Wars of Cognition

How Clausewitz and Neuroscience Influence Future War-Fighter Readiness

Maj Michael J. Cheatham, USAF

> *It is immensely important that no soldier, whatever his rank, should wait for war to expose him to those aspects of active service that amaze and confuse him when he first comes across them. If he has met them even once before, they will begin to be familiar to him.*
>
> —Carl von Clausewitz
> *On War*

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What was once thought old has become new again. After almost 200 years since the publishing of Prussian military theorist Carl von Clausewitz's treatise *On War*, emerging neuroscience research brings a fresh perspective to his enduring work. This article proposes a modern analysis of three fundamental Clausewitzian theories: fog, fear, and friction. Viewed through a neurosci-

ence lens, Clausewitz's theories offer thought-provoking insights for military leaders to consider when preparing war fighters for predicted future war.[1] This analysis examines five primary questions to help military leaders understand and guard against factors that diminish human performance in chaotic environments:

1. Why are Clausewitz's theories relevant to modern warfare?
2. How do battlefield conditions influence mental processing (fog)?
3. Why does neuroprocessing impact war-fighter performance (fear)?
4. Why are even simple things so difficult in a complex environment (friction)?
5. What recommended actions should leaders consider?

A core theme of this analysis is that a mismatch exists between what the neuroscience community knows and what military leaders and trainers *should* know about the brain and how it operates. The gap is wide between strategic-level ideals and tactical-level actions. Moving from today's current state to the desired future end state is a daunting, but necessary, challenge. Leaders at all levels are responsible for nesting local actions with strategic intent to achieve future desired effects. Those who fail to grasp the nexus between foundational brain concepts, training methodologies, and war-fighter performance inherently limit their ability to support future desired end states to their fullest potential.

The intent of this article is not to advocate that the joint community convert war fighters into pseudo-neuroscientists. The goal *is* to stop admiring emergent neuroscience research and start integrating it. The growing body of neuroscience knowledge opens new opportunities to re-examine how we address Clausewitz's enduring theories. The analysis is persuasive that even modest enhancements to training applications could make significant differences when applied to a large force over time.

Relevance in Modern Warfare

Since *On War's* publication in 1832, the world experienced three major military revolutions and numerous revolutions in military affairs. These fundamental changes to war fighting stemmed primarily from the cause-and-effect relationships of the growing embrace of the Western way of war, progressive materiel solutions, and prescriptive styles of warfare derived from Swiss military theorist and Clausewitz contemporary Antonie-Henri Jomini. Jomini's technological and formulaic approaches predominate the US war-fighting strategy through the Vietnam War and persist today. While Jomini's theories remain influential to military culture, leadership, and strategy making, his theories are no longer sufficient alone for the complexities of modern war.

Jomini's theories overemphasize the *prescriptive* "science" of war-fighting strategy on paper and undervalue the *descriptive* "art" of warfare and the nature of conflict from the human perspective. Modern multidomain battle is largely unpredictable and cannot be easily reduced to a set of algorithmic formulae. Indeed, part of what makes real war so difficult is that unexpected adversity requires improvisation because the aspects of an encounter are completely unique. The map is not

the territory, and adversaries have a vote. In contrast, Clausewitz recognized that nested within war's organic nature lay an ever-present element of the human cognitive domain.

Human cognition has been studied over the past few thousand years, but little empirical data was produced until recently. Modern advances in brain-imaging technologies are revolutionizing how cognitive function is understood. The introduction of functional magnetic resonance imaging is transforming what the scientific community held as fact as late as two decades ago. Despite the terrible losses of blood and treasure, the wars in Iraq and Afghanistan also served as valuable backdrops to sow combat-related neuroscience understanding during this transformational period. Recent military and nonmilitary derived neuroscience findings should influence how leaders prepare and war fighters perform in possible future war.

Driven by contested domains, complex terrain, technology proliferation, and information as a weapon, future operating environments will present a new warfare thesis born from the dialectic of past wars and political motives. Future adversaries will seek to place commercial technological systems and military space platforms at risk through electronic, kinetic, and cyber attacks to neutralize advantages we rely on to achieve decisive points along strategic and operational lines of operation.[2] As a result, future war success will increasingly rest on human factors more than on the technological superiority enjoyed in the recent past.

