Neuroscience for Combat Leaders

A Brain-Based Approach to Leading on the Modern Battlefield

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"EVERYTHING YOU DO in life is based on your brain's determination to minimize danger or maximize reward."[1] The brain wants to move toward things in life that give it pleasure or ensure survival, and away from things that cause pain or threaten survival.[2] Combat demands that military individuals overcome this natural impulse to survive and move toward the danger. From this perspective, succeeding in combat is a measure of how well the brain copes with dangerous situations and performs tasks that ensure survival.

The field of neuroscience has seen significant advances in recent years, and the benefits of this knowledge can positively affect numerous disciplines, including combat leadership. Using functional Magnetic Resonance Imaging, surgical methods, and experiment-based approaches, researchers have revealed many of the biological processes that underlie our most basic emotional and cognitive behaviors, such as how and why we react to threatening situations, how our brains allocate energy to cope with competing demands, and how our senses interact with our minds to create the world we know.[3]

Learning about brain function and physical reactions to stress does not simply inform the leader, but creates self-awareness that makes him better able to control those processes.[4] Tactical-level military leaders can use this new knowledge to understand the effects of combat, anticipate and recognize cognitive reactions, and adjust their leadership abilities to succeed in difficult situations. They can do this by performing exercises to decrease physiological stress reactions, using emotionally controlled leadership to guide their organizations, and creating an environment during battle that facilitates effective decision making. By educating soldiers about brain function and incorporating cognitive stressors into training, leaders can prepare their units to perform in battle with emotional stability.

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PHOTO: U.S. Marine Corps SGT Jose Paez and LCPL Anthony Lewis participate in a security and presence patrol in Sangin, Helmand Province, Afghanistan, 18 January 2010. (U.S. Marine Corps photo by CPL David Hernandez)

Basics of the Brain

Combat leaders need a basic knowledge of cerebral biology to understand the importance of the mind's function during combat. The two major brain areas most relevant to this topic are the limbic system and the prefrontal cortex.[5] The former is the collection of brain regions involved in emotions, learning, and memory. The latter is the center for higher-level thinking, which

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U.S. Army SPC Chris Avila, right, and other soldiers engage Taliban forces during a halt to repair a disabled vehicle near the village of Allah Say, Afghanistan, 20 August 2007.

actively influences body functions and performance.[6] Inputs travel along pathways in both these systems and allow us to react to scenarios with a balance of emotion and reason.

Located in the center of the brain, the limbic system primarily contains the thalamus, hypothalamus, hippocampus, and the amygdala, and is the creator of emotions and memory.[7] Its primary function is to interpret information sent from the body's senses and to issue emotional commands back to the body. The limbic system also sends its data to the executive areas of the brain (frontal lobe) for cognitive processing and receives instructions about how the body should respond to the given situation.[8]

Sometimes, the limbic system can independently respond to the world, like when we react to threatening situations. This occurs at the subconscious level, when the amygdala—the fear and anxiety response center—compares data from the world with the hippocampus, which is the memory database of experiences.[9] If the incoming information corresponds to a threat that has been tagged as negative or dangerous, the amygdala immediately commands the body into action. We have all experienced this process when our reflexes have caused us to snatch a hand away from a closing door or leap away from a snake.[10]

The more sophisticated processes of the mind occur in a sheet of tissue just behind the forehead known as the prefrontal cortex. As explained by Dr. Rand Swenson of Dartmouth Medical School, the prefrontal cortex is also known as the "thinking brain," the manager of "memory, judgment, planning, sequencing of activity, abstract reasoning . . . impulse control, personality, reactivity to the surroundings, and mood."[11] This area is what allows humans to solve math problems, develop abstract concepts, and ponder our own existence. It is also the area that military leaders use to balance risks in combat, develop courses of action, and create strategies to lead effectively.

