AU/ACSC/2016

AIR COMMAND AND STAFF COLLEGE

AIR UNIVERSITY

THE WAY OF THE GUN: APPLYING LESSONS OF GROUND COMBAT TO PILOT TRAINING

by

Andrew N. Wittke, Major

A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

Instructor: Dr. Marcia Ledlow

Maxwell Air Force Base, Alabama

29 February 2016

DISCLAIMER

The views expressed in this academic research paper are those of the author and do not reflect the official policy or position of the US government or the Department of Defense. In accordance with Air Force Instruction 51-303, it is not copyrighted, but is the property of the United States government.

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Over the past thirty years, ground combatants have experienced tremendous increases in lethality, survivability, and resilience compared to soldiers of old. All of these increases are a direct result of improved understanding of how human beings operate, particularly under the stress of deadly threat. This improved training revolution began in the 1980s with the human performance movement, driven by an Army Research Institute study on enhancing human performance. The results of these studies created a large stir, and had numerous offshoot works in multiple disciplines—self-help books for executives, performance imagery works for athletes, and of particular use to this thesis—the genesis of a new discipline—warrior science.

The realm of warrior science has sought to quantify what master martial artists have known for thousands of years—humans can effect how their bodies operate through understanding, proper training, and performance imagery. The successes demonstrated by stress inoculated ground combatants and police officers over the last decade have proven warrior science right. This thesis identifies the transferable skill sets and training methods compatible with manned flight to be adopted and integrated into the training of USAF pilots. It also provides a background on the ground combat training revolution, an overview of the science of acute reactive stress, Stress Inoculation Training (SIT) and a cross-disciplinary analysis between ground combat and air. This project employs a problem/solution framework to evaluate what practices and methods are compatible and transferable, and how they may be best implemented into the USAF pilot community, because as it stands, USAF pilots have not benefitted from this training revolution.

INTRODUCTION

I've been involved in three shootings. Before the first two, I had no training in what to expect. I performed well, but felt shocked, disoriented, confused, and at times out of control by all the weird stuff that I experienced during and after the shooting. I didn't know what to think and that made it harder to cope during and after the event. After the second shooting, I sought counseling and learned about all that weird stuff I'd been experiencing. The doctor also taught me the principles of Stress Inoculation Training and I started using it to prepare myself for the future. Then when I got into another situation, the training made all the difference in the world. This time I knew what to expect, and I was even able to control and compensate somewhat for the tunnel vision, sound distortions, and other strange things my mind and emotions were going through. I also bounced back a lot quicker because I knew I wasn't crazy and I knew what to do to take care of myself.[1]
Anonymous police officer

The above testimonial is one anecdote of many praising the effectiveness of Stress Inoculation Training (SIT). This thesis will explain how the human body works under stress, how SIT is conducted, and why it is effective. It also seeks to answer the question, how can the pilot training community harness the best practices of the ground combat SIT community to teach pilots to prepare for and deal with acute reactive stress?

As it stands, human error remains the number one cause of aviation incidents, many of which are fatal. Law Enforcement (LE) and Special Operations Forces (SOF) incorporated SIT to save lives, and it has. The USAF mishap rate has remained steady for decades, around 1.5 mishaps per 100,000 flight hours.[2] Hidden inside this nebulous mishap rate are thousands of lives lost, and undoubtedly survival stress reactions have played a central role in many of them. Unfortunately, fatal aviation mishaps tend to leave little evidence to prove elevated stress hormone levels of the pilots, but numerous studies on stress prove that a deadly threat stimulus will cause a survival stress hormone dump.

Serious emergencies, bad weather, unfamiliar tasks, or various combat situations will likely do exactly that.

Studies have proven an increase in heart rate due to stress hormones decreases cognitive abilities, increases reaction times, reduces fine and complex motor control, and causes operators to make unsatisfactory decisions.[3] [4] The techniques ground combat instructors teach to mitigate the effects of high-levels of stress originate in the realm of sports performance psychology. Warrior science pioneers Bruce Siddle and Dave Grossman effectively cross-disciplined these powerful concepts into LE and SOF training with impressive results.

Considering the common operating system of the human body's nervous system, the training techniques and courses of instruction that have worked in ground combat will likely yield similar results in air combat. Due to the enormous cost and possible risks to human life, an experimental, quantitative study on the effectiveness of this specific type of training on combat pilots has not been undertaken in a live flight atmosphere. NATO, however, conducted a simulator exercise with results proving F-16 pilots experience hormone dumps in serious situations, and it negatively affected the outcome in several situations.[5] Assumptions can be made in regards to the effectiveness of the training between air and ground, due to the common operating system and the commonalities of the operating environment. Instructing pilots in the topics proven beneficial to ground combatants should result in similar performance increases.

"Fear makes men forget, and skill that cannot fight, is useless."
Phormio of Athens, 429 BC

Problem Background

In the last decade, LE and SOF communities have undergone a training revolution through academics on the psychology and physiology of stress, coping strategies training, and high-stress simulations that educate operators on how their brains and bodies work in intensely stressful situations—in essence, their survival software. This cognitive training allows police officers and operators to thrive and survive under the intense stress of police work and ground combat. Specifically, highly-dynamic, realistic, and acutely stressful force-on-force training coupled with performance imagery, stress perception and physiology management training has improved officer decision making, resulting in less rounds fired, increased hit rates by large margins, and often reduced officer-involved shootings altogether.[6]

While officer-involved shootings may mean little in the realm of pilot training, the performance imagery exercises taught to our police brethren are unwritten doctrine for student pilots in the USAF, whether they know it or not. From the first day of Undergraduate Pilot Training (UPT) until graduation from their Basic Course two years later, students are constantly tasked to *chair fly*, a term used to encourage mental rehearsals of tasks, maneuvers, and missions. Currently, there are no academic sessions or formal instruction of any kind on exactly *how* to chair fly. If taught correctly, chair flying could be "performance imagery" sessions, which are scientifically proven to be almost effective as actual practice repetitions.[7]

Current USAF Crew/Cockpit Resource Management (CRM) and Aerospace Physiology courses do not include any instruction on the psychology and physiology of stress, or how to manage sympathetic nervous system (SNS) responses during time-

critical, high-arousal events, referred to as acute reactive stress. Yet human factors remain the single greatest causal factor in accidents (73 percent), costing the USAF many lives and millions of dollars in assets.[8] It is plausible that at least a few of these mishaps are due, at least in part, to incorrect action or inaction from acute reactive stress.

There are numerous studies on improving pilot selection and managing attrition, but little exists on improving the stress-resilience of current students, instructors, or graduates of USAF pilot training. The USAF mandates that hazards associated to human factors be briefed prior to every sortie; however, they are limited to: channelized attention, task saturation, prioritization, and complacency.[9] Air Force Risk Management (RM) directs all Air Force members to identify risks and hazards by a deliberate process.[10] In practice, pilots mark boxes with numerical values next to possible risk factors, many of them human-factors. If the numbers exceed a specified value, approval to execute the sortie rises to higher levels of leadership commensurate with score. Yet, most of the RM factors scored regard external factors of stress (life stress) and not survival stress experienced in a high-threat emergency procedure.[11] Additionally, USAF efforts toward increasing resilience USAF-wide tends to focus on life stress and other external factors.[12] With regard to pilots, the psychological and physiological effects of stress endemic to the human operating system do not seem to be on the USAF's radar.

"There are 100 billion stars in the Milky Way galaxy, roughly the same number of neurons in our brain. You may have to travel twenty-four trillion miles, to the first star outside our solar system, to find an object as complex as what is sitting on our shoulders."[13]

Michio Kaku The Future of the Mind

Problem Analysis

Three types of stress affect aircrew performance: life stress, environmental stress, and acute reactive stress.[14] USAF Crew Resource Management and Resilience programs primarily focus on life stress and crew-related environmental stress. Human psychological and physiological reactions to acute reactive stress is not discussed or trained in USAF Undergraduate Pilot Training (UPT), or any formal program before or after UPT. This thesis will focus on acute reactive stress and its effect on pilots because the body's identification of a potentially deadly threat can cause acute reactive stress, severely compromising a pilot's ability to recover the aircraft.

