep deprivation that have direct implications for military training and performance under stress.

Drucker, Canon, and Ware (1969) and Haggard (1970) tested 142 enlisted men under nearly continuous work conditions of 48 hours duration. They found that sleep-deprived subjects performed significantly worse than control subjects on a driving task (continuously tracking a winding road on a driving simulator); and that the decrements in performance were much larger during the second night than during the first. Ainsworth and Bishop (1971) duplicated this study in a field setting with 120 men. They found that the fatigued group exhibited little performance decrement in communication, gunnery, and maintenance exercises, and in two driving exercises (ditch driving and minefield). The performance of the fatigued group was significantly worse than that of the rested group only in moving surveillance and in two heavy workload driving exercises (slalom-type driving and log obstacle). They concluded that activities that demanded a high level of alertness or complex perceptual motor activity were the most sensitive to the adverse effects of sleep loss. Successful performance of skills not as cognitively demanding persisted longer, implying these tasks were performed with automaticity.

Experience may interact with the performance of subjects under conditions of sleep deprivation. Rogum and colleagues (1986) studied 24 Norwegian military cadets during a period of heavy, sustained work lasting for 107 hours, during which time they had less than 2 hours of sleep. After one day of sustained activity, all subjects were judged to be ineffective as soldiers and showed severe decrements in performance on simulated military tasks.

Of particular interest in sleep deprivation is the series of studies completed by Haslam and colleagues on soldiers in continuous operations. Haslam (1981) tested three platoons consisting of 68 soldiers over a nine-day period on vigilance, shooting, grouping capacity (which required the subject to fire five rounds of shots into as small an area as possible), weapons handling, and cognitive memory tests. For the majority of the cognitive tests, she found a rapid deterioration in performance over the first four days of sleep deprivation; tasks with a mainly physical content suffered the least, and those with a cognitive and vigilance component suffered most, deteriorating to about 50% of control values. She verified these results in later studies (Haslam, 1982, 1985). These studies were followed by another series of trials conducted by Rejman and Green (reported in Allnutt, Haslam, Rejman, & Green, 1990) under military scenarios. Five three-man crews, consisting of experienced non-commissioned officers, were used as subjects on a 3 day/2 night scenario of 65 hours continuous operation. The simulation facility consisted of a distributed microprocessor system containing a fully interactive Ground Control Station in which the crew could plan and execute target acquisition and intelligence-gathering missions realistically. Each tasks was given one of three priorities (P1, P2, P3), and the team was told that the higher priority tasks should take precedence.

They found that the total mean number of tasks accomplished per hour remained relatively constant. However, as related to the three priorities, the performance levels were clearly separated. At the beginning, the crews adhered to the priority scheme. With increased sleep deprivation, performance of medium priority (P2) tasks was elevated above control values so that there was significant difference between high (P1) and medium priority tasks. Their main finding was that performance on the system showed relatively little change over the 65 hours of sleep loss, while cognitive, subjective and physiological measures showed changes consistent with sleep deprivation. The researchers attributed this finding to the positive effects of team interaction on the performance of the group and to the stimulating nature of the task itself.

Overall, the research indicates that continuous performance has an effect on soldier and unit performance with tasks with mainly physical components suffering the least and those with complex, cognitive or vigilance components suffering the most. However, as indicated in the Rejman and Green study (Allnutt, Haslam, Rejman, & Green, 1990), the expected, detrimental effects of continuous operations can be partially ameliorated by working in teams. Therefore, it is unclear at this time to what effect group interactions have with sleep deprivation and/or continuous operations.

Environmental Stressors

Much research has been completed on environmental stressors (noise, time of day, temperature, and altitude, among others). Edland (1989), in her review of noise and performance, found that surprisingly little research has been done on the effects of noise on more complex judgment and decision processes. Based on the research, she concluded that noise seems to increase attentional selectivity; that is, if a task requires high attention to **every** cue to give optimal results, noise may deteriorate performance. Also, noise may improve performance on other tasks that require focusing on **relevant** parts of the information.

Extensive research has been done on the effect of time of day on performance (cf. Winget, DeRoshia, & Holley, 1985). An individual's circadian rhythmscan significantly influence performance depending on the time of day and task involved (Hildebrandt & Engel, 1972; Hockey & Colquhuon, 1972). Folkard and Monk (1980) reviewed the literature of circadian effects and found short-term digit span and recall tests show improved performance between 10 a.m. and 12 noon relative to other times.

Temperature is also a stressor when it is extreme. Ramsey, Burford, Beshin, and Jensen (1983) reported an observational study of thermal conditions that took place over a 14-month period in two industrial plants. Their results indicate that "temperatures below and above those typically preferred by most people have a significantly detrimental effect on the safety-related behavior of workers" (p. 105). Carter (1988; Carter & Cammermeyer, 1988) studied fifty-one US Armed Forces personnel undergoing medical evaluation for heat stress at Wounded Warrior II at Camp Roberts, California. Ambient temperature during this ten-day field training exercise ranged between 90 to 102 degrees Fahrenheit. She found that half of the heat-injured subjects demonstrated cognitive confusion and showed impairment in attention, delayed memory, situational judgment, and complex calculation. Also, she found that the "subjects' inability to assess their own condition and/or ability to convince others of their needs may preclude intervention until subjects become acutely ill" (p. 86). Ramsey (1983) reviewed the research on the effect of heat and cold on performance and determined certain relationships. (1) Performance on perceptual-motor tasks during brief exposure to high temperatures causes only a minor decrement or even enhances performance. (2) The most significant effect of cold exposure is the loss of manipulative ability of the hands. (3) Cognitive or mental tasks are much less affected by the cold than are motor tasks.

Altitude effects on problem solving have been studied by Bandaret and colleagues (Bandaret & Lieberman, 1988; Bandaret, Shukitt, Crohn, Burse, Roberts, & Cymerman, 1986; Stokes, Banderet, Francesconi, Cymerman, & Sampson, 1976). They simulated high altitudes (15,000-25,000 ft) for up to 40 days, with the dehydration, cold, and muscle atrophy that are associated with it. They found that cognitive performance (tasks as coding, number comparison, compass tasks, and pattern comparison) decreased in a linear fashion with increasing altitude with impairments usually due to decreases in the speed of performance rather than increased errors. During the American Medical Research Expedition to Everest, Townes, Hornbein, Schoene, Sarnquist, and Grant (1984) found that the acquisition of new information is impaired as altitude increases and that the disruptive effects of altitude on acquisition persisted even upon return to a low-altitude environment. This finding was verified by Oelz and Regard (1988) who reported that climbers who repeatedly ventured up to 8000 meters without supplementary oxygen had impaired concentration when returning to sea level.

In summary, environmental stressors seem to interfere with the performance of individuals, especially on cognitive tasks. Because of the nature of continuous operations in the military, some environmental stressors exist as a function of the soldier's working environment. Of particular concern to military training are the effects of temperature and noise on performance.

Psychological Factors

Psychological stressors include danger, combat stress, workload, time pressure, information load, control of information, monotony, isolation, and crowding, among others. This paper will not comprehensively review each stressor, but rather we will discuss important findings related to the military.

Danger

Studies on danger seem to imply that the danger of the situation depends on how strongly persons believe in the threat of death or injury. Idzikowski and Baddeley (1983) state that the magnitude of an individual's response to threat depends on a number of factors:

> (a) the individual's predisposition towards feeling anxious (trait-anxiety) and being aroused (trait-arousal); (b) the individual's assessment of the dangerousness of the situation and his ability to cope with it; and (c) previous exposure.

While many studies investigate danger or threat by observing individuals in inherently threatening situations, little research has been done on the effects of danger on cognitive tasks. In one study with a cognitive focus, Villoldo and Tarno (1984) studied seven explosive ordinance disposal (EOD) personnel in a simulated field operation; stressors included battlefield noise, ordnance detonation noise, operator fatigue, and disorientation. They found significant performance degradation of a Render Safe-Procedure when personnel were exposed to the stressors. The detrimental effect of danger also has been noted in chemical and biological radiological defense exercises at sea where critical shipboard tasks were degraded (Tijerina, Stabb, Eldredge, Herschler, & Mangold, 1988), and, in a study of 185 medical unit personnel participating in a 3-day simulated chemical warfare field training exercise (Carter & Cammermeyer, 1985). These studies show that the <u>anticipation</u> of dangerous/threatening situations decreases perfoi mance levels. The above studies also have yielded findings about individual differences. They suggest that it will be possible to identify and select personnel who are most resilient to the stress effects of dangerous situations. In addition, experience buffers the person against the effects of stress in carrying out a task.