Every part of the brain is packed with blood vessels that provide the oxygen needed to fuel its 100 billion cells.[12] As we engage various brain systems during daily activity (e.g., driving, throwing a ball),

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the brain redirects blood and glucose to the appropriate areas (e.g. visual cortex, motor cortex) to fuel the most important event occurring at the time.[13] This allocation leaves less fuel for other brain functions, like cognitive control, which requires vast amounts of blood and glucose to operate.[14] When the limbic system is heavily engaged, as it is during the high-threat stress of combat, it will quite literally steal fuel from the prefrontal cortex, thus handicapping a leader's ability to combat the situation with cognition.[15] As successful business consultant and CEO David Rock explains in *Your Brain at Work*, "the degree of activation of the limbic system is the degree of *deactivation* [emphasis added] of the prefrontal cortex."[16] Brain research has also shown that there are many more neural connections that flow from the amygdala directly to the prefrontal cortex than vice versa.[17] Therefore, it is easy for our emotions to guide or suppress our rational thoughts. This is a crucial fact because military leaders must preserve cognitive function when leading during combat.

The Limbic System in Combat

The limbic system is evolutionarily older than the prefrontal cortex—primitively old, in fact. It developed to help man survive the ancient battlefield of predator versus prey. The limbic system has the "chemical authority" to initiate rapid responses to threats and is good at doing so.[18] The amygdala ignites; adrenaline flows to the blood; the pulse races; the eyes focus and rapidly scan for a threatening movement.[19] We halt unnecessary digestion and tense major muscle groups in preparation for a clash. Then the brain, teeming with blood vessels, redirects the available supply of oxygen and glucose-rich blood to the limbic and motor areas so that we can react quickly in the impending fight. At this point, the mind is in its most basic survival mode; it has no spare energy to devote to solving geometry problems or to pondering philosophical dilemmas. This biological decision to focus resources toward limbic areas during dangerous situations is what keeps us alive at a time when a cerebral problem-solving approach would be fatally slow.

But today's military leaders do not face the same world that our ancestors did. While there are still many threats that require rapid, reflexive action, leaders also have to manage countless streams of information; communicate over multiple technological systems; balance political, military, and civilian considerations; and lead hundreds of men and women in the process. Combat requires a coherent and rational mind.

Combat is full of stressful moments—initial contact with the enemy, rushing to secure enemy terrain, or responding to an unexpected event—that test emotional resolve. Those involved experience intense sensory input and encounter debilitating explosions, grotesque scenes, and threatening enemy movements. As the limbic system attempts to keep pace with the environment, it starves the soldier's ability to maintain a clear mental framework. Coupled with the typically exhausting physical exertion of combat, soldiers are consistently at risk of degraded cognitive processing.

This occurrence is evident in countless historical accounts of soldiers rendered immobile by battle. In his survey of soldier actions in World War II, the famous soldier author S.L.A. Marshall observed, "Some fail to act mainly because they are puzzled what to do and their leaders do not tell them; others

(U.S. Marine Corps, CPL William J. Faffler)

U.S. Marines with Company B, 1st Reconnaissance Battalion, engage enemy forces from a patrol base near Sangin, Afghanistan, 22 October 2010.

are wholly unnerved and can neither think nor move in sensible relation to the situation."[20] Renowned historian J.F.C. Fuller's observation is similar: "In an attack half of the men on a firing line are in terror and the other half are unnerved."[21] Works by Bruce Siddel and Dave Grossman, particularly *Sharpening the Warrior's Edge* and *On Combat*, present an exhaustive analysis of combat's effect on the human body and what soldiers can expect when they face it.[22]

The Leader in Combat

Each duty position on the battlefield contains some balance of reflexive and cognitive tasks. Some can be trained repeatedly and developed into muscle memory, like loading and firing a weapon. Others are more cognitive in nature, like calling for indirect fire or coordinating a synchronized attack. While each soldier has his own personal tactical situation to react to, typically frontline riflemen operate in the reflexive region, while the cognitive component of battle increases with rank and responsibility.

In this article, the term "leader" refers to any individual who is responsible for leading several groups of soldiers in maneuver against the enemy and must manage multiple battlefield systems. This leader spends most of his battlefield time outside of his weapon's sights. While team and squad leaders are unquestionably "leaders," they use battle drills and reflexive training to guide most of their actions and will not have to rely on their abstract cognitive abilities during combat unless they are operating as an autonomous element.