To obtain a thorough understanding of how stress affects human function, one must explore the disciplines of biology, chemistry, physiology, and psychology. The primary discipline that encompasses all of these is the discipline of neuroscience—the scientific study of the nervous system. The study of neuroscience is not just for scientists, however. In recent years, high-level athletes, special operations personnel, and appropriately trained law enforcement officers have cracked the code on how to use the higher functioning cognitive processes to affect advantageous results at the subconscious level, with measurable effects at the mid-brain/brain stem level. To fully grasp the power of these concepts, a deeper understanding of the individual disciplines and a multidisciplinary approach to a solution must be undertaken. Ironically, master martial artists and Buddhist monks have understood many of the concepts presented in this thesis, yet were only recently proven by modern neuroscience. The secret they have known for untold generations is that the conscious mind can affect the operation of the subconscious mind though awareness, training, and performance imagery.

"The saber-toothed tiger either ate us or we ran away from it—or a lucky few might stab it, but the whole thing was usually over in moments."[15]
John Medina, Brain Rules

Basic Anatomy and Physiology of the Human Brain

The brain's physical structure is broken down into four areas based on levels of mental functions. These areas are listed in reverse evolutionary order and are the cerebrum, the cerebellum, the limbic system, and the brain stem. The cerebrum, also known as the cortex, is the center of higher brain activity, such as imagination and abstract thought. The cerebellum, frequently referred to as the "little brain," is located on the bottom rear of the brain and controls balance, movement, and equilibrium.[16] The limbic system lies inside of the cerebrum, and is frequently referred to as the "emotional brain," since it is the brain's center for emotional thought and response. Finally, the brain stem is the oldest part of the brain in evolutionary terms, and controls the basic survival tasks—essentially everything that occurs automatically.[17] The brain stem is much more than a simple connection of the forebrain, hindbrain and spinal cord; it is the primal part of us, containing the corporate knowledge of millions of years of human evolution.

Considering the scale of human evolution, from the industrial revolution to current time is but an eye blink in the grand scheme. The cerebrum is the new kid on the block, having evolved to provide higher brain function, evolutionarily much younger than the mid-brain. Considering the timeframes of evolution, it makes sense that the human mid-brain still very much believes it is prey, pursued by the proverbial saber tooth tiger. Thus it tends to prioritize time-sensitive and unfamiliar events as threats. Irrational fight-

or-flight response in our lives in the first world makes perfect sense in the evolutionary scale—it is a time-hardened survival mechanism. As Lt Col (ret) Dave Grossman puts it in regards to human evolution; "we have the forward-set eyes of a predator… the incisor teeth of a predator… and the neural network of a predator… we also have molars of a rabbit… and the run-like-hell-wet-yourself neural network of a rabbit. We... are in the middle of the food chain."[18] Grossman has made an excellent living suggesting humans can exercise the neural network of choice to become the predator of the predator—the proverbial sheepdog to the wolf.[19] It turns out Grossman is right. Before delving into these subjects, it is important to understand what evolutionary responses humans experience during stress, and specifically, the effects combat aviators want to avoid.

"Of the many variables affecting survival performance, the relationship between the perception of stress and accelerating heart rates is the most overlooked."[20]
Bruce Siddle, *Sharpening the Warrior's Edge*

Threat Detection & Trigger of SNS

The senses, particularly vision, constantly take in an immense amount of information, however only a small fraction of this sensory information makes it to consciousness, usually "loud" stimuli.[21] These stimuli are run through short-term and long-term memory (if required), generally faster than the conscious self recognizes. Psychophysical time is the time between detection of a stimulus and a reaction.[22] This is generally measured in milliseconds (ms). Psychophysical time is broken down into three periods: sensory organ excitation and transmission to the third Ganglionic center, a period of activity in the center, and the transmission of the motor impulse, which cues the

physical reaction.[23] Conscious awareness of a stimulus generally takes 500ms (half of a second).[24] Unconscious targeting, identification, and mid-brain response occur in the 280-355ms range.[25] While initial stimulus transmission creates neural activity around 150ms, conscious control cannot occur earlier than 500ms. Much can occur in the human brain and body before a person is actually consciously aware of the situation.

It could be inferred, then, that there is no way to completely avoid an unconscious threat response and associated hormone dump. With conscious efforts at methodical training practice(s) coupled with performance imagery, a human can train the subconscious and even engage in "spinal tuning," and pre-load a response to a given threat stimulus.[26] Preloaded (trained) responses to a given threat stimulus occurs at approximately 285ms.[27] An untrained nervous system encountering a threat stimulus for the first time, where the long-term memory must be accessed, can expect a conscious response over one second, and may reasonably expect to be in condition black, HR over 175BPM, with all of the associated negative effects, which will likely add in additional time delays.[28] A prepared and well-trained nervous system that has considered and rehearsed for an eventuality, can expect a pre-programmed response around a third of a second, and thus the reduced physiological effects associated with the trained threat response. The difference between trained and untrained is that the trained will subconsciously respond with the preloaded survival program (the desired response) before he or she is even aware of it. The untrained person may fight, flight, freeze, or any variation or combination of the three, along with possible evacuation of waste.[29]

When an individual encounters a *real* danger, the nervous system will spring into action. There are several models for nervous system arousal; most agree that some

arousal is necessary to get the human combat system to perform optimally. These models do not agree on the extreme edges of the envelope.

"A typical neuron makes about ten thousand connections to neighboring neurons. Given the billions of neurons, this means there are as many connections in a single cubic centimeter of brain tissue as there are stars in the Milky Way galaxy."[30]
David Eagleman, Incognito

Nervous System Arousal

There are several theories on nervous system arousal and human performance. First is the drive theory that states human performance increases as arousal increases (see figure I).[31] This theory has been proven to be overly simple, as in practice, every human tends to have an arousal limit. As arousal increases, so does heart rate, driven by stress hormones. If stress hormones increase HR to above 175BPM, the individual tends to have dramatic reductions of performance, dependent on the task the individual is performing. If the individual is fighting off a pack of wild dogs, the drive theory of arousal and performance is generally desirable, from an evolutionary perspective of expecting physical trauma from predators. If the individual is a pilot, though, there are significant drawbacks to extremely high HR from stress hormones. Low to moderate levels of arousal may get the pilot "in the zone," while high levels will likely drain situational awareness (SA), reduce fine and complex motor control, or even cause the pilot to freeze. Conventional wisdom suggests pilots should be as calm as possible at all times, meaning any arousal is negative. In commercial aviation, that may be true. In combat aviation, a bit of arousal can be beneficial. Pilots that perform a G-awareness

exercise can expect a hormonal surge from pulling Gs. This increases G-tolerance for expected training tasks, and is extremely beneficial in the fighter realm.

