

Judgment and Decision-making under Stress: An Overview for Emergency Managers

Kathleen M. Kowalski, Ph.D., Research Psychologist
Charles Vaught, Ph.D., C.M.S.P., Sociologist
National Institute for Occupational Safety and Health
Pittsburgh Research Laboratory
626 Cochrans Mill Road
Pittsburgh, PA 15102, USA

kkowalski@cdc.gov

Keywords: stress, judgment, decision-making, emergency management, mining

Abstract

This paper discusses human judgment and decision-making under stress. The authors review selected recent literature across various disciplines and suggest a definition of stress within the context of decision-making during the management of emergencies. They also discuss fieldwork by the Pittsburgh Research Laboratory, NIOSH, which explores traumatic incident stress, the relationship between previous training and performance under stressful conditions, and human behavior in underground mine fires. The authors assert that stress is one of the factors that decision-makers must contend with in most life-or-death situations. They suggest that a better understanding of individual's judgment and decision-making activities while under stress would yield a better understanding of how people reach the choices they make in emergencies. This enhanced understanding would be of enormous value to emergency managers, researchers, and policymakers.

1.0 Introduction

Clearly, the effect of stressful conditions on human judgment is of importance to emergency managers. In natural or human-induced emergencies, the decisions that are made in the first minutes, hours, and days are critical to the successful mitigation, damage control, prevention of structure and human loss, control of financial costs, and ultimately the overall conclusion of the disaster. The impact of the effect of stress on professional judgment is significant. During an emergency situation, critical judgments are frequently made under conditions of temporary or prolonged stress. Emergency decision-makers are required to process massive amounts of information, which is sometimes incomplete or faulty, under severe time constraints.

1.1 Definitions

The use of the term “stress” is rooted deeply in the literature. Lazarus and Lazarus (1994, p.220) discuss the use and definition of the word “stress” and note that it was used as early as the fourteenth century to mean hardship, straits, or adversity of affliction. In the seventeenth century, a physicist-biologist, Robert Hooke, tried to help engineers design man-made structures such as bridges, which had to carry heavy loads and resist buffeting by winds, earthquakes and other natural forces that could destroy them. An important and practical engineering task, therefore, was how to design bridges to resist these loads, or stresses. Hooke’s analysis greatly influenced the way stress came to be thought of in physiology, psychology, and sociology – as an environmental demand on a biological, psychological, or social system.

One popular current definition stipulates that “stress is a process by which certain work demands evoke an appraisal process in which perceived demands exceed resources and result in undesirable physiological, emotional, cognitive and social changes” (Salas et al., 1996, p.6). The authors hold this definition as one of the most appropriate for emergency management purposes, because “demand exceeding resource” is a key factor, either in the management of an emergency or in the response of an individual. The focus is on the *demand* -- which may come from numerous sources including the environment, physiological constraints and social factors -- and the human *resource*, which is dependent, again, upon numerous factors including individual perception, training, and experience.

The relationship of stress to judgment and decision-making is an aspect of human behavior that remains relatively unexplored (Hammond, 2000; Gillis, 1993). Consequently, the literature in this area is limited and not always conclusive. Gillis (1993, p. 1355) maintains that “while research on 1) the nature and consequences of stress; and 2) human judgment and decision-making are large and varied, there is virtually no overlap between the two despite the obvious practical importance of the effect of stress on judgments ...” Hammond points out that the notion of stress having an influence on judgment was only first broached during a US Congressional hearing in 1988. At issue was compensation for the victims of Iran Air Flight 655, which was shot down by the American cruiser *Vincennes* over the Persian Gulf. A second hearing was called “to examine the impact of human factors such as stress” on the crew’s performance.

1.2 The Congressional Inquiry Two questions posed during the second Congressional hearing are of interest to this discussion: 1) Does the performance during the shoot-down identify elements of human behavior that are poorly understood? and (2) What have researchers uncovered to date on man’s ability to make rapid and even complex decisions in high-stress environments? (Committee on Armed Services, U.S. House of Representatives, 1989). Four behavioral scientists, identified as expert witnesses, testified and wrote reports to the Defense Policy Panel of the Armed Services in 1989 concluding that we know almost nothing about the extent to which decisions are affected by stressful circumstances, much less the manner in which the decisions are influenced by high-stress environments.