The platoon leader and platoon sergeant are the first leaders that engage in more complex problem solving than direct-fire battle. The company-level commander is squarely in the cognitive region, with occasional moments that require reflexive action. The battalion-level commander will rarely perform actions that are not based on premeditated cognition.

What can these leaders do to mitigate the physical reactions to stress that will inevitably occur? What methods are available to regain cognitive control and place the leader in a position to maximally benefit the unit? First, actively decrease the effects of stress. Second, infuse emotional stability into the organization. Finally, create an environment that facilitates effective decision making.

"While many animals get through life mostly on emotional automatic pilot, those animals that can readily switch from automatic pilot to willful control have a tremendous advantage."[23]

Control the effect of emotional energy. As combat will readily reveal, the body and mind undergo rapid changes when reacting to stress. While moderate levels of stress improve functions like motor skills, stress can easily impair performance in cognitive areas, where today's tactical leaders typically need to operate.[24] Heart rate, blood pressure, and breathing will all increase; digestion will slow and nausea may occur; speech may falter, and auditory and visual cues may diminish.[25] All of these effects are natural as the body emotionally reacts to the fight. However, leaders have a responsibility to control the effect of emotional energy and remain calm in the face of danger.

One proven technique used by law enforcement and military professionals to combat stress is "tactical breathing."[26] As Grossman explains, tactical breathing is "a tool to control the sympathetic nervous system" that will "slow your thumping heart, reduce the tremble in your hands, deepen your voice" and "bathe yourself with a powerful sense of calm and control."[27] As one of the only two autonomic nervous system actions that we can control (the other is blinking), breath rate is the first reaction to stress that leaders can rein in.[28] Immediately after a significant stressor occurs (e.g., the enemy initiates contact) or just prior to entering a high-stress situation (e.g., the final approach to an objective), simply take several successive deep breaths and hold each one for three to five seconds. As you breathe, visualize your body relaxing and remaining calm during the event. Although time may not allow leaders to take a long tactical pause, simply diagnosing a rapid breathing pattern and forcing a couple of slow breaths will help decrease the body's agitated state.

Another method of controlling stress is a concept called "labeling and reappraisal," which is the act of naming the emotional state you are experiencing and actively reassigning a new emotion that is more productive for the situation.[29] Verbally identifying the emotions or reassuring yourself out loud activates the prefrontal cortex and begins to reclaim some power from the limbic system.[30] Simple cue-words like "steady," "stay focused,"

and "relax" are active reminders that can elicit controlled behavior. A unit's motto can be another steadying phrase. Repeating these words can trigger confidence and strength in the face of trying circumstances. More important, such statements not only have an effect on leaders, but can also filter through an organization to reinforce its members. The key is to talk oneself into a mental framework that is capable of handling the highly cognitive experience of modern combat.

Any military leader will readily support the practice of unit rehearsals before an operation. Do individuals not also have the responsibility to rehearse how they will react in combat? Professional golfers, divers, and other elites who rely on precise skills use a technique called visualization to reinforce desired behavior. Likewise, a tactical leader can benefit by visualizing himself performing with emotional calm and cognitive clarity. A leader with a clear vision of how he wants to perform will, as survival author Laurence Gonzales puts it, create a kind of "memory of the future" that the brain can access during combat.[31] Like muscle memory, proper mental processes can become reflexive.

Infuse emotional stability and control into the organization. Leaders must discover ways to control their application of emotional energy. Their behavior is a compass for the unit, an indicator of what stress is allowable and appropriate for the situation. The first actions after a significant event—like an attack with an improvised explosive device—set the unit's tone for the engagement. As General George S. Patton counsels, leaders are always on parade.[32] An uncontrolled yell, a high-pitched radio call, or even a worrisome look can transmit stress and doubt to the unit. Conversely, leaders with composure and confidence despite stressful circumstances will infuse those traits into the unit. Commanders should be deliberate and concise. Leaders should objectively verify emerging information to avoid overreacting or acting too hastily.