Clausewitz's theories universally affect all combatants. In parity conflict, the side with forces more prepared to handle fog, fear, and friction holds the cognitive high ground over its adversary. Neuroscience elements, coupled with the right mix of tactical, organizational, doctrinal, and technological innovations, have the potential to shape the foundation of a new conceptual approach to warfare. Through skillful *applications*, the fusion of neuroscience with the human cognitive domain and widespread military applications could spur a new revolution in military affairs. In this context, Clausewitz's theories remain as relevant as ever.

Battlefield Conditions and Reason: Fog

Clausewitz described war as complex and escaping of man's control.[3] Indeed, the foundations for war's uncontrollable nature stems from human clashes of wills and *fog*—the mental state of confusion or uncertainty developed from available information. Clausewitz's theory of fog was born out of the consistent unreliability of intelligence obtained by untrustworthy scouts with fallible human perception and interpretation. The undefined precision of intelligence often deepened a commander's confusion rather than assuaged it. Despite revolutionary leaps in the quality and training of personnel, technology, and proliferation of collection architecture in land, sea, air, and space domains today, human fallibility in data interpretation remains a persistent system vulnerability.[4]

Modern militaries continue to operate from estimates and laws of probability similar to those used by Clausewitz. Military intelligence, both then and now, is an inexact art. Reliance on intelligence analysts' subjective and sometimes unconsciously

biased perceptions to interpret raw data into meaningful information inherently limits its usefulness. The inability to know, for sure, the intentions behind perceived adversary behavior amplifies a commander's fog when determining how to gain and maintain positions of relative advantage.

While imprecise intelligence data can contribute to fog in the minds of commanders, Clausewitz also observed how war's nonlinear nature creates fog in the minds of soldiers. Despite leaders' preparing war fighters through plans generation and rehearsals, modern areas of operation create mental stressors and disorientation that training struggles to replicate. As the war fighter's "cognitive load"—the capacity to absorb, process, and hold information—exceeds the threshold to store, process, and interpret external and internal sensory inputs, fog pervades. Indeed, cognitive *overload* causes distractions to be more disorienting and situational understanding to become or remain shallow. Critical thinking slows, and the brain defaults to the faster, but primitive, limbic system to expedite the cognitive processing cycle. Fog makes it harder for the brain to distinguish between the relevant and irrelevant; signal from noise.[5]

In general, complex operating environments, exposure to new information, sensory overload, fatigue, and the risk of harm or death slows and shifts mental processing. More acutely, the brain integration limitations of young adults (those approximate age 26 and under),[6] familiarity with the situation, and unique "internal (mental) models" of each war fighter further complicate already complex conditions. Internal models operate with a basic input-interpretation-output brain loop. If the brain loop determines the presence of a threat (whether actual or perceived), protective outputs of pain, psychological changes, or motor responses could materialize (figure 1). To alter the output, either the input or interpretation must change. In a combat environment, the input is most often uncontrollable. Interpretation is the controllable variable; cognitive load management is the skill.

Clausewitz asserted individuals could modulate the intensity of fog experienced in war through the development of process-enhancing aspects such as confidence, judgment, expertise, and experience derived from training.[7] Current neuroscience research is confirming Clausewitz's intuitive deduction: individuals *can* deliberately mitigate fog by improving cognitive load capability. Contemporary understanding of cognitive functioning, primarily through functional magnetic resonance imaging, demonstrates cognitive load management to be a trainable, yet highly individualistic, skill.[8] Cognitive load management skill-building takes time and considerable effort to shape and, yet, is perishable; akin to filling a leaky bathtub one thimbleful at a time.[9]