Combat Stress

Combat stress is different from the other stress factors in that it is a combination of other stressors. "Combat with its very real threat of death or mutilation might represent the ultimate in naturally occurring events of stress" (Bourne, 1970, p.22). The area of combat stress has been largely the domain of psychiatric and psychophysiological researchers. One particular model of interest, based upon cognitive theories of stress and coping that emphasize the individual's response to stressful conditions (Lazarus, 1980; Arnold, 1960; Lazarus & Folkman, 1984; Gal & Lazarus, 1975), is derived from Israeli and other combat experiences and is used in the Israeli military (Gal, 1988). This model is interactional in that it contains a number of antecedent variables (individual, unit, and battlefield characteristics) acting through mediating variables (cognitive interpretations of the antecedent variables) to affect the individual's appraisal of the combat situation, which results in the combatant's mode of response in coping with the realities of combat. This model has advantages over classical models of stress in that it is derived from a combat perspective and based upon combat stress conditions. Michel and Solic (1983), after reviewing 35 articles and books on combat stress, found that neither the exact amount of performance degradation nor proof of the nature or source of those degradations could be determined based on the literature. Since combat stress includes many stress factors (including noise, danger, and fatigue), in addition to the actual stress of combat itself, it is difficult to replicate in controlled laboratory or simulation experiments. Combat stress appears to increase the amount of errors and cause cognitive narrowing (Entin & Serfaty, 1990); however, these phenomena can be mitigated by individual and/or group characteristics (Kobasa, Maddi, & Kahn, 1982; Westman, 1990).

Workload

Extensive research has been done on workload as it relates to pilots, both military and commercial. A study using realistic task performance was conducted by Hughes Aircraft (1977). Single and two-seat cockpits were compared as pilots flew simulated air-to-ground strike missions. They found that as threat density increased, the performance difference between the one and two-person crews became greater, with the latter consistently showing better performance. This difference is attributed to the effects of multiple threats upon single pilot workload. The additional crew member freed the pilot from defensive tasks such as monitoring radar and other displays and allowed him more time to scan visually for ground and air threats. Since other researchers have found that unseen threats are the most dangerous (Flanagan, 1981; O'Mara, 1979), the effects of increased workload, to the point of saturation, on pilot performance is drastic.

Hart (1989c) reported on a series of helicopter simulations that were conducted at NASA/Ames to compare pilot workload and performance with twenty combinations of stability control/augmentation systems [illegible] pilot-controlled features (altitude, airspeed, etc.). Single and dual pilot configurations were compared, yielding the following conclusions: Single pilot workload was found to be higher than dual pilot, regardless of the automation and control augmentation provided; a second crew member smoothed workload peaks, reducing the differences between mission segments; and the effects of vehicle augmentation on pilot workload varied by mission segment. Also, researchers found that missions management tasks increased the already high demands of single-pilot flight path control and contributed to higher workload and poorer performance.

A recent study by Clothier (1991, discussed in detail in the section on resource management training) seems to illustrate further the complexities of workload and pilot interaction. She found, after analyzing 6129 cases in 1989 and 3756 cases in 1990, that two-person crews consistenly outperformed three-person crews on the line and in LOFT. Clothier states (p. 336) "while the third person is an extra set of eyes, that extra communication node seems to detract more than aid behavioral operations."

Overall, it appears that pilot workload is a complicated phenomena and that two-person crews drastically decrease the effects of workload on performance. In addition, crew interaction seems to affect the amount of workload and its effects on performance.

Time Stress

Time stress is a phrase coined by Siegel and Wolf (1969): it is defined as a ratio of time to perform remaining tasks divided by the time available. Smart and Vertinsky (1977, p.642) state that during "crises when individuals are under great stress and important decisions must be made within a short time, certain pathologies may arise in the decision process that reduce its quality." They state that information overload forces decision-makers to respond quickly, use fewer channels to process information, and use mechanisms such as omission, delay of response, filtering, and processing incorrect information (also see Miller, 1960; Payne & Bettman, 1988). Other researchers have found that time stress causes the individual to screen out some essential cues or pieces of information and adopt a restricted view of the decision-making process (Ben Zur & Breznitz, 1981; Easterbrook, 1959; Edland, 1985; Wright, 1974; Svenson, Edland, & Karlsson, 1985). Also, time stress reduces the number of persons participating in the decision-making process (Mulder, van Eck, & de Jong, 1971) and reduces the quality of the resulting decision (Levine, 1971; Robinson, 1972).

In a study of pilot decision-making under stress, Wickens and his colleagues (Wickens, Barnett, Stokes, Davis, & Hyman, 1988; Wickens, Stokes, Barnett, & Hyman, 1989) compared the performance of 10 instrument-rated pilots, flying in a computer-based simulator called MIDIS, under conditions of stress (imposed by time pressure, noise, financial risk, and task loading) with a control group of 10 in a nonstressed situation. They found that stress had different effects on different kinds of decision problems: it degraded performance on problems imposing high demand on working memory, but left unaffected problems that were demanding on long term memory. In a related study, Pepitone, King and Murphy (1988) conducted a simulation study in which contingency planning and decision making performance were evaluated for sixteen crews flying a B-720 simulator. Their results suggest that rapid, accurate decision-making under time pressure is enhanced by prior contingency planning and that this planning allowed crews to develop strategies for future use.

Edland (1989) reviewed the effect of time pressure on cognitive processes involved in decision making and concluded that systematic changes, including more frequent use of non-compensatory decision rules, use of a smaller number of attributes or data, and more avoidance or negative aspects, occur when decision makers are under time pressure and related stress. Specifically, she states that

> It may be suggested that the changes occurring when people are under time pressure, start with an acceleration of the processing. Then, when there is (sic) no possibility to process

> the information fa^tor and still reach the same result, one has (sic) to filtrate the information by increasing the ctivity and focusing on a subset cn the available information (i.e., the negative cues to . . uid the negative consequences) and base the decisions or judgments on that (p. 26).

The effects of time pressure on decision-making have been well-documented and include: contraction of authority, restriction of information searching, and restriction of decision-making process.

Information Load and Control

Decision-making often occurs under less than ideal conditions. In military settings, particularly under combat conditions, the need for rapid planning is obvious. Unfortunately, decision-makers are not always in possession of all relevant information before a decision is made. Also, a decision-maker may have too little or too much information before a decision is made. For the purposes of this review, information load differs from workload in that workload is a measurement of the amount and types of activities that a subject must perform while information load is an indication of the amount of data handling that must be completed by the subject.

Streufert, Suedfeld and Driver (1965) measured the effects of information load on information search. In their study, teams of four subjects directed the fate of a small developing nation that was threatened by economic problems and a military take-over attempt by a simulated opponent. Streufert et al (1965) found that search activity decreased with increases in information load and that less integrative decision makers were more affected by information load increases than more integrative decision makers. In a follow-up to these studies, Streufert and Streufert (1981a) expanded this paradigm to determine the interactions between information load (low, medium, and high) and time pressure. They found that (1) the number of information searches decreased with increased information load, (2) the number of quick decisions and integrative decisions were greatest at intermediate load levels, and (3) the number of quick decisions and integrative decisions decreased with increasing load. In addition, they found an interaction effect: At high time urgency and high information load, there were fewer search decisions and a complete absence of integrative decisions, but subjects showed an increase in quick decisions (decisions that did not utilize all available information). Streufert and his associates have verified these results in further studies (Streufert, 1983; Streufert, Streufert, & Gorson,1981). Streufert has also considered risk-taking behavior in two studies. He found that risk-taking behavior increases as information load increases (Streufert, 1983; Streufert, Streufert, & Denson, 1982). Additionally, Lanzetta and Roby (1957) found that the error rate on task performance was correlated positively with the increased volume of information received by decision-makers.

Klein and his colleagues (Klein, 1985) found that human decisionmakers, particularly experts, quickly assess a situation and immediately make a categorization that leads to a decision, and do not carefully consider all possibilities. Also, decision makers use a small number of heuristics (rules) in making their decisions (Tversky & Kahneman, 1973), fail to consider all possible decision and outcome options (Slovic, Fischhoff, & Lichtenstein, 1978), are inconsistent in dealing with risk (Lopes, 1983), are subject to situational context in which decisions are made (Tversky & Kahneman, 1981), and have inappropriate levels of confidence in their own decisions (Einhorn & Hogarth, 1978).