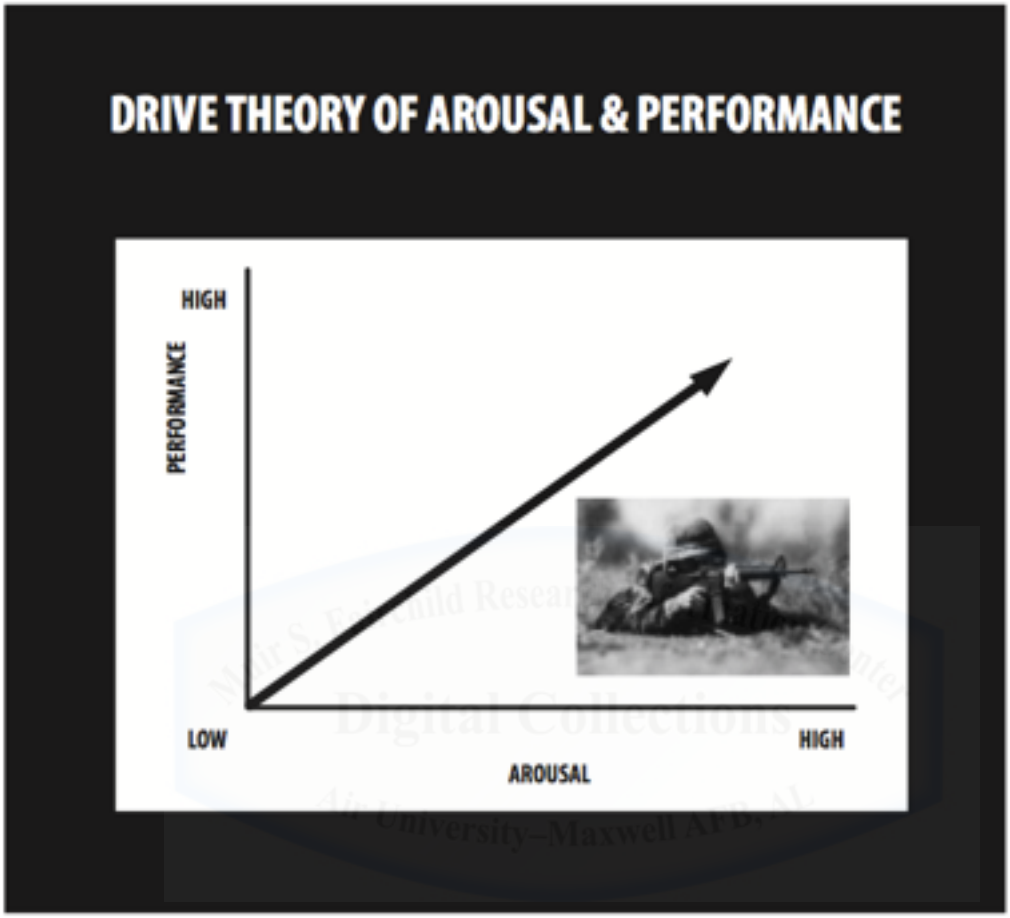

Figure I. Drive Theory of Arousal & Performance.

A second theory is call the Inverted-U Hypothesis, or Yerkes-Dodson Law, which states there is an optimal level of arousal for optimal performance.[32] Too little arousal will yield substandard performance, as will too much arousal. This hypothesis is commonly used in sports literature as a way to improve performance through understanding of stress physiology. The science of stress remains a hot topic, even amongst amateur athletes. [33] Yerkes-Dodson Law acknowledges that there is a

downward performance curve commensurate with extremely high levels of arousal (see figure II). This acknowledges there is an arousal limit.

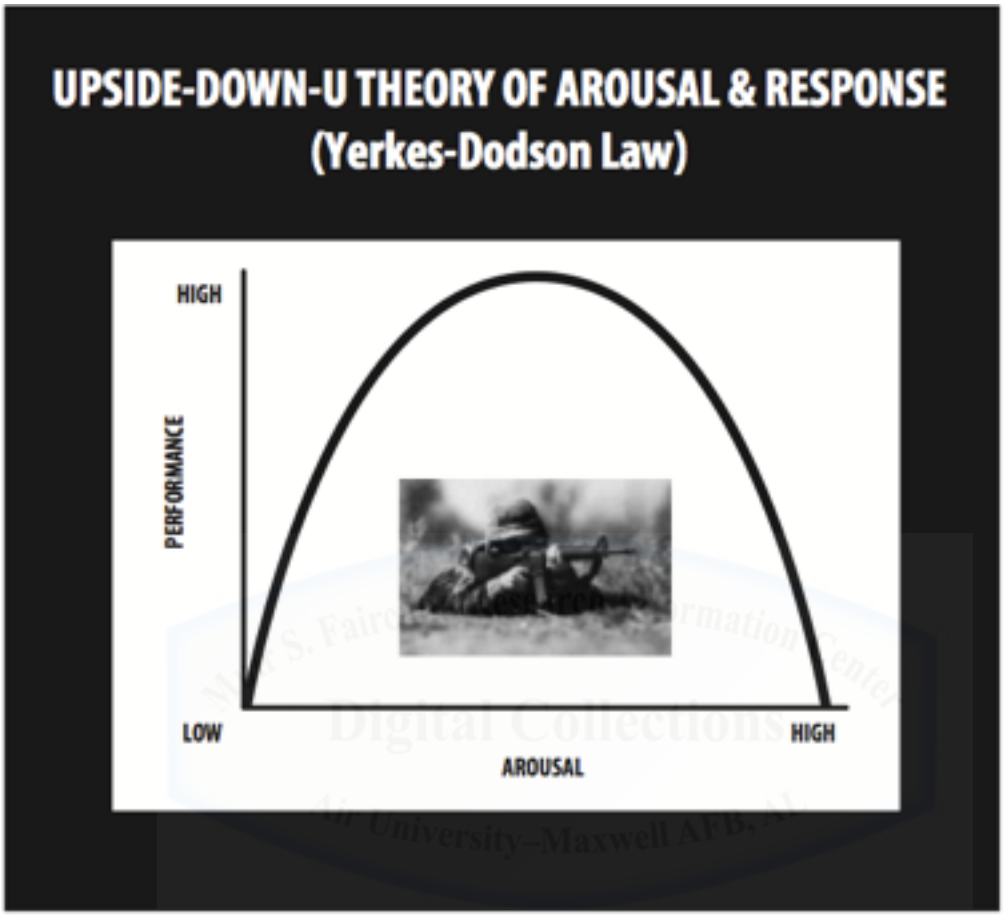

Figure II. Inverted U Theory of Arousal & Response.

Both of these theories are widely used in fields where high levels of human performance is desired, but both theories are overly simplistic considering the complexity of the human nervous system. Even Siddle & Grossman's Heart Rate Variability (HRV) diagram depicted in figure III has exceptions. Grossman acknowledges that NASCAR drivers sustain heart rates above 175BPM, yet have sufficient motor control to race at high speeds in close proximity to other racecars.[34] Clearly, high levels of training and superior stress management strategies in a specific discipline allow for high functioning at normally debilitating stress hormone HR levels.

Threat-Induced Hormonal HR Increase

Dave Grossman & Bruce Siddle's hormonal heart rate variability diagram illustrates the evolutionary aspects of survival physiology.[35] The higher the hormonal HR, the more physical trauma the individual can take due to vasoconstriction. Unfortunately, these effects come at a cost, starting with deterioration of fine and complex motor skills, and ending with deterioration of cognitive processing and initiation of irrational fight, flight, or even freeze. It is important to discern that the heart rate explanation below is stress hormone driven, not exercise driven. Conducting a Crossfit workout of the day in record time could easily place the average athlete above 175 beats per minute (BPM), firmly into "condition black" outlined below, but the athlete will not necessarily experience irrational fight or flight, or any of the other negative physiological effects listed.[36] The key to understanding the survival science is realizing the negative cognitive effects are the result of a stress hormone dump, and is not simply a factor of heart rate (see figure III). The release of adrenaline and noradrenalin are key factors to the HRV diagram.