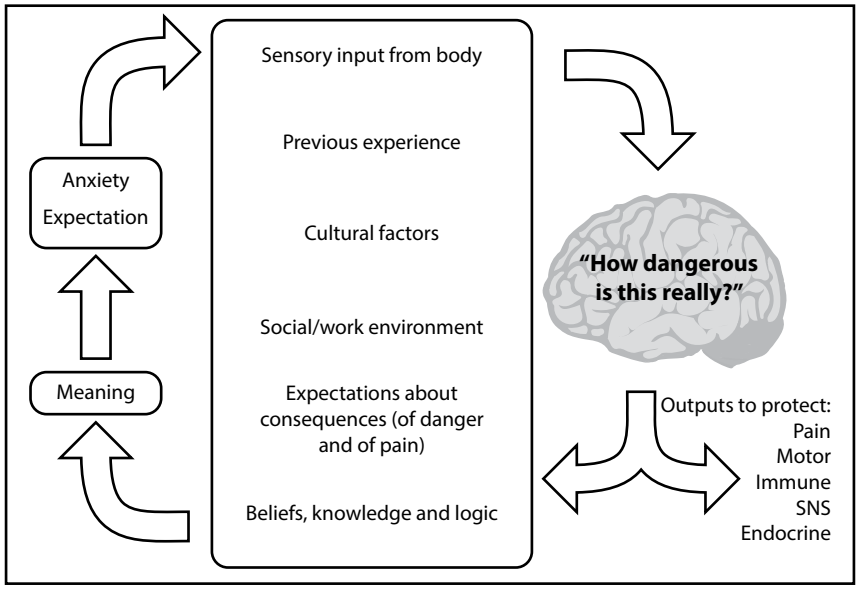

Figure 1. Internal model loop. (G. Lorimer Moseley, "Reconceptualising Pain According to Modern Pain Science," *Physical Therapy Reviews* 12, no. 3 [September 2007]: 171.)

A war fighter who encounters a complicated situation searches short- and long-term memory networks reflexively to overlay the present situation with one similar from the past. Under stress, our brains revert to past training and experiences. The closer a retrieved memory is to the current state the better the war fighter's brain can make sense of the situation. Recallable experiences expedite one's decision-making cycle. While whole-life experiences vary widely, especially those before entering service, *training* experiences are within a leader's control.

The more frequent and recent a desired skill is trained, the deeper neurosignature pathways (colloquially called *muscle memory*) become.[10] Stronger neurosignatures increase the speed of desired outputs after input-interpretation-output loops.[11] However, repetitions alone are not enough; the brain also craves novelty. *Training* improves how grouped neurons "fire" and "wire" together. *Novelty* creates neuroplastic change through stronger synapses and faster communication speeds.[12] Together, training and novel experiences build better response patterns through cognitive load resilience. Indeed, the cognitive *ease* developed over time creates the necessary time and space to improve decision making, not only in the trained situation, but also in stressful situations of this type.[13] Under this premise, fog can also be proactively mitigated using currently available tools and training models. The difficulties of this type of training lay in understanding its personalized nature and nonstandardized approach.

Traditional military training protocols prescribe generalized training to all skill levels, ages, and ranks without consideration for individual attributes. An underlying problem with standard training approaches is that every individual has a different

neurological story. What most trainers fail to realize is that blindly training without regard for an individual's cognitive load threshold can create more harm than good. The dose makes the poison. Instead, trainers should tailor instruction around constant individual or tiered threat assessment-improvement-reassessment iterations to produce progressively greater cognitive load-bearing abilities.[14]

Leaders must reexamine traditional training norms to improve cognitive loading alongside their specific threat response continuum. An important aspect of a leader's job is to facilitate specific training protocols to reduce the amount of threat perceived by each individual's brain and enable higher-level thinking. Adapting training to target an individual's nervous system is time-consuming and intimidating to some leaders. There is comfort in today's tried and true training protocols, but they may not produce the desired individual abilities needed for tomorrow's predicted future war. Leaders must determine whether today's methodologies will meet tomorrow's needs well before war fighters need them. As a special operations axiom states, competent (war fighters) cannot be created after an emergency occurs.

Neuroprocessing and War-fighter Performance: Fear

Similar to fog, fear is a natural, internally-derived human condition and a by-product of actual or perceived threat. In many ways, modern-era warfare continues to resemble Prussian military leader Frederick the Great's battle culture of forbearance and persistence.[15] Battling forces continue to seek decisive engagement to inflict and withstand casualties, both physically and cognitively, to break the adversary's center of gravity and will to fight.