Another area affecting job performance is control. Glass and Singer (1972) found that people are more comfortable and under less stress when they believe they have control in a situation. In World War II, studies of military fliers (discussed in Rachman, 1978) indicated that the controllability factor was a major dimension in fear or courage, along with competence and group membership. Studies later conducted on the Project Mercury astronauts had similar findings, with the element of controllability very important. An increase of control over one's environment can lead to a reduction in fear reactions which can lead to increased performance. In studying combat air crews, Stouffer et al (1949) found that the degree of motivation for combat was a function of type of aircraft, with the lowest motivation being in heavy bomber crews, followed by medium and light bomber crews, and fighter pilots: They attributed these differences in feelings to perceived controllability over the situation: Pilots felt more "in control" of fighters because of the perceived advantages of flying a fighter (superior speed, maneuverability, and fighter power). In a recent study, Gal-or, Tennenbaum, Furst, and Shertzer (1985) investigated the effects of self-control and trait anxiety on the performance of 11 novice parachutists. They found that subjects who had more self-control performed better after training.

Some conclusions can be drawn from the above studies. In cases of high information load, subjects tend to make decisions quickly and before considering all alternatives, thereby possibly increasing the error rate of performance. Also, control of information (whether actual or perceived) seems to have a positive effect on performance and task motivation.

Social Stressors

Many social stressors (family relationships, boss stress, among others) have been evaluated in the literature (see Fiedler & Garcia, 1987, Glass & Singer, 1972 and McGrath, 1976 for reviews). Social factors may contribute to chronic stress conditions that significantly affect an individual's performance and interact with acute stressors. We focus here on the relationship of the individual to the work group.

Cohesion

The concept of group cohesion was developed in the 1940s at the Research Center for Group Dynamics at MIT (Zander, 1979). It has been defined as "morale, 'sticking together', productivity, power, task involvement, feelings of belongingness, shared understandings of roles, and good teamwork" (Schachter, Ellertson, McBride, & Gregory, 1951, p.192). An indepth review of the literature on cohesion (Stewart, 1987; Stewart & Weaver, 1988) and recent research by the Army Research Institute (Siebold & Kelly, 1987, 1988a, 1988b) indicate that

> military cohesion consists of four major elements: 1) relationships between peers (horizontal); 2) relationships between subordinates and superiors (vertical); 3) relationship to the military as an organization or unit (organizational); 4) relationship to the nation or society (societal or cultural) (Stewart & Weaver, 1988, p. 16).

Druckman and Swets (1988) reviewed the existing literature on group cohesion. They found inconsistent results: High group cohesion can be linked to either high or low group performance, depending on the norms. Stewart and Weaver (1987), in their analysis of studies on cohesion, found only seven out of 49 to be statistically sound: 20% of the studies did not report the sample size, 14% were case studies of one to ten subjects, 22% has eleven to fifty subjects, and 39 of the 49 research studies had no control group.

In a study of nine light infantry platoons (Siebold & Kelly, 1988), measures of cohesion and performance at a training center were obtained. When outlier cases were controlled, bonding among leaders, soldiers, and between leaders and their soldiers was strong and correlated significantly with platoon performance as measured by the observers/controllers. In a later study, Siebold (1990) collected data from soldiers in five light infantry battalions at three points in time: four to six months prior to a training rotation, two to four weeks prior to a training rotation, and two to four weeks after the training rotation. He found that all the aspects of cohesion correlated significantly with platoon performance as rated by the observers and as rated by the platoon members. Milgram, Orenstein and Zafrir (1989) obtained self-report measures of combat stressors, stress reactions, personal resources, and social supports from 48 university students who were all combat veterans (aged 23-33) from different military units in Israel. They found that military performance was strongly associated with unit cohesiveness, loyalty to unit, and motivation to serve.

Individual differences play a role in how different people adjust to the cohesion of a group. Herrmann, Post, Wittmaier, and Elsasser (1977) studied the attrition factors in a Naval Academy class and found a significant difference between dropouts and remainders, with dropouts showing higher scores on self-sufficiency, resourcefulness, and preference for their own decisions in contrast to remainders' disposition to group-dependency, joining and following.

Cohesion is generally seen as having a positive effect on group performance, although all studies do not bear this out. In contrast, the literature on nonbattle casualties indicates that there is a direct correlation between cohesion (or morale) and the incidence and prevalence of combat stress reactions and/or post-traumatic stress syndrome (Stewart & Weaver, 1988). However, as indicated in the Herrmann et al's (1977) study, those who resist cohesive groups showed higher scores on self-sufficiency and resourcefulness. It seems, then, that there is a trade-off between cohesion and independent decision-making. This is a critical issue for Army officer training programs. Since cohesion is not well-defined, and often the result of self-report indices (Siebold & Kelly, 1988b), cohesion might be better understood by looking at concepts, such as familiarity, which are related to it.

Improving Performance Under Stress

In the most general terms, the research discussed above has shown: 1) that the presence of certain stressors leads to decrements in performance and 2) that the incident-related stress which accompanies these stressors can further impair performance. In addition, there seems to be significant variations in the effects of stress on different individuals. Thus, there is a clear need to develop interventions that improve performance under stress. Yet the point in at which intervention should occurand the type of intervention is far from clear. Three different approaches to reducing stress have been developed. The first involves focusing exclusively on the stress itself, with the assumption being that if individuals can be taught to manage that stress effectively, performance will improve. The second approach assumes that stress is the inevitable result of exposure to stressors and that the focus should be on skill training.If individuals can achieve automaticity on certain tasks, stress will impair performance considerably less. A third approach is seen in the Cockpit Resource Management approach in which the participants are taught effective interpersonal skills in order to deal with any potential stressor. The remainder of this paper will focus on how each of these three approaches work to overcome the effects of stress.

Stress Training

The primary focus in the literature has been on stress reduction as a means of improving performance. Research on stress management has resulted in several findings, the most notable being that different techniques for reducing stress succeed when they focus on the reduction of uncretainty about, and an increase in control over, important events in a person's environment (Druckman & Swets, 1988). Certain stress reduction techniques are not directly covered in this review because their applicability in the military is unclear. These include biofeedback (see Beatty & Legewie, 1977 and Schwartz & Beatty, 1977 for reviews), rational emotive therapy (Ellis, 1962), and time management (Lakein, 1973). This review focuses on stress management strategies that have proven effective in reducing and managing stress in military populations.

Most studies on stress management focus on physiological indicators to document the effects of stress training. Bruning and Frew (1987) studied the effects of three stress intervention strategies (management skills training, exercise, and meditation). They examined physiological measures to determine the effect of each intervention and the combinations of the different strategies. Each of the strategies led to decreases in pulse rate and blood pressure and dual combination strategies showed even more significant decreases in pulse rate under conditions of stress. Migdal & Paciorek (1989) investigated the effect of relaxation exercises on the performance of Polish cadets on a catapult simulator and found that the cadets trained in relaxation techniques displayed less emotional tension, an absence of fatigue and a lack of sense of guilt on the State-Trait Anxiety Inventory. For pilots, relaxation strategies such as progressive relaxation (Jacobson, 1938), autogenic training (Shultz & Luthe, 1959) and the pilot stress relaxation exercise (Thomas, 1988) have been used to reduce stress-related symptoms.

Few studies were found that assessed the effects of stress-reduction techniques on task performance. In his study of 214 Swedish conscripts, Larsson (1987) found that performance of an experimental group of conscripts was significantly better than a control group on actual task examinations and mental tests after the experimental group followed mental-training techniques including relaxation, mediation, and imagery rehearsal. In evaluating respiration control as a stress management technique, Burke (1980) found that jumpmasters (personnel trained to conduct landings of men and equipment) trained to use respiration control had significantly lower heart rates during the two night jumps of the course. In addition, he found that the stress management group did better than the control group, on the average, on grades received for performance as jumpmasters.

While a variety of stress management procedures exist, the one that has received the most attention is Stress Inoculation Training, or SIT. Stress inoculation training stands apart from other stress-management methods in that it does not propose any single technique that is presumed to be applicable to all stressful situations. Rather, SIT is based on the premise that a method must be flexible enough to be adapted to the needs of those receiving training (Wertkin, 1985).

SIT consists of three stages: an educational, a rehearsal, and an application stage (Meichenbaum, 1977). In the educational stage, individuals are taught about the different ways in which people respond to different types of stress. In the rehearsal stage, individuals learn one of a number of stress-management techniques that is most applicable to their specific situation. Techniques that have been used include cognitive restructuring, systematic desensitization, progressive relaxation, deep breathing, guided imagery, and stretching techniques (Wertkin, 1985). During the application stage, individuals apply the techniques they've learned. They do this first in a simulated environment and then in the actual stressful environment.

Spettell & Liebert (1986) recommend SIT to help mediate the stress present in man-machine systems operations. They comment that:

> training programs that focus on the development of widely applicable cognitive skills should improve operators' ability to ignore distracting stimuli and thus enable them to handle high information loads during stressful conditions. (p. 548).

