Modeling the Effects of Stress: An Approach to Training

Taryn Cuper
MYMIC LLC
taryn.cuper@mymic.net

Abstract. Stress is an integral element of the operational conditions experienced by combat medics. The effects of stress can compromise the performance of combat medics who must reach and treat their comrades under often threatening circumstances. Examples of these effects include tunnel vision, loss of motor control, and diminished hearing, which can result in an inability to perceive further danger, satisfactorily treat the casualty, and communicate with others. While many training programs strive to recreate this stress to aid in the experiential learning process, stress inducement may not always be feasible or desired. In addition, live simulations are not always a practical, convenient, and repeatable method of training. Instead, presenting situational training on a personal computer is proposed as an effective training platform in which the effects of stress can be addressed in a different way. We explore the cognitive and motor effects of stress, as well as the benefits of training for mitigating these effects in real life. While many training applications focus on inducing stress in order to "condition" the stress response, the author explores the possibilities of *modeling* stress to produce a similar effect. Can presenting modeled effects of stress help prepare or inoculate soldiers for stressful situations in which they must perform at a high level? This paper investigates feasibility of modeling stress and describes the preliminary design considerations of a combat medic training system that utilizes this method of battlefield preparation.

1.0 INTRODUCTION

Stress is defined as *a condition typically characterized by symptoms of mental and physical tension and strain that can result from a reaction to a situation in which a person feels threatened, pressured, etc* [1]. The effects of stress manifest both emotionally and physiologically and can be beneficial or detrimental to performance, depending on the level of stress and performance requirements. In the case of a combat medic, stress levels can be expected to be extremely high as the lives of both the medic and his comrades are at risk. In addition, the medic's performance requirements are complex, demanding both gross (e.g. running) and fine (e.g. applying a tourniquet, firing a weapon) motor skills as well as unaffected cognitive functioning. Therefore, it is important to take into account the effects of stress when designing any combat medic training program in order to adequately represent realistic situations and to prepare medics with the tools and strategies to effectively do their job.

This paper describes an investigation into the concept of stress response modeling and its inclusion in the design of a Complex Incident Response Training System (CIRTS) for Combat Medics (CM). The CIRTS-CM design is of a PC game-based system for training combat medics to respond to IED-ambush scenes. While the primary foci of CIRTS-CM are site management and casualty care, the integration of stress is considered an important element of providing a realistic approach to this type of training.

2.0 BACKGROUND

The emotional effects of stress include fear and anxiety while physiologically, stress results in, for example, an increased heart rate. Stress also affects cognitive functioning. When cognitive load surpasses capacity, the result can be decreased perception of the environment and an inability to think through known processes or to problem-solve [2]. Though the domains of the effects of stress are often addressed separately, that is not to assume they are exclusive of one another. Instead, the effects of stress are interrelated mechanisms that are divisible only by how they present in the face of a stress source, or *stressor.*

2.1 Physiological effects of stress

Siddle [3] refined reported effects of stress to physiological measurements, linking the deterioration of fine motor skills and cognitive functioning and the enhancement of gross motor skills to increasing heart rate:

- >115 bpm: loss of fine motor skills
- >145 bpm: loss of complex motor skills; visual system decreases the peripheral view and attention

- >175 bpm: gross motor skills only; auditory exclusion; tunnel vision; "freezing"; deterioration of depth perception; deterioration of information processing skills

This relationship between performance and heart rate can be explained by the Inverted U Hypothesis, which states that performance increases with arousal (e.g. heart rate) up to a certain point, at which time performance starts to deteriorate. Levitt's research supports both this hypothesis and Siddle's findings, defining this point of descent at 145bpm, with optimal performance between 115 and 145 bpm; heart rates below 80 and above 175 bpm correspond to poor performance [4].

These increases in arousal can affect almost all aspects of performance, especially vision, hearing, physical movement, and cognitive abilities, either singularly or in combination [5] depending on the length and severity of an engagement [6]. Following are some selected physiological effects of combat-related stress from a collection of first-person reports compiled by Artwohl & Christensen [7]:

- Auditory exclusion: Inability to hear or severely diminished hearing of one's own and other's gunfire, as well as sirens and verbal communications; hearing a "pop" noise and/or the sound of the weapon's slide moving forward and backward instead of the gunshot; sound of one's own gunfire sound very far away. In addition, inability to hear the shot or explosion that is close enough to harm.

- Tunnel vision or perceptual narrowing: seeing only the ring on a shooter's finger while being fired at; focusing so intently on the adversary's pistol, the office shot it and the trigger finger out of his hand; leveraging this phenomena on an adversary by side-stepping to gain the advantage. In addition, the rare occurrence of complete loss of sight, a rare occurrence.

- "Scared speechless": inability to speak intelligibly into radio; making a "weird, inarticulate garbling sound" instead of speaking; focus on training police officers to give specified verbal instructions constantly so that this is an automatic response in a real situation.