Unlike the recent exponential growth in technology, the human brain remains physiologically similar as it was more than 10,000 years ago.[16] Today's war fighters are reflections of the soldiers Clausewitz observed: *biological beings who accumulate physical and emotional tolls*. The legitimate possibility of death or severe injury in war, compounded by each war fighter's perception of danger, activates the sympathetic or parasympathetic nervous systems. These autonomic neurological threat responses can overstimulate an individual's central nervous system and produce sympathetic fight-or-flight or parasympathetic freeze-or-faint reactions.[17] Both threat response types employ different ways to achieve the same end: *survival*.

The human brain is experience-expectant, prioritizing survival over performance.[18] The survival mechanism is based on predictive mental models and pattern recognition "wetware" to appraise threat in the current situation. The unconscious brain continually evaluates millions of bits of sensory inputs per second. As important new information is received, the conscious brain is alerted, predictions are made, and behaviors are modified. If the brain lacks either adequate data inputs or previous experience, its predictive abilities decline, and performance is hijacked. Uncertainty about a situation, the incapacity to control what happens, and an inability to predict future outcomes create fear and threat responses. Alternatively, competence and experience deactivate "emotional load" to enable more desirable rational responses. The need for survival becomes the need for safety.

Clausewitz asserted courage was the compensation to fear and presented itself in two forms: as a permanent condition and as an impermanent emotional state.[19] The cultivation of both forms of courage is best. Since the days of Napoleon, militaries sought to develop both forms within their soldiers. Modern armies are no different. Supported by society-at-large, courage is woven into the fabric of the military system and impressed upon the minds of all war fighters through heritage, discipline, peer pressure, realistic training, recognition, societal status, and psychological rewards. Concurrently, today's military leaders seek to reinforce or instill values for honorable and effective action through deliberate emotional and cognitive training approaches.

Emerging neuroscience and psychology-based performance programs, such as the USAF's *Defender's Edge* and the US Army's (USA) *Human Dimension Strategy*, seek to instill self-regulation techniques designed to improve resilience, decrease threat perception, and increase both the confidence and courage to respond to highly stimulating events.[20] These are significant endeavors because, as Clausewitz noted, "ordinary men. . . tend to lose self-confidence when they reach the scene of action: things are not what they expected."[21] While external factors are uncontrollable, the internal factors—our ability to interpret, predict, and respond—are the most important. Emerging performance programs are a step in the right direction. However, most current programs operate independently of, and not integrated with, traditional combat readiness programs. Leaders should seek to weave current performance programs with training efforts seamlessly to synergize understanding and application.

Understanding feeds prediction; the ability to accurately predict what will happen next is a proactive tool to combat fear. *The fusion of neuroscience education with training using real-world equipment, in realistic scenarios, with progressive complexities and consistent feedback loops develops confidence and prediction.* Well-designed training allows one to practice metacognition (thinking about thoughts) while under stress and answer "danger-reasoning" questions in a controlled environment. In future events, when facing real-life high-threat situations, the brain can draw on previous experiences and reduce the bandwidth demand on our limited mental resources. The more frequently and steadily leaders expose war fighters to dynamic situations and objects of fear, the greater the opportunity to develop threat habituation.[22]

Cognitive distance, or the gap between the training form and its applied context, strongly influences deliberate training effectiveness. The closer the simulated training environment is to expected reality the more prepared war fighters will be cognitively. A cognitively-readied war fighter is more confident and more likely to anticipate what comes next. For instance, the cognitive distance of active shooter response training is much less during an actual rehearsal walkthrough than when using a PowerPoint presentation; real firearms with blank ammunition are closer than a rubberized blue gun; actual expected response locations are better than conceptual "glass houses."

Time and money are limited assets and prohibit frequent rehearsals of every conceivable situation. Fortunately, the menu of options available now is safe, repeatable, and highly effective. Modern technologies such as dye-marking and laser-based munitions, four-dimension virtual reality simulators, and highly-realistic

training scenarios supplement experience gaps while practicing doctrinally-based concepts and learning to manage judgment in the fog of simulated war. Additionally, emerging tools, such as augmented reality and brain activity monitors (e.g., the smartphone-sized BrainScope monitor), promise even greater future training and evaluation capabilities.[23] Habituation takes time but increases the likelihood that sound decision making will occur while under stress. Leaders should incorporate as many simulation tools as possible to exploit their full cognitive and survival enhancement benefits over time.