In a commentary on Spettel and Liebert, Starr (1987) reports that students who receive CPR training enhanced by SIT perform faster and more accurately than traditionally taught students when tested without warning 6 or 12 months after original training. In an attempt to make SIT more efficient, Schuler, Gilner, Austrin, and Davenport (1982) compared the effectiveness of SIT with and without the first stage, education. In examining the stressor to stress reaction link, they found that the full SIT group improved significantly more than the group receiving SIT without the education phase, on both the behavioral observations and self-report indices.

Hytten, Jensen and Skauli (1990) studied the effects of a one-hour SIT on subjective experience, performance, and physiological activation in two fear-provoking situations. In a free-fall lifeboat situation, the experimental group reported higher acceptance of the free fall lifeboat after SIT than the control group. In smoke diving, the experimental group reported less need of success and reported learning self confidence instead of skills more often than the control group and received less help from the instructor during diving. However, in contrast, the experimental group reported higher anxiety than the control group during training.

As discussed above, there have been few studies which investigated the effects of stress management strategies on task performance. Two of these studies, Starr (1987) and Larsson (1987), found that using stress management strategies during training increases the performance of individuals when compared to those not trained with stress intervention. Because of these findings, further research should be done with an emphasis on task performance measures instead of physiological ones.

<u>Skill Training</u>

Although much research has been conducted on stress management training, skill training can also ameliorate the effects of stress by producing overlearned behavior (Zajonc, 1965). As Wickens (1984) noted, as behaviors become more practiced, cognitive load is reduced and the speed and accuracy of performance is increased. The Army practices this strategy in the form of basic training when recruits are drilled on tasks crucial to their performance as military personnel. While the goal of overtraining is to make skills resistant to the effects of stressors, few studies have directly tested this notion. Training studies that address effects on stress tend to focus on the effects of training on participants' self-perceptions and sense of control. Increased levels of confidence and competence are associated with subjects' willingness to participate in dangerous tasks and on their actual performance levels. For example, Smith (Smith et al, 1990) analyzed the effect of skill training on job proficiency in handling chemical agents. A treatment group, composed of 150 soldiers, knew that their training would involve lethal agents in the Chemical Decontamination Training Facility at Fort McClellan, Alabama. There were two control groups, one of 30 soldiers trained in the same facility and the other of 158 soldiers trained in a different, nonlethal environment. The researchers found that there were no differences in job proficiency, as measured by written examinations, among the groups. However, soldiers who had undergone training involving lethal agents had the **perception** that they were better able to survive in combat and to perform their mission in the event of a chemical attack.

Keinan (1988) studied the quality of soldiers' performance and the intensity of experienced stress in a combat situation using 297 male recruits in the Israeli Defense Forces and found that soldiers who assigned a low probability to being physically injured were found to benefit more from dangerous rather than nondangerous training. Also, exposure to serious physical threats during training yielded better training results than training that did not involve such threats only when the soldiers concluded their training with a feeling of success. From this study, it appears that individual perceptions and differences are strongly related to performance under stress.

Subjects' expectations were manipulated directly in a study by Novaco, Cook, and Sarason (1983), who completed a study with Marine recruits in San Diego. They showed a 35-minute videotape called "Making It," which depicted skills and coping strategies needed for success in boot camp. Their results suggested that recruits viewing this film manifested higher expectations of personal control than did recruits seeing a control film. How those perceptions influenced recruits' actual performances was not reported.

Level of experience or practice at dangerous tasks goes beyond initial training level and would be expected to affect both task performance and confidence. A series of studies has investigated the interaction of experience and stress, using divers and parachutists as subjects. As in most studies on stress training, the measures for these studies were predominately physiological or self-report indices of stress. In an early study, Epstein and Fenz (1965) compared novice parachute jumpers with experienced jumpers on self-report avoidance ratings. With experienced jumpers, they found that the maximal avoidance occurred the night before, while the maximal avoidance for novice jumpers occurred at the "ready" signal. Over the next ten years, Fenz (1975) followed up this work. In addition to replicating earlier findings, Fenz also found that experienced but incompetent jumpers have similar physiological responses to novices. In a similar study, Beaumaster, Knowles, and MacLean (1978) noted that the execution and, to a lesser extent, the anticipation of a jump was stressful for novice parachutists. These findings have been replicated with undersea divers. Biersner and Larocco (1987) found that more experienced divers showed less signs of physiological stress than inexperienced divers. Jorna (1985) found that novice divers showed increased performance level (on a continuous memory task) as a function of diving training; however, for experienced but inefficient divers, performance on the memory task was reduced by an increased depth of dive. Together these studies indicate that, while diving and parachute jumping create stress and avoidance for both novice and experienced participants, experienced and competent subjects mentally prepare the night before, thus reducing anxiety when performing the task.

General fitness training, as opposed to specific task practice, also has an indirect effect on performance. Pleban, Thomas, and Thompson (1985) investigated the role of physical fitness in moderating both cognitive work capacity and fatigue onset under sustained combat operations. Sixteen male Ranger Officers' Training Corps cadets were followed through a 2.5 day, Pre-Ranger Evaluation exercise. Cognitive performance and subjective measures of fatigue were assessed at regular intervals before, during, and one day after the exercise. Their results indicated that fitness may reduce the effects of stress on cognitive work capacity for tasks requiring prolonged mental effort, particularly as sleep loss and other stressors mounted.

In certain types of situations, stress can cause a decrement in performance, even after skill training. Stepanov and Stetanov (1979, see also Lomov, 1966; Khachatur'yants, Grimak, & Khrunov, 1976; Khrunov, Khachatur'yants, Popov & Ivanov, 1974) reported on a series of experiments carried out in the Soviet Union on long-term spaceflight. Their findings indicate that there is a destruction in skills acquired in training in the first three to five days of flight which is caused by a decrease in the sensorimotor component. With the passage of time and increased adaptation to flight condition, the quality of motor activity normalizes, reaching the values obtained in the course of training sessions.

Some conclusions can be derived from the above studies. In contrast with stress training, skill training is concerned with hardening specific behaviors to reduce the effect of potential stressors on those behaviors. Few evaluative studies have been done, although the potential of this approach for the Army is great. The Pleban et al (1985) study found that high levels of physical training were positively correlated with performance on cognitive tasks. Second, skill training appears to affect the attitudes of individuals facing stressful situations (Smith et al, 1990); that is, soldiers feel that they are better equipped to perform under stressful conditions after undergoing skill training. Since nonperformance in battle is a continuing dilemma for the military, these findings can be helpful for future training. The last finding relates to the effect of level of experience on performance under stress: As indicated in the studies on divers and parachutists, experienced and competent subjects mentally prepare for the stressful event in advance, thus reducing anxiety when performing the task, and presumably, increasing their ability to perform.

Crew Resource Management Training

Crew resource management training was originally developed to improve the performance of air transport crews in high-risk, high-stress conditions. It includes training in communication, decision making, and resource and task allocation. In principle, it applies to any environment in which coordinated action is required by teams of highly trained professionals who must function under dynamic high workload conditions (as in the military or nuclear power plant, space, and railroad operations). Cooper, White and

Lauber (1980) analyzed jet transport accidents which occurred between 1968 and 1976 and found more than 60 which involved problems with decision-making, leadership, pilot judgement, communications, and crew behavior. From this analysis and other studies (Foushee & Manos, 1981; Ruffell Smith, 1979), there seemed to be a direct correlation between measurable performance of a crew and cockpit communications. In 1979, the National Transportation Safety Board (NTSB), after investigating a United Airlines DC-8 accident in Portland, Oregon, recommended operational implementation of cockpit resource management (CRM) programs (NTSB, 1979). In the following decade, these programs came into widespread civilian and military use. CRM programs are largely based on social psychology and management theory, with many of the programs developed with data and expertise from NASA (Helmreich, 1991; Lauber, 1984; Foushee & Helmreich, 1988). The Dutch National Airline (KLM) developed the first such course (Hawkins, 1987) with other programs being developed by United Airlines (Nance, 1986), and the United States Air Force--labeled Aircrew Coordination Training (Alkov, 1988, 1991), among others.

CRM training has been credited with saving the day in the case of the United Airlines DC-10 that lost all controls at 33,000 feet when an engine explosion severed all hydraulic lines. The NTSB investigation concluded that CRM training prepared the crew to figure out how to control the plane using only engine thrust and to bring it in for a controlled crash landing. Many lives were saved that surely would have been lost had the crew not worked together so well under incredibly stressful and totally unanticipated conditions.