- Slow-motion time: time slowed so that an officer felt he could consider options and carefully aim in what was actually an extremely quick movement; ability to see bullets in the air as if they were low-velocity projectiles, e.g. paintball rounds.

A similar phenomena to these experiences is hypervigilance [8]. Hypervigilance is characterized by freezing in place or existing in a state of extreme agitation in reaction to perceived threat. In such cases, an individual may persist in a frantic search for escape routes, perform irrational actions, or perform the same actions over and over again though they have proven ineffective at achieving the individual's goal. Each of these reactions can be found within the effects of high performance anxiety, which is characterized by the, "temporary loss of cognitive efficiency and a temporary loss of perceptual acuity, perceptual-motor coordination, and motor skills," [9]. This similarity in the effects of combat related stress and anxiety indicates that hypervigilance is a complex response to both a perceived threat and a lack of confidence in one's ability to control the threat.

2.2 Coping with and/or overcoming the effects of stress

Training to expected conditions is a common way to prepare individuals for the challenges they will face in a real-life situation. This can be accomplished via live exercise with varying levels of simulation augmentation [10] wherein trainees have direct exposure to real-life or close to real-life stressors. One of the goals of this approach is to make training the first place these stressors are experienced to hopefully mitigate their debilitating effects on an individual when his life is threatened and/or his performance is a determining factor of others' survival.

Stress Inoculation Training (SIT) extends this approach, utilizing lessons learned from cognitive behavioral therapy. This process consists of three phases: conceptualization, skills acquisition and rehearsal, and application and follow through [11]. During the conceptualization phase, the trainee is educated about the nature and possible impacts of stress and trained to view stressors as problems to be solved; in this way, the trainee's mental model of the stress has been modified. Next is the skills acquisition and rehearsal phase, in which coping skills are taught and practiced in a "laboratory" setting. Last, during application and follow-through, trainees apply the coping skills in increasingly stressful situations, such as realistic training scenarios. SIT has been successful at enhancing one's skill at coping in extremely stressful situations, such as military combat [12] [13]. A particularly significant aspect of SIT is the conceptualization phase, in which trainees are educated about the effects of the stress they will encounter.

2.3 Survival stress management

Survival stress management can be best characterized by first examining Martens' definition of stress [14], which emphasizes threat perception, perception of response capability, and perception of time required for effective threat management. Survival stress management training addresses these perceptions, the primary goal of which is to increase the trainee's confidence in his own capabilities; remaining training goals include experience, visualization, and breathing [3].

As mentioned in the discussion above on the relationship between the effects of fear and anxiety, confidence is a determining factor of the strength of one's survival stress response. Building this confidence takes a two-pronged approach: confidence in the specific skills to be performed and confidence in the context in which the skills are performed. As such, the trainee builds this confidence through both skills training and effectiveness and experience through dynamic exercises.

Recognition of the symptoms leading to adverse effects of stress is a key component of learning to control these effects. Situational awareness plays a role in this step as trainees learn to recognize potential threats and visualize Plan A and Plan B responses. This objective is enhanced by the last training goal of breath control. Among other physiological effects, controlling the rate of breathing can result in a lower heart rate, thereby minimizing the physiological effects of stress associated with bpm above.

3.0 CIRTS-CM PRELIMINARY DESIGN FOR STRESS

Some training modalities are not amenable to stress inducement; in these cases, direct exposure to stressors may not be practical, feasible, or desired. For example, consider the training environment of the CIRTS-CM. In this case, it is not feasible to impart fear for one's life or the physical effects of running for cover to the trainee when they are safely located in a training room in front of a computer. While the trainee may become so engrossed in training that an accompanying increase in heart rate is experienced, this physiological response will not meet the levels experienced in combat.

In addition, it is not desirable for this tool to induce stress for the purpose of eventual inoculation as this additional training focus may take away from the stated training goals of the system. However, in recognition of a desire for elevated engagement and realism, the element of stress will be addressed in a manner that can be adequately executed on a PC as well as enhance the training goals of the system.

Teaching the effects of stress, not only the effects on perception but also on the accompanying effects on job performance, is a unique opportunity for game-based training. The proposed approach to this challenge is *stress response modeling*. This concept is similar to the conceptualization stage of SIT, in which trainees are educated about the effects of stress. It also addresses the Visualization training goal of survival stress management, in which trainees learn to recognize the onset of survival stress in order to take steps towards mitigation. In this environment, stress response modeling can occur in situ; the nature of the model presents the effect of stress while the resulting inability of the trainee to perform actions that require that perceptive capability compromises performance in the game, as it would in real life. This representation thereby enhances the realism of training modality.

For example, the CIRTS-CM will impose the effect of tunnel vision on the player by blacking out the periphery of the screen. Another possibility is muting the sound temporarily to replicate auditory exclusion. These models can serve as practical experience to reinforce the education of the medic as to what can happen to him in a real-life, stress inducing scenario.

In addition to modeling the effects of stress to the trainee, CIRTS-COM will address the element of stress with regard to task difficulty. External stimuli, i.e. visual and auditory stimuli, will build from level to level, requiring high performance in the face of diminishing cognitive resources.