The agreement among these experts was three-fold. First, stress is an area that has not been thoroughly studied and we know little about stress in group situations. Secondly, it is believed that the competence of human judgment is decreased by stress (even though the experts could not cite empirical data). Finally, the scientists concluded that stress narrows the focus of attention, implying a negative impact on judgment. In hindsight, these experts appeared to be completely correct only in their first conclusion - that stress is not a thoroughly studied area of human behavior. Conclusions two and three are discussed further in this paper, and the authors suggest the 1989 analysis was too simplistic.

One recommendation of the Committee to Congress was that stress needed to be studied further. Meanwhile, the American Psychological Association and the National Institute for Occupational Safety and Health (NIOSH) joined forces in 1990, declaring the 90's to be the "Decade of Stress." During that decade, resources and attention were focused on increasing knowledge about the human stress response and its relationship to numerous variables.

1.3 Paper Overview

Over a dozen years have passed since the Congressional hearings on Iran Flight 655, and although no conclusive data on judgment and decision-making have emerged, a number of studies have reached conclusions of interest to those who must make decisions under stress. The research is scattered throughout the social, psychological, physiological, and medical literature with varying degrees of quality and breadth. This paper presents a selection of these studies with the intention of stimulating a dialogue among those managers and others who are responsible for developing models and planning responses that require decision-making in disaster situations.

2.0 Assumptions and key issues

2.1 Stress is affected by perception. It is critical to include the concept of perception when discussing stress in relation to performance, including performance in judgment and decision-making. The reader should note that in Section 1.1, discussing the definition of stress, the key phrase "*perceived demands*" is used. Ability to cope with stress is dependent upon an individual's perception or interpretation of an event. Gillis (1993) suggests that stressful circumstances do not automatically lead to problems in judgment; it is the perceived experience of distress. One obvious implication of such a notion is that an attempt should be made whenever possible to minimize distress by psychological, pharmacological, or other means – before a subject enters the judgmental arena.

2.2 Competence in judgment is always compromised under stress. This particular conclusion of the experts in the 1989 Congressional hearings deserves further evaluation. It is important to note that both *improved performance and performance degradation* have been associated with increased stress (Poulton, 1976). For some individuals, heightened stress elevates their performance. Others are vulnerable to the negative impacts of stress, which results in diminished performance. A physiological example of this positive/negative dynamic of stress is athletic

performance. An athlete desiring to be at an optimal performance level while competing demands an optimal stress level. The stress level should be enough to stimulate top performance, but not enough to over-stress the body, because performance declines as the body moves toward exhaustion.

Studying the effect of stress on performance and judgment, Dorner and Pfeifer (1993) subjected 40 subjects to a computerized forest firefighting game. Half of the subjects were placed under conditions of stress (a disturbing noise) and the others were left to focus on their task. The exercise involved varying levels of difficulty and lasted five hours. The researchers found that subjects under stress performed equally to those not stressed, but their problem solving patterns were different. Stressed subjects focused on the general outline of the problem, while non-stressed individuals relied on in-depth analysis. Consequently, stressed subjects made fewer errors in setting priorities while non-stressed subjects controlled their firefighting operations better.

Two Greek researchers, Kontogiannis and Kossiavelou (1999), examined the decision-making strategies and cooperation patterns used by proven, efficient teams in adapting their behavior to cope with stressful emergencies. The authors conclude that stress restricts cue sampling, decreases vigilance, reduces the capacity of working memory, causes premature closure in evaluating alternative options, and results in task shedding. A study of military commanders (Serfaty and Entin, 1993) found that teams with records of superior performance have one common critical characteristic: They are extremely adaptive to varying demands. The teams in their study could maintain performance using just one-third of the time usually available to make decisions, but the mode of communication changed. Initially, the team responded to explicit requests in communications from commanders. As time pressure increased, they stopped waiting for explicit requests and instead provided commanders with information they implicitly determined would be useful.