Many of the CRM programs currently in use are designed to change attitudes and to raise crews' awareness of the need for communication and coordination, as well as to provide tthe foundation for behavioral change. Several studies have shown positive changes in attitudes following CRM training (Butler, 1991; Helmreich & Foushee, in press; Helmreich & Wilhelm, in press; Irwin, 1991). Training program effectiveness has been evaluated by examining reductions in human errors during flight or in accident rates. This approach has been used mainly in the military or general aviation, where accident rates are relatively high. Commercial airline companies primarily evaluate CRM programs using cockpit observers during line (actual flight) or LOFT (Line Oriented Flight Training) operations using full-mission simulators. Diehl (1991) reported on six government sponsored, independent evaluations of various CRM and aeronautical decisionmaking (ADM) programs and found that training was followed by reductions in the error rates in each study, ranging from 8% to 46% fewer errors (for details on the individual studies see Berlin et al., 1982; Buch & Diehl, 1983; Connolly & Blackwell, 1987; Diehl & Lester, 1987; Telfer & Ashman, 1986). Bell Helicopter's human-error accident rate (reported in Diehl, 1991), comparing the 1983-1986 period (before training was begun) with the 1987-1990, period declined by 36% for the Jetranger helicopter following crew training. This decrease in accident rate is confirmed by the experience of Petroleum Helicopter who reported an initial accident rate of 2.3 accidents per 100,000 for the period 1980-1986; and post-ADM training accident rates of 1.86 and 1.05 per 100,000 in 1987 and 1988, respectively. Diehl also reported on the safety record of the United States Air Force Military Airlift Command (MAC), comparing the five years before CRM training and the five years after CRM training. It was found that the total number of aircraft destroyed dropped from 21 to 10 and the class A and B operations-related flight mishap rate dropped from 0.679 to 0.333 per 100,000 hours flight time.

Alkov (1991) reviewed the results of Aircrew Coordination Training (developed by the US Navy), on the error mishap rate in three aircraft types: helicopters, attack bombers, and multi-crewed fighters. Overall, the aircrew error mishap rate (per 100,000 flight hours) declined from 1986 to 1990 as follows: for attack bombers, 7.56 to 1.43; for helicopters, 7.01 to 5.05; and for multi-crewed fighters, 13.78 to 6.27.

The effects of CRM training in one major domestic airline have been analyzed by Clothier (1991). Day-to-day activities of crews on the line and in LOFT--full mission simulator training were evaluated by expert observers using standard checklists. The airline provided CRM training to its entire pilot force in 1989, then continued with recurrent training in 1990. After training, crews flying on the line and in LOFT showed improved performance. In comparing line performance of 2000 untrained crews and approximately 1000 trained crews, significant improvements were seen in twelve out of fourteen areas on the observers' Line/LOS checklist. Under LOFT, the 485 trained crews significantly outperformed the 1625 untrained crews in all categories.

Overall, the results indicate that CRM training improves crew performance and contributes to reduction in accident rates. Flying airplanes, whether single-engine Cessnas or jumbo jets, is a hazardous activity, particularly when systems fail or weather or traffic is encountered. Most accidents occur on take-offs or landings, when workload is highest, with fatigue often a factor in landings. While CRM training is not designed to reduce stress per se, it does appear to improve performance by providing behavioral mechanisms for coping with specific task demands and conditions that may lead to poor crew performance.

Conclusions

In the most general terms, the research discussed on individual stressors has shown: 1) that the presence of certain stressors leads to decrements in performance, and 2) that the incident-related stress which accompanies these stressors can further impair performance. In addition, there seems to de significant variations in the effects of stress on different individuals. Three different approaches to reducing stress have been discussed. The first involves focusing exclusively on the stress itself, with the assumption being that if individuals can be taught to manage that stress effectively, performance will improve. The second approach assumes that stress is the inevitable result of exposure to stressors and that the focus should be on skill training.If individuals can achieve automaticity on certain tasks, stress will impair performance considerably less. A third approach is seen in the Crew Resource Management approach in which the participants are taught effective interpersonal skills in order to deal with any potential stressor. Research discussed showed that each of these three methods of reducing stress can cause improvements in the performance of individuals and crews. However, in each of these three strategies, most of the measures involved were not of task performance, but were affective or physiological indicators of individual stress. Therefore, much research still needs to be done evaluating each of these techniques utilizing realistic tasks.

REFERENCES

Alkov, R.A. (1988). The Naval Safety Center's Aircrew Coordination Training program. Approach, 34(3).

Alkov, R.A. (1991). US Navy Aircrew Coordination Training - A progress report. In R.S. Jensen (ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 368-371). Columbus, OH: The Department of Aviation, The Ohio State University.

Allnutt, M.F., Haslam, D.R., Rejman, M.H., & Green, S. (1990). Sustained performance and some effects on the design and operation of complex systems. London: Army Personnel Research Establishment, Ministry of Defense.

Ainsworth, L.L., & Bishop, H.P. (1971). The effects of a 48-hour period of sustained field activity on tank crew performance(HumRROTech. Rep. No. 71-16). Alexandria, VA: Human Resources Corporation.

Arnold, M.B. (1960) Emotion and personality (2 volumes). New York: Columbia University Press.

Backer, P.R., & Orasanu, J.M. (1992). Stress, stressors, and performance in military operations: A review (Contract No. DAAL03-86-D-001). Alexandria, VA: Army Research Institute.

Banderet, L.E. & Lieberman, H.R. (1988). Treatment with tyrosine, a neurotransmitter precursor, reduces environmental stress in humans (DTIC Technical Report AD-A199 199). Natick, MA: Army Research Institute of Environmental Medicine.

Banderet, L.E., Schukitt, B.L., Crohn, E.A., Burse, R.L., Roberts, D.E., & Cymerman, A. (1987). Effects of various environmental stressors on cognitive performance (DTIC Technical Report AD-A177 587). Natick, MA: Army Research Institute of Environmental Medicine.

Beatty, J., & Legewie, H. (Eds.). Biofeedback and behavior. New York: Plenum.

Beaumaster, E.J., Knowles, J.B., MacLean, A.W. (1978). The sleep of skydivers: A study of stress. Psychophysiology, 15(3), 209-213.

Belenky, G., Balkin, T., Krueger, G., Headley, D., & Solick, R. (1986). Effects of continuous operations (CONOPS) on soldier and unit performance. Phase I Review of the literature. Ft. Leavenworth, KS: US Army Combined Arms Combat Developments Activity.

Belenky, G., Balkin, T., Krueger, G., Headley, D., & Solick, R. (1987). Effects of continuous operations (CONOPS) on soldier and unit performance: Review of the literature and strategies for sustaining the soldier in CONOPS. Bethesda, MD: Walter Reed Army Institute of Research.

Ben Zur, H., & Breznitz, S.J. (1981). The effect of time pressure on risky choice behavior. Acta Psychologia, 47, 89-104.

Berlin, J.I., Gruber, J.M., Holmes, C.W., Jensen, P.K., Lau, J.R., Mills, J.W., & O'Kane, J.M. (1982). Pilot judgement training and effectiveness (DOT/FAA Report CT-82-56). Washington, DC: FAA.

Biersner, R.J., Larocco, J.M. (1987). Personality and demographic variables related to individual responsiveness to diving stress. Undersea Biomedical Research, 14, 67-73.

Bourne, P.G. (1970). Men, stress, and Vietnam. Boston: Little, Brown and Co.

Bruning, N.S., & Frew, D.R. (1987). The effects of exercise, relaxation, and management skills training on physiological stress indicators: A field experiment. Journal of Applied Psychology, 72, 515-521.

Buch, G.D., & Diehl, A.E. (1983). Pilot Judgement training manual validation. Unpublished Transport Canada Report.

Burke, W.P. (1980). An experimental evaluation of stress-management training for the airborne soldier (Technical Report 550). Alexandria, VA: Army Research Institute. (ERIC Document Reproduction Services No. ED 242 928)

Butler, R.E. (1991). Lessons from cross-fleet/cross-airline observations: Evaluating the impact of CRM/LOS training. In R.S. Jensen (Ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 326-331). Columbus, OH: The Department of Aviation, The Ohio State University.

Campbell, D.B. (1974). A program to reduce coronary heart disease risk by altering job stresses (Doctoral dissertation, The University of Michigan, 1973). Dissertation Abstracts International, 35, 564-B. (University Microfilms no. 74-15681)

Caplan, R.D. (1972). Organizational stress and individual strain: A social-psychological study of risk factors in coronary heart disease among administrators, engineers, and scientists. Doctoral dissertation, The University of Michigan, 1971. Dissertation Abstracts International, 32, 6706B-6707B (University Microfilms no. 72-14822).