4.0 DISCUSSION

While examples of human stress response modeling are not common, two similar approaches were identified and are explained below.

One example leverages technology to educate people on the effects of cognitive states other than stress. In the domain of abnormal psychology, the University of California at Davis has created the Virtual Hallucinations Project, which seeks to educate by modeling an exemplar experience of schizophrenia for visitors in the Second Life virtual world [15]. Virtual Hallucinations presents visitors with auditory and visual "hallucinations" similar to what a schizophrenic might experience. This use of computer-based stimuli to communicate the physiological effects on perception is very similar to the stress response modeling concept presented in this paper.

In addition, flight simulation training provides instances that further support this idea. For example, Microsoft's Combat Flight Simulator 3, a PC-based flight simulation application, incorporates G-force effects such as vision degradation and blackout. It recognizes the significance of these effects by making G-tolerance a criteria for pilot profile selection and skill point allocation [16]. Other simulators incorporate similar blackout simulation capabilities, such as Aero-Elite for PlayStation 2, Falcon 4, and Aces High for PC.

G-force blackout modeling is a controversial aspect of flight simulation. Critics claim the models are not accurate and thereby detract rather than add to realism [17]. Supporters respond by highlighting the unrealistic nature of a pilot who is not affected by any level of G-Force (while in some cases the non-player character opponents are affected by G-force). This school of thought maintains that some representation of G-Force effects is better than none when the end goal is to cause the pilot to discontinue high-G maneuvers [18].

5.0 CONCLUSION

While using physics models to simulate the effects of environmental stimuli are a common way to utilize technology in training, examples of similarly modeling human responses to external stimuli are rare. However, it appears possible that this approach might serve some benefit to combat medics who might experience and be confused by the effects of stress in real life situations by providing them with the knowledge of what these effects are and how these effects can hinder performance. This promises to be an effective method for addressing the non-training focus element of stress in PC game based training.

6.0 REFERENCES

[1] Agnes M & Guralnik DB (Eds.). (2007). *Webster's New World College Dictionary*. Wiley Publishing Inc: Cleveland, OH.

[2] Hockey GRJ. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. *Biological Psychology*. 45:73-93.

[3] Siddle BK. (1995). *Sharpening the Warrior's Edge: The* Psychology *& Science of Training*. PPCT Research Publications: Belleville, IL.

[4] Levitt S. (1972). The effects of exercise induced activation upon simple, two-choice and five-choice reaction time and movement time. Doctoral Dissertation.

[5] Grossman D & Christensen LW. (2007). *On Combat: The Psychology of Deadly Conflict in War and in Peace*. PPCT Research Publications.

[6] Huey BM & Wickens CD. (1993). Workload factors. *In Workload transition: Implications for individual and team performance* (pp. 54–93). Washington, DC: National Academy Press.

[7] Artwohl A & Christensen LW. (1997). *Deadly Force Encounters*. Paladin Press: Boulder, CO.

[8] Janis IL & Mann L. (1977). *Decision making: A psychological analysis of conflict, choice, and commitment*. Free Press: New York, NY (Accessed July 2009 at: http://www.cedu.niu.edu/~fulmer/groupthink.htm).

[9] Janus I, Defares P, & Grossman P. (1983). Hypervigilant reactions to threat. In H. Selye (Ed.), *Selye guide to stress research*, Vol. 3. Scientific and Academic Editions: New York.

[10] Seibel JA. (2009). *Reality-based training: Skill development in Survival Stress Response.* Department of Interdisciplinary Technology, School of Police Staff and Command. Flint, Michigan.

[11] Meichenbaum D (1996). Stress inoculation training for coping with stressors. *The Clinical Psychologist*. 49:4-7.

[12] Meichenbaum D. (1994). Stress Innoculation Training: A treatment and preventative approach. in Lehrer PM, Woolfolk RL, & Sime WS (Eds.). (2007). *Principles and Practice of Stress Management* 3rd Edition. Guilford Press.

[13] Novaco RW. (1977). Stress inoculation: a cognitive therapy for anger and its application to a case of depression. *Journal of Consulting and Clinical Psychology*. 45(4): 600-608.

[14] Martens R. Arousal and motor performance. *Exercise and Sports Sciences Reviews*. 2(1): 155-188.

[15] Cook J. UC Davis: Virtual Hallucinations Project. In Linden Lab's *Second Life* virtual world. Accessed May 2009 at: http://slurl.com/secondlife/sedig/27/45/22/.

[16] Rymaszewski M. (2002). *Combat Flight Simulator 3: Sybex official strategies and secrets*. Sybex, Inc..

[17] "Smoke"CO. (1999). Blackout modeling in sim design. Combatsim.com. Accessed August 2009 at: http://www.combatsim.com/htm/may99/blackout.htm.

[18] Crenshaw D "Crash". (2009). To blackout or not to blackout. Aviation and Air Combat. Accessed August 2009 at: http://www.simhq.com/_air/air_03 6a.html