The authors suggest that changes from 'explicit' to 'implicit' communication can help teams maintain performance under time pressure. Implicit coordination patterns, anticipatory behavior, and redirection of the team communication strategy are evident under conditions of increased time-pressure. The authors conclude that effective changes in communication patterns may involve updating team members, regularly anticipating the needs of others offering unrequested information, minimizing interruptions, and articulating plans at a high level in order to allow flexibility in the role of front-line emergency responders. The authors found support for the main hypothesis that team coordination strategies will evolve from explicit coordination under low workload conditions to implicit coordination as work load increases.

2.3 Stress is related to information. In studies of escape from underground mine fires, researchers have identified several human behavioral and organizational dimensions relevant to understanding decision-making under duress. First, initial warnings in dangerous situations are often unclear, sometimes due to the way technology behaves, and sometimes due to faulty communication. This

can lead to different interpretations of the problem. Second, people frequently fail to gather the right kinds of information, which prevents them from making appropriate responses. Third, once a decision is made, individuals respond well to a leader; however, if leadership is lacking people tend to become confused. Finally, apparatus (e.g., those used in mine emergencies) may not work as expected or may fail. Thus, emergency decision-makers under stress not only have the effects of their own stress response and its resulting consequences, the information they must base their judgments on is often unclear, faulty, and incomplete (NIOSH, 2000).

2.4 Stress narrows the focus of attention. A primary conclusion of the experts at the Congressional hearing was that stress narrows one's focus. Time pressure studies, where the subject is given a task and a specific, usually unreasonable, time to complete it, generally support this conclusion. Other studies, however, indicate inconclusive results for this conclusion (Hammond, 2000). *Negative information gains* become important under time pressure, because they need to be evaluated and discarded. If a situation involves *risk* (as in response to an emergency), time pressure studies show that the subject becomes more cautious and adopts risk-avoiding behavior with an importance placed on *avoiding losses* (Flanagan, 1954). These studies have shown that under time pressure the *subject adopts a simpler mode of information processing* in which alternatives are not explored fully, and certain important "cues" are used to determine the decision. From these studies, the experts conclude that stress *narrows the focus of attention*. In other words, the focus of attention shrinks, and the individual focuses just on critical issues and elements. This focused attention was assumed to be bad, but it actually may be good because it can eliminate nonessential information and highlight the most important sources.

Citing two studies reported in 1993, Gillis (1993) did not find support for the "narrowing of attention" hypothesis. Keinan et al. (1987) tested the proposition that deficient decision-making under stress is due largely to an individual's failure to fulfill adequately a most elementary requirement of the decision-making process, i.e., the systematic consideration of all relevant decision alternatives. In their study, which required participants to solve decision problems while under stress, one group was put under stress and compared to a non-stress control group. Stress was found to induce a tendency to offer solutions before all decision alternatives had been considered and to scan such alternatives in a non-systematic fashion.

2.5 Dynamic environments impact decision-making. According to Kerstholt (1994), decision-making behavior is considerably affected by the dynamics of environment, because most natural dynamic situations contain much uncertainty. He notes that a dynamic situation continually changes, and thus a decision-maker has to take temporal changes into consideration. He further notes that a decision-maker can use feedback on the effect of his/her actions on the system. In other words, as decisions are made and action is taken, the results of the decision may be taken into consideration and the information used in subsequent decisions. Additionally, in dealing with the uncertainty of a continually changing environment, the decision maker must achieve a trade-off between the cost of action versus the risk of non-action.

To test his hypothesis Kerstholt conducted a computer experiment in which subjects had to control a system that changed over time. In this experiment, the subjects had to monitor the continuously changing fitness level of a simulated athlete, and prevent him/her from collapsing. Information requests were treated as costs in the subjects' incentive system, and correct treatments were treated as benefits. The decision-making strategy remained constant. False alarms and "real" change in system parameters represented sources of deterioration in the system. Time pressure in the study was related to the development of the situation itself, and the allocation of time had to be correlated to the risk of negative consequences and the cost of delaying further information requests. The results showed a general speed-up of information processing as time pressure increased. Under high levels of time pressure, this strategy led to a significant increase in system crashes.