Carter, B.J. (1988). Prevention of heat stress injury. In A. D. Mangelsdorff (Ed.), Proceedings Sixth Users Workshop on Combat Stress (Consultation Report #88-003, pp. 83-88). Ft. Sam Houston, TX: US Army Health Services Command. (DTIC Report AD-A199 422)

Carter, B.J., & Cammermeyer, M. (1985). Emergence of real casualties during simulated chemical warfare training under high heat conditions. Military Medicine, 150(12), 657-665.

Carter, B.J., & Cammermeyer, M. (1988). A phenomenology of heat injury: The predominance of confusion. Military Medicine, 153(3), 118-126.

Clothier, C.C. (1991). Behavioral interactions across various aircraft types: Results of systematic observations of line operations and simulations. In R.S. Jensen (Ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 332-337). Columbus, OH: The Department of Aviation, The Ohio State University.

Connolly, T.J., & Blackwell, B.B. (1987). A simulator-based approach to training in aeronautical decision making. In Proceedings of the Fourth International Symposium of Aviation Psychology. Columbus: Ohio State University.

Cooper, G.E., White, M.D., & Lauber, J.K. (Eds.). (1980). Resource management on the flightdeck: Proceedings of a NASA/Industry workshop (NASA CP-2120). Moffett Field, CA: NASA Ames Research Center.

Department of the Army (1983). Soldier performance in continuous operations (Field Manual 22-9). Washington, DC: Government Printing Office.

Dewulf, G.A. (1978). Continuous operations study (CONOPS) final report. Ft Leavenworth, KS: US Army Combined Arms Combat Development Activity.

Diehl, A.E. (1991). The effectiveness of training programs for preventing aircrew "error." In R.S. Jensen (Ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 2, pp. 640-655). Columbus, OH: The Department of Aviation, The Ohio State University.

Diehl, A.E., & Lester, L.F. (1987). Private pilot judgement training in flight school settings (DOT/FAA Report 87/6). Washington, DC: FAA.

Drucker, E.H., Canon, L.D., & Ware, J. R. (1969). The effects of sleep deprivation on performance over a 48-hour period (Tech. Rep. No. 69-8). Alexandria, VA: Human Resources Office.

Druckman, D., & Swets, J.A. (Eds.). (1988). Enhancing human performance. Washington, DC: National Academy Press.

Easterbrook, J.A. (1959). The effect of emotion on cue utilization and the organization of behavior. Psychological Review, 66, 183-201.

Edland, A. (1985). Attractiveness judgements of decision alternatives under time stress. Reports from the Cognition and Decision Research Unit, Department of Psychology (University of Stockholm, Sweden), No. 21.

Edland, A. (1989, May). On cognitive processes under time stress. Reports from the Cognition and Decision Research Unit, Department of Psychology (University of Stockholm, Sweden), Suppl. 68.

Einhorn, H.J., & Hogarth, R.M. (1978). Confidence in judgement: Persistence in the illusion of validity. Psychological Review, 85, 395-416.

Ellis, A. (1962). Reason and emotion in psychology. New York: Lyle Stuart.

Entin, E.E., & Serfaty, D. (1990). Information gathering and decisionmaking under stress. Burlington, MA: Alphatech

Epstein, S., & Fenz, W.D. (1965). Steepness of approach and avoidance gradients in humans as a function of experience: theory and experiment. Journal of Experimental Psychology, 70, 1-13.

Fenz, W.D. (1975). Strategies for coping with stress. In I. Sarason & C. Spielberger (Eds.), Stress and anxiety. Washingon: Hemisphere Publishing Co.

Fiedler, F.E., & Garcia, J.E. (1987). New approaches to effective leadership. New York: Wylie.

Flanagan, W.A. (1981). The fighter force: How many seats? Air University review, 32(4), 2-21.

Folkard, S., & Monk, T.H. (1980). Circadian rhythms in human memory. British Journal of Psychology, 71, 295-307.

Foushee, H.E. (1987). Dyads and triads at 35,000 feet: Factors affecting group process and aircrew performance. Cockpit resource management training (NASA Tech. Report CP-2455). Moffett Field, CA: NASA Ames Research Center.

Foushee, H.E., & Helmreich, R.L. (1988). Group interaction and flight crew performance. In Human factors in aviation. San Diego: Academic.

Foushee, H.E., & Manos, K.L. (1981). Information transfer within the cockpit: Problems in intracockpit communications. In C.E. Billings & E.S. Cheaney (Eds.), Information transfer problems in the aviation system (NASA TP-1875). Moffett Field, CA: NASA Ames Research Center (NTIS No. N81-31162).

Freeh, S.H. (1988). Operational level warfare and the violent environment (DTIC Technical Report AD-B122 058). Newport, R.I.: Naval War College.

French, J.R., & Kahn, R.L. (1962). A programmatic approach to studying the industrial environment and mental health, Journal of Social Issues, 18, 1-47.

French, J., Rogers, W., & Cobb, S. (1974). A model of person-environment fit. In G. Coelho, D.A. Hamburgh, & J.E. Adams (Eds.), Coping and adaptation. New York: Basic Books.

Gal, R. (1988). Psychological aspects of combat stress: A model derived from Israeli and other combat experiences. In A. D. Mangelsdorff (Ed.), Proceedings Sixth Users Workshop on Combat Stress (Consultation Report #88-003, pp. 101-122). Ft. Sam Houston, TX: US Army Health Services Command. (DTIC Report AD-A199 422)

Gal, R., & Lazarus, R.S. (1975). The role of activity in anticipation and confronting stressful situations. Journal of Human Stress, 1(4), 4-20.

Gal-or, Y., Tenenbaum, G., Furst, D., & Shertzer, M. (1985). Effect of self-control and anxiety on training performance in young and novice parachuters. Perceptual and Motor Skills, 60(3), 743-746.

Gaume, J.G. & White, R.T. (1975). Mental workload assessment II. Physiological correlates of mental workload: Report of three preliminary laboratory tests (DTIC Technical Report AD-B050 864). St. Louis, MO: McDonnell-Douglas Corporation.

Glass, D.C., & Singer, J.E. (1972). Urban stress. New York: Academic.

Haggard, D.F. (1970). HumRRO studies in continuous operations (HumRRO professional paper 7-70). Alexandria, VA: Human Resources Research Organization.

Harrison, R.V. (1978). Person-environment fit and job stress. In C. Cooper & R. Payne (Eds.), Stress at work (pp. 175-207). New York: Wiley & Sons.

Hart, S.G. (1989). Overview of NASA rotorcraft human factors research. Paper presented at the American Helicopter Society 45th Annual Forum, Boston, MA, May 22-24.

Haslam, D.R. (1981). The military performance of soldiers in continuous operations: Exercises 'Early Call' I and II. In The twenty four hour workday: Proceedings of a symposium on variations in work-sleep schedules. Cincinnati, OH: U.S. Dept. of Health & Human Services.

Haslam, D.R. (1982). Sleep loss, recovery sleep, and military performance. Ergonomics, 25(2), 163-178.

Haslam, D.R. (1985). Sustained operations and military performance. Behavior Research Methods, Instruments, and Computers, 17(1).

Hawkins, F.H. (1987). Human factors in flight. Brookfield, VT: Gower.

Helmreich, R.L. (1991). Strategies for the study of flight crew behavior. In R.S. Jensen (Ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 338-343). Columbus, OH: The Department of Aviation, The Ohio State University.

Helmreich, R.L., & Foushee, H.C. (in press). Why crew resource management? In E.L. Weiner, B.G. Kanki, & R.L. Helmreich (Eds.), Crew resource management. New York: Academic.

Helmreich, R.L., & Wilhelm, J.A. (in press). Outcomes of CRM training. International Journal of Psychology.

Herrmann, D.J., Post, A.L., Wittmaier, B.C., & Elsasser, T.C. (1977). Relationship between personality factors and adaptation to stress in a military institution. Psychological Reports, 40, 831-834.

Hildebrandt, G., & Engel, P. (1972). The relation between diurnal variations in psychic and physical performance. In W.P. Colquhuon (Ed.), Aspects of human efficiency (pp. 231-240). London: The English Universities Press.

Hockey, G. R., & Colquhuon, W. P. (1972). Diurnal variation in human performance: A review. In W.P. Colquhuon (Ed.), Aspects of human efficiency (pp. 1-24). London: The English Universities Press.

Hughes Aircraft Company (1977). Crew size evaluation for tactical all-weather strike aircraft (Technical Report AFAL TR-76-79). Wright-Patterson Air Force Base, OH: Air Force Avionics Laboratory.

Hytten, K., Jensen, A., & Skauli, G. (1990). Stress inoculation training for smoke divers and free fall lifeboat passengers. Aviation, Space, and Environmental Medicine, 61(11), 983-988.