Although training capabilities vary from place to place, leaders must take advantage of existing opportunities and innovate the best they can with what is available. In some cases, leaders may need to assume more risk in training to more closely mirror real-world conditions. Leaders must seize the initiative to shape war fighters' battlefield responses by building the *character* of competence. "Training is the most important thing we do" is the philosophy organizational leaders should embrace to support the *skills* of competence.

Fear is an important part of the human condition; it exists to increase the likelihood of survival. Fear is an alarm programmed to alert the brain that a threat is present. A leader's goal is not to prevent fear from presenting itself. Rather, a leader's goal is to dilute the corrosive effects uncontrolled fear can have on an individual's performance to improve the odds of survival and mission success.

Complexity: Friction

Fog and fear are individual factors of war's internal struggle. Together, fog and fear contribute to create an invisible force Clausewitz termed *friction*. Clausewitz notes how everything in war is very simple; yet what is simple is also difficult.[24] On paper, theoretical war and real war are the same. In real war, they are quite different. Friction is the difference between the best-laid conceptual plans and what actually happens—it is the original Murphy's Law. Friction manifests through external and internal means.

Externally, friction is the unforeseeable, unplanned, and uncontrollable difficulties of war. The accumulation of often small irritants produces mental and physical complications that are inconceivable to those who have not experienced it firsthand. In action, both sides in the US Civil War experienced the friction of small-scale raids against railroad infrastructure, suicide bombers vex conventional militaries today, and the loss of cyber and communication capabilities will frustrate tomorrow's forces. Beyond the adversary, weather, resource shifts, obstacles, and countless other factors contribute to "unknown-unknowns" that are impossible to know in planning phases.

Internally, friction manifests from the presence of unclear information (fog), the danger of war (fear), and—most notably—by war's demanding physical and mental efforts (fatigue). The immense energy required to move humans and hardware is exhausting. Physically, the body fatigues from constant tension and stress under the load of restrictive combat load and countless other factors. Neurologically, brain function wanes from lack of sleep, loss of energy, and decision-making fatigue. The

brain and body have finite resources unique to each individual. Once stores are exhausted, the combined effects of friction and war as a human endeavor inevitably lead to mistakes and missteps.[25]

Friction is an ever-present peripheral opponent to all militaries in the modern era. US joint forces recognize friction as a core warfare limitation, and, thus, have embedded mitigation strategies into their cultures and doctrines. Current joint operations doctrine embrace *simplicity* as a core principle to combat the self-imposed friction in planning. Commanders are educated to recognize that every degree of increased complexity or rigidity directed by mission orders exponentially increases the difficulty of completion at the execution level. Clausewitz promoted the idea that plans must leave a margin for uncertainty, in the greatest things as much as in the smallest.[26]

Commanders should know they cannot instill certainty into an order, no matter how perfectly the plan is conceived. Instead, commanders must allow for improvisation when inevitable human factors emerge at unknown places and times for even the simplest tasks. Friction is a human problem because it creates both real and perceived threats. As friction creeps onto the operating environment, tactical flexibility is essential. War fighters executing a plan must be empowered to compensate for unanticipated friction and uncertainty through their own originality and creativity.

The USA approaches tactical flexibility through the philosophical fusion of the art of command and science of control, otherwise known as *mission command*. According to Army Doctrine Reference Publication (ADRP) 6-0:

> Mission command is the exercise of authority and direction by the commander using mission orders to enable disciplined initiative within the commander's intent to empower agile and adaptive leaders in the conduct of unified land operations. Mission command is one of the foundations of unified land operations [ADRP 6-0]. This philosophy of command helps commanders capitalize on the human ability to take action to develop the situation and integrate military operations to achieve the commander's intent and desired end state. Mission command emphasizes centralized intent and dispersed execution through disciplined initiative. This precept guides leaders toward mission accomplishment.[27]

Disciplined initiative enables tactical leaders to overcome friction at the lowest levels by allowing freedom of action. Disciplined initiative supports the chairman of the Joint Chiefs of Staff's future operations intent to create a force that is adaptable, thinks critically, and can make rapid, independent decisions at the point of friction.[28]

Since friction is organic to war, mental agility and adaptation are premium skills to train while preparing for the unexpected. While friction persists in the mission command construct, empowering soldiers engaged in a decisive point the flexibility to adjust their actions based on the conditions presented dissipates its effects. Leaders who understand war's innate complexities amplify efforts to combat friction. Those who understand basic brain functionality and apply core concepts into training will optimize each individual's performance in chaos.