It is interesting to note that requests for information were not congruent with conditions – subjects tended to wait until an already deteriorating situation had further deteriorated before acting. It can be assumed that if information is expensive in time, and actions are cheap, subjects will be more inclined to use an action-oriented strategy. To the contrary, subjects did not select the most efficient strategy – they chose further information over action. Results indicated that selection of a decision strategy in dynamic tasks is less adaptive than is generally concluded from studies with static tasks.

Kidd et al (1996) linked stress and injury in another dynamic environment – farming. In a three-step secondary analysis of focus group data, one of their conclusions stated, the dimensions of workload that were particularly important included job and task complexity and lack of time. Both of these dimensions are relevant to the emergency worker. Further, as a preventative measure, the researchers suggested that a decrease in the number of roles performed exclusively by one individual could improve successful task performance.

2.6 Stress affects behavior in emergencies. There are limited studies regarding *the effects of stress* on behavior in emergencies. Researchers working with the United States mining industry have explored the issues of traumatic incident stress in mine disasters (Kowalski, 1995), burnout (Kowalski and Podlesny, 2000) stress levels related to training during a simulated escape through smoke (Vaught et al., 1997), and behaviors in underground mine fires (NIOSH, 2000). In the training study, small groups of miners were required to don self-contained self-rescuers (breathing apparatus), enter an area of an underground limestone mine that had been filled with non-toxic theatrical smoke, and travel approximately 270 meters to a door, through which they exited into fresh air. Individual subjects then provided a self-report of their experiences on questionnaires administered immediately upon completion of their walk through smoke. The general finding was that miners who had more experience or training also tended to report less stress during the exercise.

In the study of worker behaviors in underground mine fires, researchers examined eight cases in which groups of miners had escaped their workplaces through smoke. One goal was to determine whether it would be possible to model those factors that impact one's ability to make good decisions during an emergency. The researchers suggested that any person engaged in decision-making is actively involved in a process characterized by certain elements: 1) detection of a problem; 2) definition or diagnosis; 3) consideration of available options; 4) choice of what is seen to be the best option given the perceived needs; and 5) execution of the choice based on what has transpired. At any moment in this process, several factors significantly impact one's ability to solve complex problems in a limited time: 1) psychomotor skills, knowledge, and attitudes; 2) information quality and completeness; 3) stress - generated both by the problem at hand and any existing background problem; and 4) the complexity of elements that must be attended to. The resulting model posited interactions among the major components, so that heightened stress, for instance, might interfere with an accurate diagnosis, while an accurate diagnosis would lead to lowered stress levels.

3.0 Analytical vs. intuitive judgment under stress

There is an assumption that the best decisions are rational – based on logic and factual information. This assumption has implications for the discussion of judgment and decision-making under stress. Researchers have tended to look at reason and emotion separately. A value has been placed on decisions made with reason: “. . . it is a careless – but common – usage to suggest that when we make bad decisions, they are based on emotion, but when we arrive at good decisions, they are based solely on reason” (Lazarus and Lazarus, 1994, p.199). Hammond posited that different situations demand different forms of cognitive activity, some calling for increased analytical cognition, and others calling for increased reliance on intuition. Both situational analysis and people's reactions to them are key as we learn about judgment and stress.

It is instructive to examine some instances of judgment under stress in which decision-makers followed different paths but achieved successful outcomes. Hammond describes the following:

Case 1: The USS Samuel B. Roberts, operating in the Persian Gulf, struck a mine, caught fire, and began to sink. The Roberts' captain, Commander P.X. Rinn, drawing upon his training and experience, analyzed the situation and determined a course of action directly opposed to Navy protocol. Realizing, from his knowledge of how much water the ship could take on and still stay afloat, that the Roberts would sink before his crew could extinguish the fire, Commander Rinn made a decision to focus on keeping the ship afloat and give the fire second priority. He is on record as having arrived at his decision analytically, based on available information, training, and operational experience.