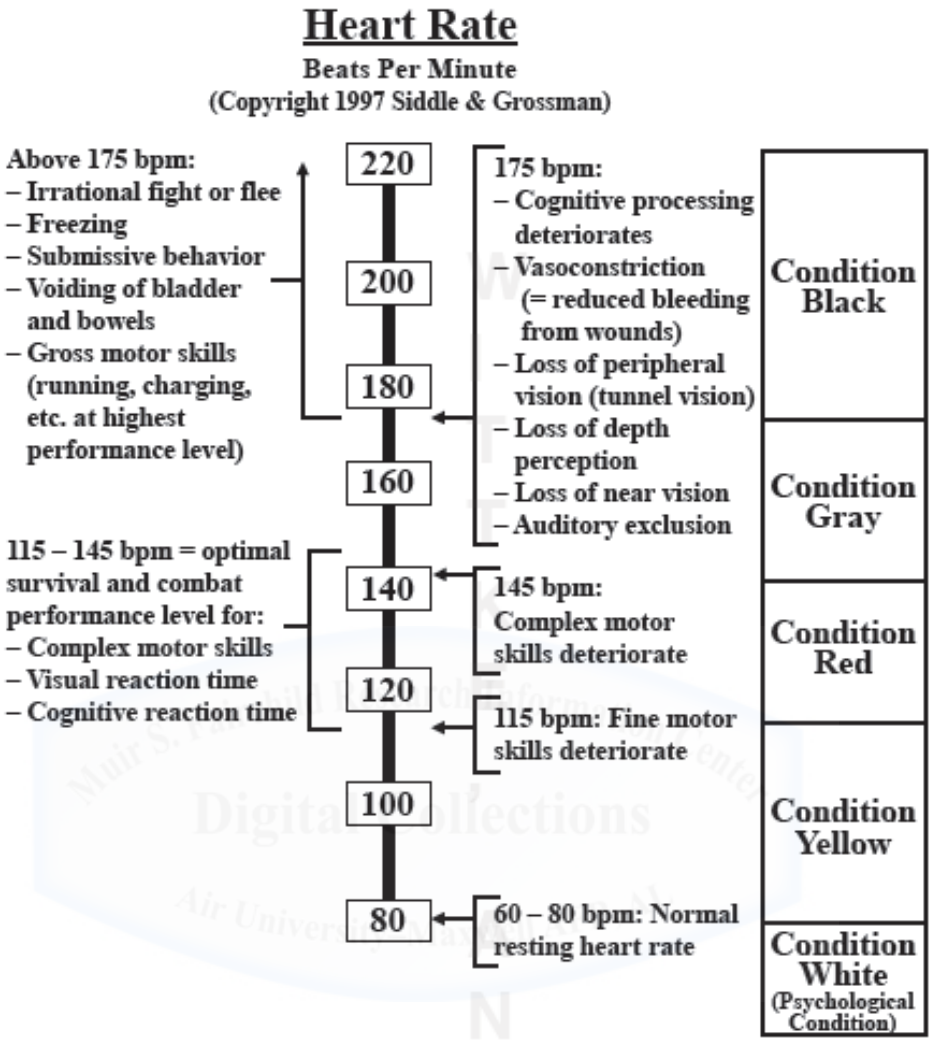

Figure III. Hormonal HR Variability.[37]

When the human fight-or-flight survival system is placed into action, certain survival mechanisms take place. These hormonal reactions occur near-instantaneously, often ahead of conscious understanding. Referencing figure III, a heart rate above 115BPM, crossing the boundary from condition yellow to condition red, physiological effects begin to manifest with deterioration of fine motor control. Top-notch athletes, police officers, and special operations personnel train to operate along this regime, expecting to experience the effects of stress hormone HR increase as a part of normal

operations. While the stress of an Olympic performance will have physiological effects on the athlete, will it trigger a threat/survival response? Could the response rival that of a police officer in a firefight? The answer is—it depends. Responses to stress vary by individual, because stress is *generally* perceived. Anxiety attacks are the result of perceived stress and subsequent triggering of the SNS leading to high condition red, or even condition black. So an athlete may reach high HR levels in competition due to perceived stress, but a human being threatened with actual life or limb can *almost* be guaranteed to reach such levels. Survival stress and the associated acute reactive stress response, which occurs at a SC level on preconscious timelines guarantee high HR levels and associated physiological degradation. The good news is that the survival stress response can be recognized and countered.

Law Enforcement & SOF Training Revolution

Since a prevention model that seeks to avoid a survival stress response entirely is unlikely to be successful, Law Enforcement (LE) and military ground combatant training communities have adopted training practices to, in essence, deal with it. These training practices focus on three areas: training the human body's reaction to acute reactive stress, training a subconscious (and correct) reaction to a deadly threat stimulus, and teaching strategies to cope with the physiological difficulties. The LE training community experienced this training revolution out of necessity—too many officers were dying or found to be performing unpredictably under acute reactive stress. After a deadly force encounter, many officers would report what is depicted in Figure IV at rates depicted in Figure V below.

Figure IV, Perceptual Distortions.[38]

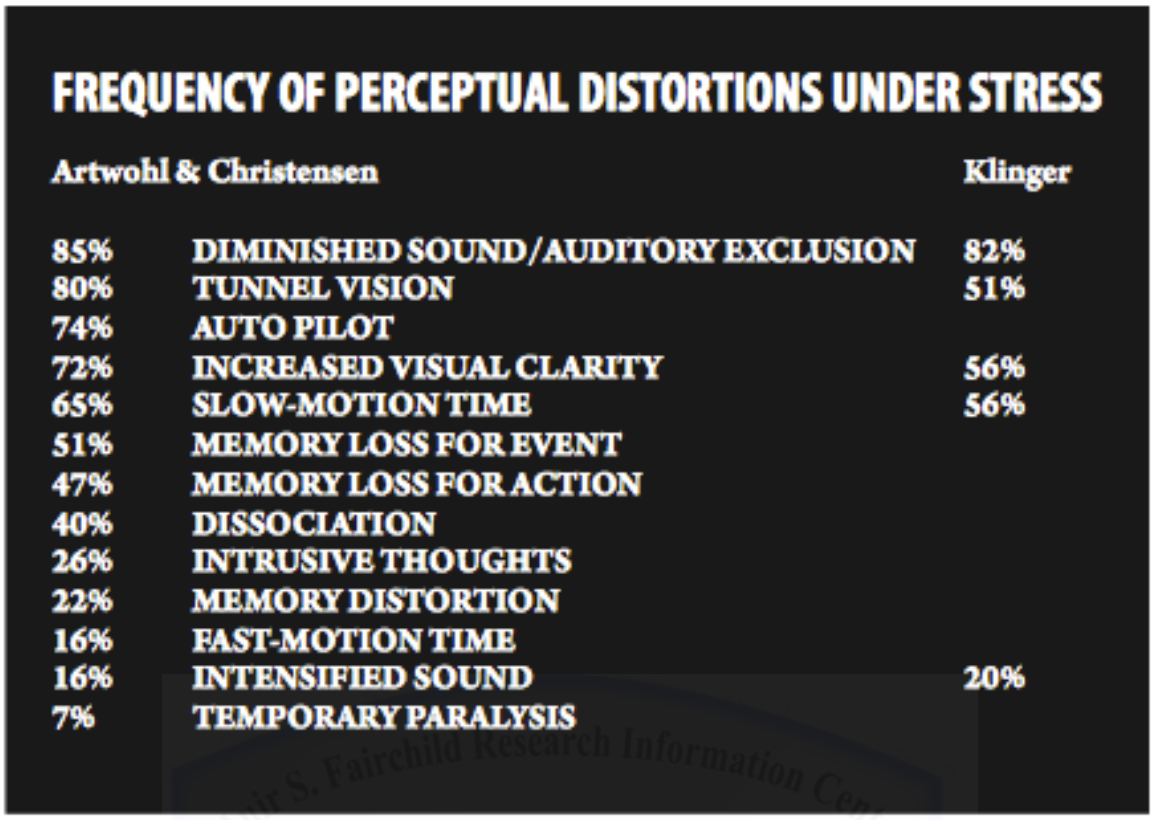

Figure V. Frequency of Perceptual Distortions.[39]

The percentages in Figure V should bring any reader pause, as 85% of officers experienced a significant perceptual distortion under acute reactive stress, and 7% experienced temporary paralysis! These numbers are statistically significant in any discipline. Aviators in time-critical, life-or-death situations could experience similar perceptual distortions, and are yet untrained.

How do LE and SOF personnel prepare for such reactions to acute reactive stress? To repeat an adage used in Dave Grossman's *Bulletproof Mind* seminar, "forewarned is forearmed."[40] Educating officers on the effects of acute reactive stress does much to inoculate officers for a time-critical survival event. By simply teaching officers, for example, that the guns go quiet in combat inoculates them from suspecting a bad lot of ammunition or firearm malfunction when their guns go "pop" instead of "bang."[41] This

first piece of the puzzle is called Survival Stress Management, and it is the most basic level of education that promotes a basic awareness of human survival physiology, and has shown to improve officer performance and reliability under pressure. Awareness is important to overall officer or troop performance, but the real training revolution has occurred at the instructor level in regards to stress inoculation. Instruction thorough a training regimen incorporating a synthesis of this knowledge is revolutionary.