Beyond training design and operation, leaders have a direct role in helping forces overcome friction. Leaders can assume personal responsibility to fight the effects of friction in two key ways: *cultivating military genius and skillful use of leader-imposed stress*.

Military Genius

Clausewitz's concept of coup d'oeil describes a leader who possesses an advanced ability to draw upon experience and intuition to see clarity amidst chaos almost immediately and *act*. Napoleon and Patton had coup d'oeil. This developed mastery—what Clausewitz characterized as *military genius*—offers a firm understanding of the situation at hand and the ability to skillfully mitigate and infuse human limitations into a simple, coherent plan repelling the effects of chance and probability. Military genius is at the heart of the USA's mission command philosophy and what Clausewitz deemed as the solution for both external and internal friction.

From a neuroscience perspective, coup d'oeil refers to a leader's ability to consciously and deliberately consider and understand a situation at the "stroke of an eye"—to *thin-slice* a moment in time. Thin-slicing refers to the trained ability to recognize patterns and, in turn, create accurate expectations of what will happen next.[29] This unconscious quick cognition ability stems from the development of sophisticated wetware. On average, the cognitive brain's ability to hold information is limited to about seven items (plus or minus two); it processes about 40 bits of information per second. The more primitive unconscious brain holds troves of information; it processes more than 11 million bits of sensory information per second.[30] The unconscious brain expedites information interpretation to produce focused, complex judgments quickly—often in ways not immediately articulable. The abilities to produce accurate quick-glance decisions and immediately distinguish nuance separate those who have military genius from those who do not.

Military genius is neither ingrained at birth nor accidentally developed. *Military genius can only develop from deliberate practice, focused professional and personal study, and experience over time*.[31] Today's US military is the most educated of any in any nation's history. However, it is stretched thin and lacks the developmental time, expertise, and cultural support necessary to facilitate the neural network development required to produce more widespread military genius for future war. Brains have not changed much over the millennia, but access to dopamine-producing activities has. When we overindulge in digital immersion, it has a threefold effect: it addicts us to engage in more digital activity over time, it affects how we absorb information, and it removes what already limited time exists to focus on the work that really matters.[32]

Strategic-level leaders must strive more than ever to provide the cultural scaffolding necessary to encourage service- and self-directed efforts required to produce military genius in a modern society driven by distraction. Trainers cannot teach military genius through formal training alone. Leaders must set conditions that encourage thought-shaping. However, individuals must take personal responsibility from there by studying and shaping their neural connectomes on their own. It is the sincere *pursuit* of military genius that matters most.

Leader-imposed stress

Clausewitz notes, "Iron will-power can overcome friction. . . but of course, it wears down the machine as well."[33] Known today as the Yerkes–Dodson Law (figure 2), Clausewitz intuitively identified that, at times, *deliberate bursts of leader-imposed stress (eustress) and passion could increase the performance of war fighters, especially in high-threat environments*.[34] However, the resulting burst of performance and consistency of application is not sustainable. Pushed too far (distress) for too long, individuals experience a significant drop in performance, create diminishing returns, and *increase* the amount of friction experienced. Again, a leader's ability to apply coup d'oeil is likely the difference between success and failure in this instance.