Case 2: A United DC-10, on its way from Denver to Chicago, lost its hydraulic fluid, and hence, its controllability. Captain Al Hayes and his crew had to discover an alternative way to fly the plane by using the throttles – something their training had not prepared them for – and do it with few of the cues usually available to pilots. That they were able

to land with minimal loss of life may be attributed to intuitive decision-making under stress.

The two cases cited by Hammond portray decision-making under stress within two scenarios: one where the training of the decision-maker was readily applicable, and one where the decision makers' training had not prepared them for the exigency they faced. Yet, both instances involved individuals who were highly trained. In many dynamic settings, such as mining, those who are forced to make decisions in emergency situations have little training. That is because mines, fishing boats, and logging operations, among others, are dedicated to production activities rather than to emergencies. Thus, their personnel may have had minimal drilling on how to react during crises. Their decisions must, almost of necessity, be based on intuition or fragmentary knowledge.

Considering this issue of analytical vs. intuitive judgment, a NIOSH (2000) report observed:

“The point here is that research which focuses on judgment must include scrutiny not only of decisions that are made, but also of real-world variables that influence them. The quality of any decision may have little or no direct relationship to the eventual outcome of its execution in a given situation. This is because a decision-maker is constrained not only by the stress of the situation or personal knowledge and attitudes, but also because he or she can only weigh information that is available.”

Acknowledging the complex context of concrete decision-making environments and their various sources of stress is a first step to understanding the skill of decision-making and learning to evaluate the abilities of decision-makers.

4.0 Conclusions and observations

Growing research interest has led to the question of what factors influence a person's ability to make good decisions during an emergency. There is still little agreement on how to define those basic concepts, including stress, necessary to assess the soundness of decisions from within both environmental and group contexts. The need to better understand judgment and decision-making under stress stems from high-risk occasions and emergency situations. The fundamental assumption is that, while there are untold successes, there are also notable failures resulting from decisions that can be ascribed to one or more errors in judgment. What part, then, does stress play in the commission of these errors? From a cognitive perspective, any person engaged in decision-making (either alone or in a group) is actively involved in a process characterized by certain elements. At any moment in this process, there are factors that have a large impact upon one's ability to solve complex problems in a limited time.

So what is the advice for the emergency manager based on the data? Unfortunately, the authors cannot offer a “list” of factors to consider in judgment and decision-making under stress. The present, limited data does not support such an approach. There are serious limitations to generalizing from laboratory studies to real-life emergencies. We know that there is an

interaction, that human stress affects human decision-making. What we do not know is the exact nature of that interaction.

The research suggests that successful teams communicate amongst themselves and as the emergency intensifies, a flatter communication hierarchy develops with more (unsolicited) information coming from the field to the command center. Command Center personnel can facilitate and encourage this type of information. Stress is affected by perception; it is the perceived experience of stress that an individual reacts to. An implication of this notion, is that an attempt should be made to minimize distress for the responders by psychological, pharmacological or other means before entering the judgmental arena. Contrary to popular opinion, judgment is not always compromised under stress. Although stress may narrow the focus of attention (the data is inconclusive), this is not necessarily a negative consequence in decision-making, as some studies show that the individual adopts a simpler mode of information processing which may help in focusing on critical issues. Decisions can only be made based on the information available, and studies have shown that many times decisions are made with incomplete information. In addition, the issue of training plays a part in stress and decision-making.

Regarding the development of decision support systems, the authors offer several suggestions. Decision support programs should be tested under conditions of stress (time pressure is one option) to evaluate their effectiveness. Simulations should be used to replicate stress conditions in the field. New simulations should include a stress component, taking into consideration the issues presented in this paper. A simulation should also take into account the increased need, as an emergency progresses, for explicit and implicit information to be received from the field and integrated into the decision-making process.

This paper has suggested that a better understanding of the interplay between stress and an individual's judgment and decision-making activities would yield a better understanding of how people reach the choices they make in emergencies. As far as studies of judgment and decision-making are concerned, the limited literature in this area suggests a strong need for increased attention to the topic.