Second, ground combatants are trained to program their nervous systems with desired survival programs, executed from detection of expected stimuli.[42] This neural programming is accomplished by methodical training practice, use of performance imagery, and reinforced through realistic, highly stressful, force-on-force training. This area is the fascinating piece—real "Jedi mind tricks," according to Grossman.[43] The goal is to program a desired response to a threat stimulus at the subconscious level for the shortest reaction times (see Figure VI).[44] This training is comprised of demonstration, instruction, and practical application of the survival program tasks. The programs are taught in chunks, demonstrated at 25% speed to allow the student to grasp the task(s) in the mind's eye. Then, the task(s) are practiced, critiqued, and perfected under the watchful eye of the trainer in a static environment. These tasks are finally tested in realistic employment under increasing levels of intensity (SIT).

Third, officers are trained on how their psychology and physiology will operate after the fact. They are taught about flashbacks, nightmares, and PTSD. They are taught that these post-traumatic reactions are normal, and it is normal to seek help. This has undoubtedly saved numerous officers from taking their own lives.

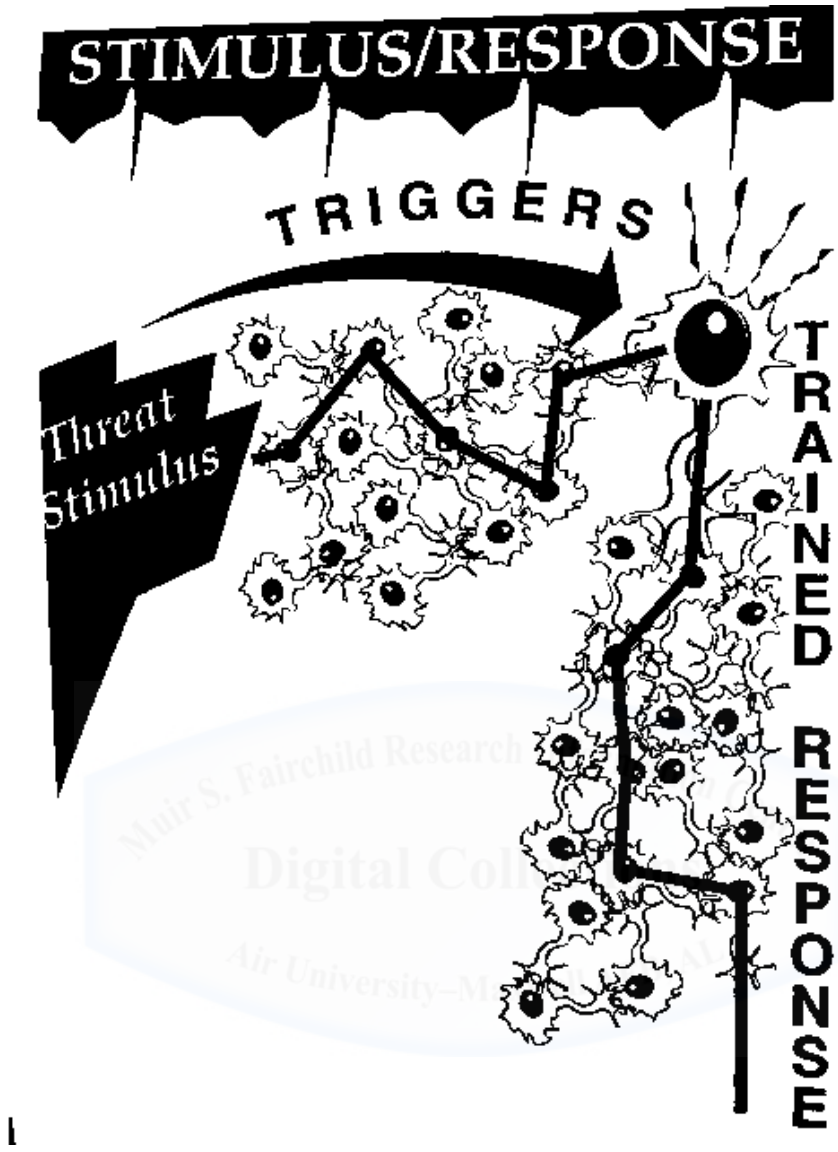

Figure VI. Survival Neural Program.[45]

SIT works for them; it will work for pilots, and should be taught to them from the beginning of pilot training. As it stands, none of the three areas listed above are taught to pilots. This is already taught to some USAF members—battlefield airmen.

"On the battlefield, the real enemy is fear, not the bayonet or bullet."[46]
Robert Jackson

Stress Inoculation & Cross-Disciplinary Link Between Ground & Air

The term stress inoculation is a relatively new term, yet has wide use across numerous disciplines with various definitions. Perhaps the most pertinent and current study on Stress Inoculation Training (SIT) in regards to the USAF was a 2014 RAND Corporation study. This study raised serious concerns regarding whether the USAF was appropriately training battlefield airmen for combat. For this study, RAND defined battlefield airmen as Pararesecue, Combat Control, Tactical Air Control Party, and Combat Weather.[47] RAND selected these career fields due to their propensity to go *outside the wire* with great possibility of experiencing hostile fire.

With no disrespect to the airmen that perform these duties and an acknowledgement of the risk, the USAF failed to direct RAND to include an enormous USAF demographic in their study—that of combat pilots. This mistake is easy to make, considering the fact that the past 13 years of counterinsurgency has been a relatively permissive environment for the fighters, bombers, gunships, manned surveillance, and helicopters that have supported ground personnel, and the fact that a great deal of ground combatants have died in this effort compared to fewer, but not insignificant numbers of aircrew. The fact remains, however, that these pilots technically *leave the wire*, and that human factors (human error) have been the vast majority of mishaps in the USAF, a number of which occurred in combat at immense cost and the loss of critical combat assets.

Led by LE trainers and SOF, ground combatants are experiencing the revolution of methodical and comprehensive SIT while combat aviators have not. F-16 pilot training, for example, has remained as it has since inception, adapting only to new

mission sets, hardware, software, and budget constraints. The RAND study explains the crux of the matter perfectly:

> The U.S. Air Force continuously strives to ensure that all of its airmen receive the best training available to meet mission requirements. In some career specialties, such as battlefield airmen, the mission requires performing in stressful and sometimes life-threatening environments. To ensure that these battlefield airmen are optimally trained to perform under stress, RAND was asked to review the empirical literature and the state-of-the-art for stress inoculation training.[48]

Unfortunately, the USAF forgot the 'Air' part of the Air Force by limiting the study to ground combat personnel. *Combat pilots* are easily substituted for *battlefield airmen* in the above statement, since the act of manned flight can also be an acutely stressful and life-threatening environment. Studies have shown that acute reactive stress occurs in pilots faced with time-critical, life-or-death tasks as certain as it does for the subjects of this RAND study.[49] Obviously, this study was commissioned with an intentionally narrow focus, but what works for ground combatants will work for pilots, and the proof lies in comparisons of the operating environments.

The operating environments, while dissimilar from the conventional sense, are quite similar in the realm of acute reactive stress. The similarities of environment are twofold. First, threats are presented in a compressed timeframe. Second, the threats are potentially deadly. According to Siddle, "survival stress is a result of a life threatening perception."[50] Stokes defines acute reactive stress as "a response to a threatening event or circumstance… probably associated with elevated adrenalin and noradrenalin levels."[51] Stokes' work, *Flight Stress*—the seminal work on stress in aviation—further explains stress in every conceivable variation, but the information on acute reactive stress was particularly telling. Acute reactive stress, cued by a threat stimulus, such as an emergency procedure, affects pilots in the same way a gunfight affects ground combat

personnel. Stokes states, "…in very stressful circumstances, even trained personnel (pilots) may fail to implement the simplest procedures."[52] Stokes further identifies temporal distortion, hypervigilance (freezing), and negative attention and memory effects.[53] This is due to the similarities of the threat stimuli received by humans in both realms, and of course, the shared operating system of the human nervous system.

With the common operating system and commonalities of the threat stimuli established, it must be acknowledged that the actual tasks to be performed by the operators are quite different between ground and air. To train pilots using the best practices of ground combat training, only completely transferable skill sets and methodologies will be evaluated.