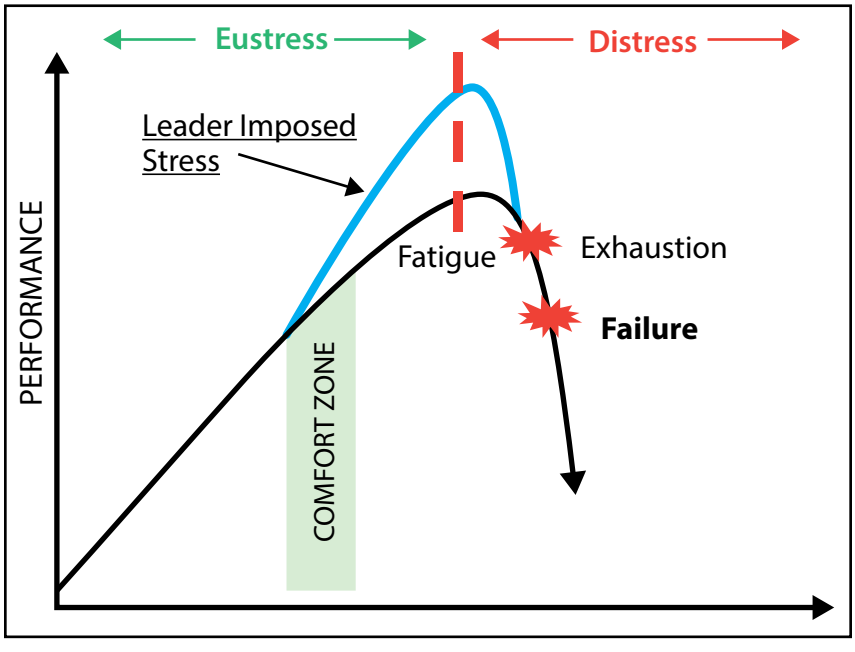

Figure 2. Yerkes-Dodson Law. (William McCollum and Matthew Broaddus, "Leader-Imposed Stress and Organizational Resilience," Fort Leavenworth, KS: US Army Command and General Staff College [August 2016]: 6.)

Recommendations

Adopting neuroscience education as a training concept is necessary—and it can be done. What is unclear, however, is whether it will be embraced in the face of tradition. Accumulating scientific knowledge indicates neuroscience education would benefit a wide range of trainees—from recruits to experienced war fighters.[35] However, additional institutional scaffolding is required to allow neuroscience education to enhance desired effects. Before leaders direct ad-hoc neuroscience education protocols to local training and leadership programs, I submit the following recommen-

dations as *starting points* to facilitate holistic program development and long-term success:

1. *Leaders*. Neuroscience education should be woven into professional military education (PME) as a proactive performance element to improve war fighters' metacognition capabilities. Neuroscience evidence should inform the "why" behind the "what" of combat support procedures and decision-making processes. Creating awareness that limitations are present creates a natural internal motivation to want to reduce those gaps. I recommend each PME level—enlisted and officer alike—incorporate into the curricula tiered and tailored courses focused on the neuroscience of motivation, capacity, and effectiveness in an enhanced military. Tiered and tailored "Neuro 101" courses should progressively inform on the brain's structure, how its design affects enduring human elements of fog, fear, and friction, and why understanding it matters for future war. PME must prepare leaders to understand how human factors influence strategy alongside strategy itself.
2. *Trainers*. Creating awareness of biological functions and limitations using a tiered and tailored approach is the first step to elevating performance. The next step is to re-conceptualize unit training program templates. Unit training programs should specifically consider known neuro limitations while deliberately striving to "close the gap" between the young adults and their mature adult counterparts. Trainers should receive additional training describing effective training methodologies grounded in neuroscience to close existing neuro gaps. Beyond PME, I recommend career-fields develop specialized "train-the-trainer" programs tailorable to the needs of unit-level, readiness training center, and technical training instructors to develop specific and mutually supportive warfighter traits.
3. *Individuals*. Accounting for practical variations in training requires a framework to corral individual differences. Trainers should follow a simple assess-improvement-reassess model to determine specific skill proficiency. However, training variation *needs* are not so obvious from individual to individual. Personality inventories may offer clues to tailor training and improve performance at the individual level. Organizations most often use personality inventories as fringe team-building or novelty self-awareness tools. While successful as a team-building drill, training programs are not designed to translate personality inventories into meaningful training application aids. I recommend career fields develop routine personality inventory protocols to establish foundations of training variation requirements across individuals. As individuals change over time, so do their needs. Currently available trait tests (e.g., Myers-Briggs Type Indicator, DNA Behavior, Jung typology, DISC personality tests, and so forth) offer insights that, when leveraged effectively, may increase the effectiveness of a given training program.
4. *Research*. Beyond neuroscience applications, I recommend the Air Force and each career field develop a list of enduring "Future War-fighting Challenges." Career-field directors should offer topics needing solutions to officers and se-