Stress is one of the key factors that underlies the demands on decision-makers in most life-or-death situations. Whether the individual is a naval commander, an airline pilot, a mineworker, or an emergency manager who has access to a decision support system, an emergency makes it necessary to deal with an enormous number of variables in a rather short time- frame.

Authors:

Kathleen M. Kowalski, Ph.D. is a Research Psychologist, certified Mine Trainer, and psychotherapist. She received her B.S. and M.S. from the University of Wisconsin-Madison and her Ph.D. from the University of Pittsburgh. Dr. Kowalski is on the TIEMS Board of Directors and Vice-President for Membership.

Charles Vaught, Ph.D. is a Certified Mine Safety Professional with a Ph.D. in the sociology of organizations from the University of Kentucky. His memberships include the American Sociological Association, the International Society of Mine Safety Professionals, and the United States Mine Rescue Association.

References

- Committee on Armed Services, U.S. House of Representatives (1989). Iran air flight 655 compensation. H.A.S.C. No. 100-119. Washington, D.C.: U.S. Government Printing Office.
- Dorner D. and Pfeifer F. (1993). Strategic thinking and stress. *Ergonomics* 36 (11):1345-1360.
- Flanagan, J. (1954). The critical incident technique. *Psychological Bulletin*, 51, 327-358.
- Gillis, J.S. (1993). Effects of Life Stress and Dysphoria on Complex Judgments. *Psychological Reports*, 72, 1355-1363.
- Hammond, K.R. (2000). *Judgments Under Stress*, Oxford University Press, Inc. New York, New York.
- Keinan, G., Friedland, N. Ben-Porath, Y. (1987). Decision-making Under Stress: Scanning of Alternatives Under Physical Threat. *Acta Psychologica* 64, 219 - 228, Elsevier Science Publishers B.V. North Holland.
- Kidd, P., Scharf, T, Veeazie, M. (1996). Linking stress and Injury in the Farming Environment: A Secondary Analysis of Qualitative Data. *Health Education Quarterly*, Vol. 23 (2): 224-237.
- Kontogiannis, T. and Kossiavelou, Z. (1999). Stress and team performance: principles and challenges for intelligent decision aids. *Safety Science*, Vol. 33, Issue 3. December 103 - 128.
- Kowalski, K.M. (1995). A human component to consider in your emergency management plans: the critical incident stress factor, *Safety Science* 20 115-123.
- Kowalski, K.M., Podlesny, A. (2000). *The Effects of Disaster on Workers: A Study of Burnout in Investigators of Serious Accidents and Fatalities in the U.S. Mining Industry*.
- Lazarus, R.S. and Lazarus, B.N. (1994). *Passion and reason: Making sense of our emotions*. New York: Oxford University Press.
- NIOSH (2000). *Behavioral and Organizational Dimensions of Underground Mine Fires*. Information Circular 9450. Authors: Vaught, C., Brnich, M., Mallett, L., Cole, H., Wiehagen, W., Conti, R., Kowalski, K., Litton, C. U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health NIOSH Publication dissemination Cincinnati, OH.
- Poulton, E.C. (1976). Arousing environmental stresses can improve performance, whatever people say. *Aviation, Space, and Environmental Medicine*, 47, 1193-1204.
- Salas, E., Driskell, E., and Hughs, S. (1996). The study of stress and human performance. In: Driskell, J.E. and Salas, E. Editors, 1996 *Stress and Human Performance* Lawrence Erlbaum Associates, New Jersey, pp. 1- 45.
- Serfaty, D. and Entin, E.E. (1993). Adaptation to Stress in Team Decision-Making and Coordination, *Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting* Vol. 2, pp 1228 - 1232. Santa Monica, CA: Human Factors and Ergonomics Society.

Vaught, C., Mallett, L., Kowalski, K. Brnich, M. (1997). Workers Response to Realistic Evacuation Training. The International Emergency Management Conference Proceedings, Riso National Laboratory, Copenhagen, Denmark.