"When you're shooting a match, don't tell yourself to slow down, hurry up, watch the front sight—don't tell yourself anything. Show yourself what you want to do."[54]
Brian Enos, Practical Shooting

Criteria for Selecting Training Methods

To implement appropriate training on transferable skill sets, several implementation scenarios will be evaluated. The criteria to evaluate various implementation scenarios are listed below:

1. Must be applicable to pilot training
2. Transferable skill set, cross-discipline
3. Directly impacts operator lethality, survivability, or resilience
4. Appropriately taught by instructor pilots

The criteria will be used to evaluate the expected effectiveness of the following implementation options:

1. Academics or CBT on survival stress management
2. Add survival stress to human factors hazards in 11-2-MDS AFIs
    2a. Initiate a Flight Crew Information File (FCIF)
    2b. Mandatory academics with a Go/No Go sign off
3. Add topics to formal courses and make it a tracked currency.
    3a. Initial: UPT by Aerospace Physiology
    3b. Advanced: FTU by trained instructor pilots
    3c. Recurring: Annual by trained instructor pilots
    3d. Instructor pilots taught stress inoculation training (SIT) & performance imagery concepts and methods to synthesis

Analysis of Evaluation Criteria

First, an effective implementation scenario must be applicable to pilot training. In formal SIT conducted by ground combat trainers, one of the pieces of the training is physical pain (or the possibility thereof), resulting from the impact of a paintball cartridge from an adversary's firearm.[55] The psychological pressure of these quite realistic scenarios tends to bring about a stress hormone HR increase, especially when hit. In flight training, physical pain is not particularly helpful or prudent. Logically, a physical pain stimulus in combat would typically be the result of getting hit by a missile or Anti-Aircraft Artillery in flight. While this would have the effect of raising pilots' heart rates, the logical conclusion to having been hit by a missile is that the aircraft is likely no longer combat effective, thus the point is moot.

Second, a training method must be a transferable skill set, cross-discipline. For example, primary ground combat skills trainers teach their students survival motor programs typically involving firearms. Since weapon manipulation and marksmanship training is only valuable to the aviator after ejection over hostile territory, it is not particularly important for the primary skills of combat aviators, and is thus not a necessarily a transferable skill set.

Third, the selected method must directly contribute to operator lethality, survivability and resilience. Ground combatants are generally trained to perform specific combat tasks, and they must perform them correctly under hostile fire. SIT is specifically designed to increase lethality, survivability, and resilience, but it is the synthesis of the information and application in a realistic environment that is the key. The various implementation methods listed will span from academic to practical to comprehensive, and may or may not increase lethality, survivability, and resilience as standalone methods.

Fourth, the methods and concepts outlined in the literature must be synthesized and applied by instructor pilots. Kenneth Murray, the creator of Simunitions (the paint ammunition used in formal SIT) and father of the realistic training movement in LE, believes the best instructors are themselves students. They are students of human performance psychology and physiology.[56] Siddle agrees that the primary task trainer should teach with these concepts in the forefront. He goes further stating that it is critical the instructor must be well read on the latest research involving the motor sciences.[57] If the concepts and methods are accepted and synthesized by IPs, it will likely be much more successful of a program, and thus avoid the fate of the Cockpit/Crew Resource

Management program, which has never been accepted by fighter pilots as a particularly useful program for single-seat fighters.[58]

Analysis of Possible Solutions

To select appropriate and implementable solutions, the most probable must be analyzed. First, pilots will be educated on the basic operating principles of the human operating system under acute reactive stress, and the actions they can take to reduce the effects of the survival stress reaction to get their heart rates down to manageable levels. Knowledge of what will likely happen forewarns them, thus forearming them to expect such psychological and physiological degradations. Combat breathing techniques bring stratospheric HR levels down to manageable levels—getting the operator out of condition black, and back into the functional realm of condition red. Combat breathing is widely taught, and the DoD even commissioned an app on iTunes to increase proliferation of this powerful technique.[59] This first piece of SIT is called survival stress management.[60] As the lowest level of SIT, survival stress management lays the groundwork for the higher-level activities. Survival Stress Management training is best taught in a classroom by a qualified instructor. Some agencies give in-service credit to Grossman's "On Combat" certification, which is approximately eight hours of self-paced Computer-Based Training (CBT)—the same length as his "Bulletproof Mind" seminar.[61]

Second, adding acute reactive stress effects to human factors hazards to aviation in the AFI-11-2MDS series will keep this information in the forefront, making it a mandatory briefing item prior to every sortie. Pilot awareness can be raised by disseminated through the Flight Crew Information File (FCIF) program, which ensures all applicable aircrew will review the information prior to their next flight. While this

ensures widest dissemination, busy or overly tasked aircrew may merely scan the pages and sign off the FCIF, well short of full synthesis of the material.

Third, these topics could be added to formal courses and make it a tracked currency, much like the Instrument Refresher Course (IRC). A thorough and scaled approach to teaching these concepts would be the most likely to foster a synthesis of the material, and allow specific areas to be taught at appropriate times in training.

Initial training would comprise the initial portion of SIT, survival stress management, taught as a part of Aerospace Physiology Training in UPT. AP personnel already have a foundation in human physiology, and UPT provides the perfect platform to instruct the basics of Survival Stress Management. UPT instructors would teach students *how* to "chair fly" by instructing how to accomplish formal performance imagery sessions. Advanced spinal tuning exercises could be taught at the Formal Training Unit (FTU) level, with students well practiced at formal performance imagery, having practiced it throughout UPT. All pilots will require recurring annual training on all of the above topics. To maximize effective student training, IPs may need to be taught SIT and performance imagery concepts in depth sufficient to produce full synthesis of the concepts and methods, which could take considerable time and effort. Without IP acceptance of the program and full synthesis of the material and methodology, SIT becomes less effective.

Comparison of Solutions*

	CBT on Survival Stress Mgmt	Academics on Survival Stress Mgmt	Add acute reactive stress to AFIs, FCIF	AP teach survival stress mgmt in UPT	IPs teach perf imgry in UPT, FTU	IPs receive instr to full synthesis
Applicable to training pilots	2	5	5	10	10	10
Skill set transferable cross-discipline	2	2	5	10	6-9**	10
Impacts lethality, survivability, resilience	0	2	2	8	6-9**	10
Appropriately taught by Instructor Pilots	0	0-2***	1	0	10	10
Assessment:	4	9-11	13	28	32-38	40

Table I

*A 1 to 10 scale was used to simulate degree of impact for visual interpretation for each of the methods considered in accordance with the evaluation criteria. Table I is for visual reference only and is not based on statistical data.
**IP effectiveness instructing performance imagery in UPT & FTU will depend on whether they receive instruction to full synthesis of the subject matter.
***This score could be higher, if taught by an IP that has synthesized the subject matter.

Application of Solutions

The matrix above shows the most effective path of implementation, greatly favoring the multifaceted and phased approach to instructing these powerful concepts. Of all of the concepts, practices, and methodologies of SIT, the following are the most transferable:

Survival Stress Management

The academics on the physiology and psychology of stress are generic and completely transferable. The topic most applicable to pilots would be stress perception management. According to Siddle, the level of survival stress (acute reactive stress) a person experiences is based on three perceptions: the perceived level of threat, the person's confidence in his or her ability to control the threat, and whether the exposure to the threat stimulus is a first time experience.[62] As a part of initial SIT, pilots would be taught academics appropriate to convey the physiological effects of acute reactive stress and appropriate counters, just like their ground combat counterparts. In addition, pilots should be encouraged to view bad situations as challenges instead of threats. If synthesized, this would likely reduce the effects of stress hormone HR increase in normal and combat operations. The USAF already does an excellent job of training pilots in UPT to respond to an emergency procedure methodically: "I will maintain aircraft control, analyze the situation, take the proper action, and land as soon as conditions permit."[63] Teaching student pilots how their bodies will react when faced with a threat stimulus will be a more masterful and comprehensive method of instruction, over the current rote memorization and classic conditioning seen now.

Jedi Mind Tricks

Law enforcement officers are taught to rehearse survival programs until they are unconsciously competent.[64] Navy SEALS build mock-ups of high-profile raids and physically rehearse every action multiple times. The USAF Thunderbirds sit together and verbally and mentally rehearse their routine before stepping out to their aircraft. All of these people are executing performance imagery. If an individual is familiar enough with a given task to see it in the mind's eye, it is Visual Motor Behavioral Rehearsal (VMBR), and it is as effective as actual practice when performed correctly.