nior noncommissioned officers before attending mid- and late-career PME. The intent of Future War-fighting Challenges is to identify problems in need of research, both neuroscience- and nonneuroscience related, and to translate existing concepts into viable applications. Air Force functional leaders should require graduate degree completion for students who attend an in-residence graduate-level PME course where the degree program is optional. The institutional requirement to continuously adapt alongside an ever-evolving operating environment should necessitate increased returns on investment in the form of target-focused research from the Air Force's brightest strategic thinkers. PME institutions must also evolve to support the research needs for predicted future war.

Conclusion

In predicted future war, our military becomes a weak link system.[36] In recent decades, the military succeeded as a strong link system. Superior weapons and technology supplanted service member focus and end-strength numbers. But the military sovereignty that got us here does not entitle us to future victories. The uncertainty of digital superiority in predicted future war compels us to reconsider war-fighter preparation efforts.

If we accept the premise that adversaries will have the motivation and capability to neutralize key nodes of our strong link advantages, the weak links—the individual Airmen—become the critical determinants to success. The *analog* superiority—the cognitive skills used to execute sound decision making while under great stress—demonstrated by tactical-level Airmen will be the decisive point between mission success and failure. For predicted future war, improving the skills of weak link elements may provide greater relative benefit than improving strong links with vulnerable nodes. This is not to say we should not seek to improve the capability and resilience of our strong links—we should. However, the commitment to retain our technological edge should be rivaled closely by our determination to optimize human dimension strategies. Our future military success will rely upon both technological and human cognitive domains.

Some will argue that each service component is already pursuing multiple approaches to build a better war fighter. While cursorily true, current programs are often niche, and many military leaders, especially at tactical levels, are resistant to seemingly "softer" approaches to change. Strategic- and operational-level leaders must embrace and advocate for neuroscience education and applications to become culturally accepted practices of our military systems, not just peripheral programs, to prepare now for predicted future war.

Clausewitz believed that the seeds of a nation's war-fighting success are sown in the limited and interwar periods. Our military leaders face an important choice. We can cling to a traditional view of war fighting grounded in past successes rather than future challenges. Or we can evolve the Western way of war by listening to emerging neuroscience research, embracing new approaches to war-fighter preparation, and developing or embracing an operating philosophy that helps future war fighters, organizations, and joint services operate a little better.

Better ways are within our grasp. Cultural change will neither be easy or happen overnight. However, change is favorable to irrelevance. Two assumptions for future war should guide our actions now—wars of *attrition* will favor our adversaries; wars of *cognition* should favor us.[37] Now is the time to link relevant neuroscience research to our strategic-, operational-, and tactical-level end-state objectives. ✪

> *Our true legacy is the ability to see and shape the future in order to win. It's time to get started—the future is closer than we think.*
>
> —Gen Terrence J. O'Shaughnessy

Notes

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Maj Michael J. Cheatham, USAF

Major Cheatham (MA, American Military University; MMAS, US Army Command and General Staff College; BA, University of Arkansas) is the commander, 374th Security Forces Squadron, Yokota AB, Japan. He is responsible for the protection of 11,000 military, civilian members, and dependents and more than $2 billion of DOD facilities, equipment, and aircraft. Major Cheatham also ensures the readiness of all assigned personnel to conduct security operations for air expeditionary force deployments and wartime taskings. He provides air provost services to the Yokota community, fly-away security teams for Pacific Air Forces and Air Mobility Command aircraft, and liaises with host-country police forces, defense forces, and other local agencies. Major Cheatham is a career security forces officer whose deployment history includes tours with the 586th Expeditionary Security Forces Squadron, Camp Bucca, Iraq, and the 450th Military Police Detachment, Forward Operating Base Fenty, Afghanistan in support of Operations Iraqi and Enduring Freedom. Before his current assignment, Major Cheatham was commander, 799th Security Forces Squadron, Creech AFB, Nevada.

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