Idzikowski, C., & Baddeley, A.D. (1983). Fear and dangerous environments. In G.R. Hockey (Ed.), Stress and fatigue in human performance (pp. 123-144). New York: Wiley & Sons.

Irwin, C. (1991). The impact of initial and recurrent CRM training. In R.S. Jensen (Ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 344-349). Columbus, OH: The Department of Aviation, The Ohio State University.

Jacobson, E. (1938). Progressive relaxation (2nd. ed.). Chicago: University of Chicago Press.

Jensen, R.S. (1987). Cockpit resource management training (Final report DOR/FAA/SCT/OSURF/APL). Arlington, VA: Systems Control Technology.

Jensen, R.S. & Adrion, J. (1988). Aeronautical decision making for commercial pilots (DTIC Technical Report AD-A198 772). Washington, DC: Federal Aviation Administration.

Jorna, P.G.A.M. (1985). Heart-rate parameters and the coping process underwater. In J.F. Orlebeke, G. Mulder, & L.J.P. van Doornen (Eds.), Psychophysiology of cardiovascular control (pp. 827-839) [Proceedings of a NATO Conference on Cardiovascular Psychophysiology: Theory and Methods, held June 12-17, 1983, Noordwijkerhout, The Netherlands]. New York: Plenum.

Keinan, G. (1988). Training for dangerous task performance: The effects of expectations and feedback. Journal of Applied Social Psychology, 18(4, pt2), 355-373.

Khachatur'yants, L.S., Grimak, L.P., & Khrunov, Y.V. (1976). Eksperimental'naya psikologiya v kosmicheskikh issledovaniyakh [Experimental psychology in space investigations]. Moscow: Nauka Press.

Khrunov, Y.V., Khachatur'yants, L.S., Popov, V.A., & Ivanov, Y.I. (1974). Chelovek-operator v komicheskom polete [The human operator in spaceflight]. Moscow: Mashinostroyeniye.

Kobasa, S.C, Maddi, S.R., & Kahn, S. (1982). Hardiness and health: A prospective study. Journal of Personality and Social Psychology, 42, 168-177.

Lakein, A. (1973). How to get control of your time and your life. New York: Peter W. Wyden.

Lanzetta, J.T., & Thornton, B. R. (1957). Effects of work-group structure and certain task variables on group performance. Journal of Abnormal and Social Psychology, 53, 307-314.

Larsson, G. (1987). Routinization of mental training in organizations: Effects on performance and well-being. Journal of Applied Psychology, 72(1), 88-96

Lassiter, D.L., Vaughn, J.S., Smaltz, V.E., & Morgan, B.B. (1990). A comparison of two types of training interventions on team communication performance. Paper presented at the 1990 Human Factors Society meeting.

Lauber, J.K. (1984). Resource management in the cockpit. Air Line Pilot, 54 (9).

Lazarus, R.S. (1980). Stress and the coping process. New York: McGraw-Hill.

Lazarus, R.S. & Folkman, S. (1984). Stress, appraisal, and coping. New York: Springer.

Lazarus, R.S., & Monat, A. (1977). Stress and coping-some current issues and controversies. In A. Monat & R.S. Lazarus (Eds.), Stress and coping. New York: Columbia University Press.

Levine, S. (1971). Stress and behavior. Scientific American, 224, 26-31.

Lomov, B.F. (1966). Chelovek i teknika [man and technology] Moscow: Sovetskoye radio.

Lopes, L. (1983). Some thoughts on the psychological concept of risk. Journal of Experimental Psychology, 9, 137-144.

Mackie, R.R., Wylie, C.D., & Evans, S.M. (in press). Fatigue effects on human performance in combat: A literature review [Draft]. Alexandria, VA: US Army Research Institute.

McGrath, J.E. (1970). A conceptual formulation for research on stress. In J.E. McGrath (Ed.) Social and psychological factors in stress. New York: Holt, Rinehart, and Winston.

Meichenbaum, D. (1987). Cognitive-behavior modification: An integrative approach. New York: Plenum.

Michel, R.R., & Solick, R.E. (1983). Review of literature on the effects of selected human performance variables on combat performance (Field Unit Working Paper FLV-FU-83-4). Ft. Leavenworth, KS: US Army Research Institute.

Migdal, K., & Paciorek, J. (1989). Relaxation exercises as a stress reducing factor during simulation training (K. Gebert, Trans). Polish Psychological Bulletin, 20(3), 197-205.

Milgram, N.A., Orenstein, R., & Zafrir, E. (1989). Stressors, personal resources, and social supports in military performance during wartime. Military Psychology, 1(4), 185-199.

Miller, J.G. (1960). Information input overload and psychopathology. American Journal of Psychiatry, 16, 695-704.

Mulder, M., van Eck, J.R.R., & de Jong, R.D. (1971). An organization in crisis and non-crisis situations. Human Relations, 24, 19-41.

Nance, J.J. (1986). Blind trust. New York: Morrow.

Novaco, R.W., Cook, T.M., & Sarason, I.G. (1983). Military recruit training: An arena for stress-coping skills. In D. Meichenbaum & M.E. Jaremko (Eds.), Stress reduction and prevention. New York: Plenum.

NTSB (1979). Aircraft incident report, United Airlines, DC-8, Report No. AAR-79-7, Washington, DC.

NTSB (1990). Aircraft incident report, United Airlines, DC-10, Report No. AAR-90-6, Washington, DC.

Oelz, O., & Regard, M. (1988). Physiological and neuropsychological characteristics of world-class extreme-altitude climbers. American Alpine Journal, 83-86.

O'Mara, K.P. (1979, August). Past performance and mission dictate that the Corps use a two-seat fighter. Marine Corps Gazette, 62.

Payne, J.W., & Bettman, J.R. (1988, June). The adaptive decision-maker: Effort and accuracy in choice. Paper prepared for a conference entitled **Insights in decision making: Theory and applications -- A tribute to Hillel J. Einhorn**, University of Chicago, IL.

Pepitone, D., King, T.A., & Murphy, M. (1988). The role of flight planning in aircrew decision performance (SAE Technical Paper Series 881517). Warrendale, PA: The Engineering Society for Advancing Mobility Land Sea Air and Space.

Pleban, R.J., Thomas, D.A., & Thompson, H.L. (1985). Physical fitness as a moderator of cognitive work capacity and fatigue onset under sustained combat-like operations. Behavior Research Methods, Instruments, and Computers, 17(1), 86-89.

Poulton, E.C. (1976). Arousing environmental stresses can improve performance, whatever people say. Aviation, Space, and Environmental Medicine, 47, 1193-1204.

Predmore, S.C. (1991). Microcoding of communication in accident investigation: Crew coordination in United 811 and United 232. In R.S. Jensen (ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 350-355). Columbus, OH: The Department of Aviation, The Ohio State University.

Rachman, S. (1978). Fear and courage. San Francisco: Freeman.

Ramsey, J.D. (1983). Heat and cold. In G. R. J. Hockey (Ed.), Stress and fatigue on human performance (pp. 33-60). New York: Wiley.

Ramsey, J.D., Burford, C.L., Beshin, M.Y., & Jensen, R.C. (1983). Effects of workplace thermal conditions on safe work behavior. Journal of Safety Research, 14, 105-114.

Robinson, J.A. (1972). Crisis: An appraisal of concepts and theories. In C.F. Hermann (Ed.), International crises: Insights from behavioral research (pp. 20-35). New York: Free Press.

Rognum, I.O. et al. (1986). Physical and mental performance of soldiers on high- and low-energy diets during prolonged heavy exercise combined with sleep deprivation. Ergonomics, 29(7), 859-867.

Ruffell Smith, H.O. (1979). A simulator study of the interaction of pilot workload with errors, vigilance, and decisions (NASA Technical Memorandum 78482). Moffett Field, CA: NASA-Ames Research Center.

Rutenfranz, J., Aschoff, J., & Mann, H. (1972). The effects of a cumulative sleep deficit, duration of preceding sleep period and body-temperature on multiple choice reaction time. In W. P. Colquhuon (Ed.), Aspects of human efficiency (pp. 217-229). London: The English Universities Press Limited.

Schachter, S., Ellertson, N., McBride, D., & Gregory, D. (1951). An experimental study of cohesiveness and productivity. Human Relations, 4, 229-239.

Schuler, K., Gilner, F., Austrin, H., & Davenport, D.G. (1982). Contribution of the education phase to stress-inoculation training. Psychological Reports, 51, 611-617.

Schwartz, G.E., & Beatty, J. (Eds.). Biofeedback: Theory and research. San Francisco: Academic.

Selye, H. (1973). The evaluation of the stress concept. American Scientist, 61, 692-699.

Selye, H. (1977). Selections from the stress of life. In A. Monat & R.S. Lazarus (Eds.), Stress and coping. New York: Columbia University Press.