According to Asken, who calls it "tactical performance imagery," VMBR is most effective when the individual imagines situations as realistically as possible, using all of the individual's senses.[65] The practice session should be made as vivid as possible, and the individual should move with the imagery, at real-time speed.[66] For a pilot, this would mean moving the imaginary stick and throttle, or reaching over to find an appropriate switch. While all of these factors are important to a tactical performance imagery session, it is absolutely imperative the individual images correct responses and victorious outcomes—failure should never be imaged.[67] A mentally rehearsed victory will increase the individual's confidence in a given task or maneuver, thus reducing the stress hormone response if the threat stimulus actually occurs later. As outlined above, increased confidence in an individual's ability to handle a threat stimulus has a direct correlation to the amplitude of the physiological response.

In FTU, students should be taught to perform what Siddle calls "spinal tuning."[68] This informal, but effective method preloads a desired response to a given stimulus. An example of spinal tuning in the LE realm could involve a police officer on a felony stop.

Before leaving his cruiser to approach the suspect's vehicle, he runs through a few scenarios in his mind's eye: "If the suspect races away, I will run back to my cruiser and pursue. If the suspect exits his car, I will draw my service weapon and command him to lie on the ground. If the suspect exits his car and raises a weapon, I will draw my service weapon and return fire." By imaging a few if-then statements in his mind, the officer has preloaded a few desired responses to his nervous system. This has shown to reduce reaction times and increase the accuracy of the response. This type of performance imagery is very applicable to pilots.

Currently, student pilots are conditioned through numerous emergency procedure tests, briefing items (EP of the day), and simulators. With training in performance imagery, a pilot lining up for takeoff will engage in spinal tuning: "if I get a fire light on takeoff before I rotate, I will abort the takeoff by applying the CAPS, THROTTLE-IDLE, HOOK DOWN." "If I have already rotated, I will perform the CAPS, CLIMB, STORES-JETTISON." By preloading these responses, the pilot will reduce his reaction times and increase the accuracy of his responses. Additionally, a student pilot with comprehensive SIT will be less likely to panic, have more accurate responses to the threat stimulus, and will do it more quickly.

Both of these types of performance imagery are excellent fits for pilots, and can be expanded to mission-specific items, tasks, and sight pictures. Once a student pilot has his ground operations flow down to an acceptable level of accuracy, the student can perform a formal performance imagery session, where he sits comfortably, closes his eyes, and visualizes the sights, sounds, smells, and feel of every switch actuation, challenge and response item with his crew chief, and preflight check. A more advanced

student in the Basic Fighter Maneuvers (BFM) phase may perform a spinal tuning session between sets. While she is climbing up to the 18-19,000 foot block, she hears "next set is a defensive 9000 foot set for number 2." She acknowledges. In her mind, she knows what she will see after the "fights on" call from her flight lead, and knows that she has a decision to make as the adversary approaches her turn circle. She imagines to herself: "If the adversary continues to point at the fights on, I will remain in my break turn, lift vector on, and continue with my flares, and get out of plane if I see gun cues." "If the adversary rolls out, drives to my turn circle and enters on time, I will execute my aggressive denial defense." "If the adversary rolls out, drives to my turn circle, and performs a late turn circle entry, I will over-rotate my lift vector and perform a split plane maneuver to neutralize the adversary." In her mind's eye, she visualizes the sight picture for each scenario and preloads a desired stick & rudder response, reducing her reaction times and increasing the accuracy of her responses.

Conclusion

Instructing pilots on survival stress management and performance imagery will increase their survivability, lethality, and resilience as it has for trained ground combatants. SIT will teach pilots to view time-critical high-stress events as challenges instead of threats. Pilots who view such events as challenges perform better than pilots who view them as threats.[69] Formalizing academics on *chair flying* will train students to execute performance imagery sessions, where they program correct responses to threat stimuli into their subconscious minds. This will increase response accuracy and reduce reaction time. It will also assist them in managing their own physiological responses to acute reactive stress.

Recommendation

The USAF should implement a methodical, phase-based approach to instruction of: Survival Stress Management academics taught by Aerospace Physiology in UPT, Performance Imagery basics (*how* to chair fly) taught by Instructor Pilots in UPT, and advanced performance imagery & Spinal Tuning exercises taught by IPs in FTU. All of this will be made most effective by integrating the transferable aspects of SIT to the USAF's Instructor Pilot corps to synthesis. With today's fiscal realities, many may ask if SIT is worth the cost. Those charged with training ground combatants believe so. Also, if SIT prevents a single aircraft crash (and the subsequent safety and accident investigations), the program will more than likely pay for itself—it will save multi-million dollar aircraft. More importantly, it will save the lives of American Airmen. Considering the stakes, integrating the best and most applicable parts of SIT into pilot training is the right thing to do.

---

[1] Dave Grossman, *On Combat*, (Millstadt, IL: Warrior Science Publications, 2008) 73.
[2] Matthew G. Cho, Capt, *The Air Force Operational Risk Management Program and Aviation Safety*, (Dayton, OH: Air Force Institute of Technology, 2003), xii.
[3] Bruce Siddle, *Sharpening the Warrior's Edge*, (Bellville, IL: PPCT Research Publications, 1995) 87.
[4] AGARD Conference Proceedings, *Human Behaviour in High Stress Situations in Aerospace Operations* (The Hague, NL: NATO, 1988), 102.
[5] Ibid, 102.
[6] Grossman, 104.
[7] Michael J. Asken, Et Al., *Warrior Mindset*, (Millstadt, IL, Human Factors Research Group, 2012.
[8] Air Force Safety Center, *Human Factors in Action*, Online, http://www.afsec.af.mil/proactiveaviationsafety/hfinaction/index.asp Accessed 08 Sep 2015.
[9] Air Force Instruction (AFI) 11-2F-16V3, *F-16 Operations Procedures*, 2013, 54.
[10] Air Force Instruction (AFI) 90-802, *Risk Management*, 11 February 2013.
[11] 162WG *Operational Risk Management Worksheet*.
[12] Air Force Instruction 90-506, *Comprehensive Airman Fitness*, 2 April 2014.
[13] Michio Kaku, *The Future of the Mind*, (New York, NY: Random House, 2014), 1.

[14] Stokes, 131
[15] John Medina, *Brain Rules*, (Seattle, WA: Pear Press, 2014), 63.
[16] Rita Carter, *The Human Brain Book*, (New York, NY: DK Books) 63.
[17] Carter, 63.
[18] Grossman, Bulletproof Mind Seminar,
[19] Grossman, *On Combat*, 180.
[20] Bruce Siddle, *Sharpening the Warrior's Edge* (Bellville, IL: PPCT Research Publications, 1995) 87.
[21] Carter 79.
[22] Siddle, 67.
[23] Siddle, 67.
[24] Libet, 33.
[25] Libet, 55.
[26] Libet, 68.
[27] Libet, 73.
[28] Grossman, 31.
[29] Grossman, 8.
[30] David Eagleman, *Incognito, The Secret Lives of our Brains* (New York, NY: Random House, 2011) 2.
[31] Asken, 72.
[32] Ibid, 73.
[33] Kristine Hayes, "The Science of Competition, Stress and the Shooter." *Front Sight.* Jan/Feb 2016, Vol 33. No 1, 28-31.
[34] Asken, 76
[35] Grossman, 42.
[36] Ibid, 31.
[37] Ibid, 31.
[38] Ibid, 55.
[39] Ibid.
[40] Grossman, *Bulletproof Mind* seminar.
[41] Grossman, 50.
[42] Siddle, 36.
[43] Grossman, *Bulletproof Mind* seminar.
[44] Siddle, 37.
[45] Ibid.
[46] Dave Grossman, *On Combat*, (Millstadt, IL: Warrior Science Publications, 2008), 30.
[47] Robson, iii.
[48] Ibid, iii.
[49] Stokes, 69.
[50] Siddle, 87.
[51] Stokes, 132.
[52] Ibid, 207.
[53] Ibid, 207-222.
[54] Brian Enos, *Practical Shooting, Beyond Fundamentals* (Clifton, CO: Zediker Publishing, 1990) 126.
[55] Murray, 203.

[56] Ibid, 44.
[57] Siddle, 15.
[58] Merrill R. Karp, *Survey of Cockpit/Crew Resource Management for F-16 Pilots* (Mesa, AZ: AFRL, 2000), 27.
[59] iTunes.com, *Tactical Breather*, iPhone application.
[60] Siddle, 87.
[61] Dave Grossman, "On Combat" *Grossman Academy*, online, www.grossmanacademy.com
[62] Siddle, 92.
[63] Author's input on conduct of EP of the day, every day for 52 weeks of UPT.
[64] Murray, 28.
[65] Asken, 269.
[66] Ibid, 274.
[67] Ibid, 281.
[68] Siddle, 102.
[69] Samuel J. Vine, Et Al, "Individual Reactions to Stress Predict Performance During a Critical Aviation Incident" *Anxiety, Stress, & Coping* (Exeter, UK: University of Exeter 2015) 475.

BIBLIOGRAPHY

AGARD Conference Proceedings No. 458. *Human Behaviour in High Stress Situations in Aerospace Operations*. The Hague, NL: NATO, 1988.

Alexander, John B., Col, Maj Richard Groller, and Janet Morris. *The Warrior's Edge*. New York, NY: William Morrow and Company, Inc. 1990.

Air Force Instruction (AFI) 11-2F-16V3, *F-16 Operations Procedures*, 18 Dec 2013.

Air Force Instruction (AFI) 11-290. *Cockpit/Crew Resource Management Program*. 15 Oct 2012.

Air Force Instruction (AFI) 11-403. *Aerospace Physiological Training Program*. 30 Nov 2012.

Air Force Instruction (AFI) 90-506, *Comprehensive Airman Fitness*, 2 Apr 2014.

Air Force Instruction (AFI) 90-802, *Risk Management*, 11 Feb 2013.

Asken, Michael J., Dave Grossman, and Loren W. Christensen. *Warrior Mindset*. Millstadt, IL: Human Factor Research Group, Inc., 2012.

Aurelius, Marcus. *Meditation*s. Oxford: Oxford University Press, 2011.

Ayoob, Massad. *Deadly Force*. Iola, WI: F+W Media, 2014.

Backer, Patricia R., and Judith M. Orasanu. *Stress and Performance Training: A Review of the Literature With Respect to Military Application*. San Jose, CA: San Jose University, 1992.

Carter, Rita. *The Human Brain Book*. New York, NY: DK Publishing, 2014.

Cho, Matthew G. Capt. *The Air Force Operational Risk Management Program and Aviation Safety*. Dayton, OH: Air Force Institute of Technology, 2003.

Cooksey AM, Momen N, Stocker R, Burgess SC. "Identifying Blood Biomarkers and Physiological Processes That Distinguish Humans with Superior Performance under Psychological Stress." *PloS ONE*, 2009.

Coram, Robert. *Boyd, The Fighter Pilot who Changed the Art of War*. New York, NY: Back Bay Books, 2002.

De Becker, Gavin. *The Gift of Fear*. NY: Dell Publishing, 1997.

Druckman, Daniel and John A. Swets, Editors. *Enhancing Human Performance, Issues, Theories, and Techniques.* Washington, DC: National Academy Press, 1988.

Druckman, Daniel and Robert A. Bjork. *In the Mind's Eye, Enhancing Human Performance*. Washington, DC: National Academy Press, 1991.

Eagleman, David. *Incognito*, New York, NY: Random House Inc., 2011.

E.V. Luzik & A.N. Akmaldinova. "Psychological Aspects of Ensuring Flight Safety in Civil Aviation." *Aviation*, 10:1. 2009. 25-35.

Enos, Brian. *Practical Shooting, Beyond Fundamentals*. Clifton, CO: Zediker Publishing, 1990.

Epictetus. *Discourses*. Cambridge, MA: Harvard University Press, 1925.

Epictetus. *The Encheiridion*. Cambridge, MA: Harvard University Press, 1928.

Gielan, Michelle and Shawn Achor. "Make Yourself Immune to Secondhand Stress" *Harvard Business Review*. Online Journal. Online: https://hbr.org/2015/09/make-yourself-immune-to-secondhand-stress (accessed 01 September 2015).

Grossman, Dave. *On Combat 3rd Edition*. Millstadt, IL: Warrior Science Publications. 2008.

Grossman, Dave. *On Killing*. Revised edition. Boston, MA: Little, Brown and Company, 2009.

Hayes, Kristine. "The Science of Competition, Stress and the Shooter" *Front Sight*. Vol 33 No 1, Jan/Feb 2016.

Kaku, Michio. *The Future of the Mind*. New York, NY: Random House Inc., 2014.

Katz, Lawrence C. "Assessment of Aircrew Stress." *U.S. Army Aeromedical Research Laboratory*. Fredrick MD: U.S. Army Medical Research and Material Command, 1997.

Kaufman, Stephen F. *Musashi's Book of Five Rings*. Boston, MA: Tuttle Publishing. 1994.

LeBlanc, Vicki R. "The Effects of Acute Stress on Performance: Implications for Health Professions Education" *Academic Medicine: Journal of the Association of American Medical Colleges*, October 2009.

Libet, Benjamin. *Mind Time*, Cambridge, MA: Harvard University Press, 2004.

McClernon, Christopher K Maj, *Stress Effects on Transfer from Virtual Environment*

Flight Training to Stressful Flight Environments. Monterrey, CA: Naval Postgraduate School, 2009.

Medina, John. *Brain Rules*. Seattle, WA: Pear Press, 2014.

Merlin, Peter W., Gregg A. Bendrick, Dwight A. Holland. *Breaking the Mishap Chain: Human Factors Lessons Learned from Aerospace Accidents and Incidents in Research, Flight Test, and Development*. Washington DC: NASA, 2012.

Miller, Linda K., and Keith A. Cunningham. *Secrets of Mental Marksmanship*. Boulder, CO: Paladin Press, 2010.

Murray, Kenneth R. *Training at the Speed of Life*. Gotha, FL: Armiger Publications, 2004.

Robson, Sean. *Psychological Fitness and Resilience*. Santa Monica, CA: RAND Corporation, 2014.

Robson, Sean, and Thomas Manacapilli. *Enhancing Performance Under Stress*. Santa Monica, CA: RAND Corporation, 2014.

Ross, Darrell L and Bruce K. Siddle. *Survival Stress Research Abstract*. Online. http://www.hfrg.org/research-abstracts/ accessed 1 Jan 2016.

Salas, Eduardo, C. Shawn Burke, Clint A. Bowers, and Katherine A. Wilson. *Team Training in the Skies: Does Crew Resource Management (CRM) Training Work?* Orlando, FL: University of Central Florida.

Salas, Eduardo, C. Shawn Burke, Katherine A. Wilson, and Dennis C. Wightman. *Does Crew Resource Management Training Work? An Update, an Extension, and Some Critical Needs.* Orlando, FL: University of Central Florida, 2006.

Sherman, Nancy. *Stoic Warriors*. Oxford, GBR: Oxford University Press, 2005.

Siddle, Bruce K. *Sharpening the Warrior's Edge*. Bellville, IL: PPCT Research Publications, 1995.

Stokes, Alan and Kirsten Kite. *Flight Stress: Stress, Fatigue, and Performance in Aviation*. Brookfield, VT: Ashgate Publishing, 1997.

Sullenberger, Chesley. *Highest Duty*. New York, NY: HarperCollins Publishers, 2009.

Tasbasi, Bayram. *Stress Management in Army Aviation*. Ankara Turkey: Bilkent University, 2002.

Vine, Samuel J., Liis Uiga, Aureliu Lavric, Lee J. Moore, Krasimira Tsaneva-Atanasova

& Mark R. Wilson. “Individual Reactions to Stress Predict Performance During a Critical Aviation Incident.” *Anxiety, Stress, & Coping: An International Journal*, 28:4, 2015. 467-477.

Young, James A. *The Effects of Life-Stress on Pilot Performance*. Moffett Field, CA: NASA Ames Research Center, 2008.