Shultz, J., & Luthe, W. (1959). Autogenic training: A psychophysiological approach in psychotherapy. New York: Grune & Stratton.

Siebold, G.L. (1990). Cohesion in context. Paper presented at the 32nd Annual Conference of the Military Testing Association, Orange Beach, Al, November 5-9.

Siebold, G.L., & Kelly, D.R. (1987, May). Cohesion as an indicator of command climate. Paper [resented at the Third Annual Leadership Research Conference sponsored by the Center for Army Leadership, Kansas City, MO.

Siebold, G.L., & Kelly, D.R. (1988a). The impact of cohesion on platoon performance at the Joint Readiness Training Center (DTIC Report ARI Tech. Rep No. 812). Alexandria, VA: ARI.

Siebold, G.L., & Kelly, D. R. (1988b). A measure of cohesion which predicts unit performance and ability to withstand stress. In A. D. Mangelsdorff (Ed.), Proceedings Sixth Users Workshop on Combat Stress (Consultation Report #88-003, pp. 12-15). Ft. Sam Houston, TX: US Army Health Services Command. (DTIC Report AD-A199 422)

Siegel, A.I., Pfeiffer, M.G., Kopstein, F.F., Wilson, L.G., & Ozkaptan, H. (1979). Human performance in continuous operations: Volume I. Human performance guidelines (Tech. Rep. 80-4a). Alexandria, VA: US Army Research Institute.

Siegel, A.I., Pfeiffer, M.G., Kopstein, F.F., Wolf, J.J., & Ozkaptan, H. (1980). Human performance in continuous operations: Volume III. Technical documentation. Wayne, PA: Applied Psychological Services.

Siegel, A., & Wolf, J.J. (1969). Man machine simulation models. New York: Wiley.

Slovic, P., Fischof, B., & Lichtens, S. (1978). Behavioral decision theory. Annual Review of Psychology, 28, 1-39.

Smart, C. & Vertinsky, I. (1977). Designs for crisis decision units. Administrative Science Quarterly, 22, 640-657.

Smith, P., et al. (1990). Effects of training with lethal chemicals on job proficiency and job confidence. Paper presented at the American Educational Research Association (ERIC Document Reproduction Service No. ED 319 948).

Spettell, C.M. & Liebert, R.M. (1986). Training for safety in automated person-machine systems. American Psychologist, 41, 545-550.

Starr, L.M. (1987). "Training for safety in automated person-machine systems": Comment. American Psychologist, 42, 1029.

Stepanov, V.N., & Stetanov, E.N. (1979). Engineering-psychological questions oftechnical support in space. In B.N. Petrov, B.F. Lomov, & N.D. Semsonov (Eds.), Psikhologicheskiye problemy kosmicheskikh poletov [Psychological problems of space flights]. Moscow: Nauka Press.

Stewart, N.K. (1987). Miltary cohesion: Literature review and theoretical model. Arlington, VA: Army Research Institute.

Stewart, N.K., & Weaver, S. (1988). A methodological analysis of the link between cohesion and combat stress and post-traumatic stress syndrome. In A. D. Mangelsdorff (Ed.), Proceedings Sixth Users Workshop on Combat Stress (Consultation Report #88-003, pp. 16-20). Ft. Sam Houston, TX: US Army Health Services Command. (DTIC Report AD-A199 422)

Streufert, S. (1983). Load effects on the use of strategy in motivated personnel (DTIC Technical Report AD-P000 818). In Proceedings: Annual Conference of the Military Testing Association (24th) held at San Antonio, Texas, November 1982.

Streufert, S. & Streufert, S.C. (1981). Stress and information search in complex decision making: Effects of load and time urgency (DTIC Technical Report AD-A104 007). Arlington, VA: Office of Naval Research.

Streufert, S., Streufert. S.C., & Denson, A.L. (1982). Information Load Stress, Risk Taking, and Physiological Responsivity in a Visual-Motor Task (DTIC Technical Report AD-A118 079). Arlington, VA: Office of Naval Research.

Streufert, S., Streufert, S.C., & Gorson, D.M. (1981). Time urgency, load, and managerial decision making (DTIC Technical Report AD-A095 969). Arlington, VA: Office of Naval Research.

Streufert, S., Suedfeld, P., & Driver, M.J. (1965). Conceptual structure, information search and information utilization. Journal of Personality and Social Psychology, 2, 736-740.

Stouffer, S.A., Lumsdaine, A.A., Lumsdaine, M.H., Williams, R.M., Smith, M.B., Janis, I.L., Star, S.A., & Cottrell, L.S. (1949). The American soldier: Combat and its aftermath (Vol. II). Princeton, NJ: Princeton University Press.

Svenson, O., Edland, A., & Karlsson, G. (1985). The effect of numerical and verbal information and time stress on jusgements of the attractiveness of decision alternatives. In L.B. Methlie & R. Sprague (Eds.), Knowledge representation for decision support systems. Amstersam: North-Holland.

Swezey, R.W., Llaneras, R.E., Prince, C., & Salas, E. (1991). Instructional strategy for aircrew coordination training. In R.S. Jensen (ed.), Proceedings of the Sixth International Symposium on Aviation Psychology (Vol. 1, pp. 302-307). Columbus, OH: The Department of Aviation, The Ohio State University.

Telfer, R.A., & Ashman, A.F. (1986). Pilot judgement training, an Australian validation study. Unpublished research report, University of Newcastle, New South Wales.

Thomas, M. (1988). Managing pilot stress. New York: Macmillan.

Tijerina, L., Stabb, J.A., Eldredge, D., Herschler, D.A., Mangold, S.J. (1988). Improving shipboard decision making in the CBR-D environment: Concepts of use for and functional description of a decision aid/training system (DTIC Report No. Ad-A207 219). Edgewood, MD: Chemical Warfare/Chemical Biological Defense Information Analysis Center.

Townes, B.D., Hornbein, T.F., Schoene, R.B., Sarnquist, F.H., & Grant, I. (1984). Human cerebral function at extreme altitude. High Altitude and Man, 31-36.

Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judgement frequency probability. Cognitive Psychology, 5, 207-232.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. Science, 211, 453-458.

Villoldo, A., & Tarno, R.L. (1984). Measuring the performance of EOD equipment and operators under stress (DTIC Technical Report AD-B083 850). Indian Head, MD: Naval Explosive and Ordnance Disposal Technology Center.

Wertkin, R.A. (1985). Stress-inoculation training: Principles and applications. Social Casework: The Journal of Contemporary Social Work, 66, 611-616.

West, V. & Parker, J.P. (1975). A review of recent literature: Measurement and prediction of operational fatigue (DTIC Final Report ADA008 405). Arlington, VA: Office of Naval Research.

Westman, M. (1990). The relationship between stress and performance: The moderating effect of hardiness. Human Performance, 3(3), 141-155.

Wickens, C.D. (1984). Engineering psychology and human performance. Columbus, OH: Charles Merrill.

Wickens, C.D., Barnett, B., Stokes, A., Davis, T., & Hyman, F. (1988, October). Expertise, stress, and pilot judgement. Paper presented at the NATO/AGARD Panel Meeting/Symposium of the Aerospace Medical Panel on Human Behavior in High Stress Situations in Aerospace Operations, Hague, Netherlands.

Wickens, C.D., Stokes, A., Barnett, B., & Hyman, F. (1989). The effects of stress on pilot judgment in a MIDIS simulator. (AAMRL-TR-88-057). Wright Patterson AFB, Ohio.

Wilkinson, R.T. (1971). Hours of work and the twenty-four hour cycle of rest and activity. In P.B. Warr (Ed.), Psychology at work (pp. 31-54). London: Penguin Books.

Williams, H.L., Lubin, A., & Goodnow, J.J. (1959). Impaired performance with acute sleep loss. Psychological Monographs, 73, 1-26.

Winget, C.M., DeRoshia, C.W., & Holley, D.C. (1985). Circadian rhythms and athletic performance. Medicine and Science in Sports and Exercise, 17(5), 498-516.

Winget, C.M., DeRoshia, C.W., Markley, C.L., & Holley, D.C. (1984). A review of human physiological and performance changes associated with desynchronosis of biological rhythms. Aviation, Space, and Environmental Medicine, 55(12), 1085-1096.

Wright, P. (1974). The harassed decision maker: Time pressure, distraction and the use of evidence. Journal of Applied Psychology, 59, 555-561.

Zajonc, R.B. (1965). Social facilitation. Science, 149, 269-274.

Zander, A. (1979). The psychology of group processes. In M.R. Rosenweig & L.W. Porter (Eds.), Annual review of psychology, 30, 417-451.