Neuroscience research reveals that there are methods leaders can use to do this. Noted author Malcolm Gladwell describes "deliberate emotion" in *Blink*: "We take it as a given that first we experience an emotion, and then we may—or may not—express that emotion in our face. We think of the face as the residue of emotion. . . . The process works in the opposite direction as well. Emotion

U.S. Army, PFC Cameron Boyd

A U.S. soldier patrols a field in Nangarhar Province, Afghanistan, 19 January 2011.

can also *start* in the face. It is an equal partner in the emotional process."[33]

A German psychology experiment revealed that people who were physically made to smile by holding a pen clenched in their teeth rated cartoons as funnier than people who watched the same cartoons while holding a pen in their lips, which prevented smiling.[34] Facial expressions are not just a representation of emotions; they can *direct* emotions. Leaders can physically incite a more positive, relaxed emotional response in their bodies by intentionally forming a relaxed facial expression during combat events. This demeanor will also cue similar responses in the soldiers around them.

"Insight comes from a quiet brain."[35]

Create an effective decision making environment. Regardless of rank, and even in the midst of intense combat, leaders must create an environment that is conducive to making cognitive, not emotional, decisions. They can start creating this environment by physically and emotionally disengaging from the immediate fight. This may mean finding sufficient cover for a local command post. A company commander seldom belongs in the hatch of his vehicle or exposed on a street, scanning for targets like a rifleman. Of course, desperate times will call for every gun to be in the fight, but only a handful of commanders will ever face that situation. The goal is for the leader to mentally "zoom out" from his personal tactical situation and take a more macro-level view of the battle, preparing his brain to handle the impending cognitive challenges.

The commander should then use his "space" from the battle to focus on what he has trained to do: assess and analyze what has occurred, recognize friendly force vulnerabilities, predict what the enemy will do next, decide on a feasible course of action, communicate the plan to the unit, and apply the appropriate leadership skills to inspire the unit to accomplish the mission.

The specifics of these steps can include conducting rapid terrain analysis and land navigation using complex digital systems; calling for mortar, artillery, or aircraft fires; establishing hasty graphic control measures to prevent fratricide; assimilating frantic, vague reports from subordinates; and relaying relevant data to higher echelons, among many other

(U.S. Marine Corps, CPL David Hernandez/)

U.S. Marine Corps 1LT Brad Fromm coordinates on the phone while clearing compounds in Sangin Valley, Afghanistan, 1 December 2010.

tasks. These are not reflexive actions that one can repeat until they are muscle memory. Nor are they actions that the emotional limbic system can control. They are highly cognitive and require a steady mind.

A leader needs to find a suitable environment where she or he can generate new ideas, new insights, for each unique tactical situation encountered. Battle drills are, of course, an effective method units use to survive the first moments of a new event. But leaders must think beyond the battle drill and formulate innovative ways to beat the enemy. As neuroscientist Jonah Lehrer explains in *How We Decide*, "This is where the prefrontal cortex really demonstrates its unique strengths. It is the only brain region able to take an abstract principle and apply it in an unfamiliar context to come up with an entirely original solution."[36]

The brain assembles new ideas using a system called "working memory." Working memory is the temporary storage area the prefrontal cortex uses to hold concepts in place while it accesses other, more permanent bits of information (like stored knowledge, past experiences, and technical data).[37] This ability "allows the brain to make creative associations as seemingly unrelated sensations and ideas overlap."[38] "Once this overlapping of ideas occurs, cortical cells start to form connections that have never existed before, wiring themselves into entirely new networks."[39]

To create new ideas in combat, leaders must enable and facilitate this process. They must "think about what they're thinking about." The prefrontal cortex cannot generate new ideas while stressful events constantly bombard its working memory. Leaders must protect their cognitive faculties, prioritize facts, and not let extraneous information distract them.[40] Sometimes deliberate problem solving is necessary; other situations are novel and require a creative solution. When successful, the prefrontal cortex will hold the crucial facts of the situation in its working memory and compare them with previous knowledge and experience to generate new solutions. Again, this can only occur when the leader has created a suitable environment. He will not obtain any genuine insights if he is distracted by incoming fire, annoyed by a radio operator screaming information, or if he has allowed his stress levels to spike.

In combat, the process may occur like this: the enemy attacks on one side of a platoon combat outpost with machine gun and rocket fire. The platoon's guard force reacts instinctively, returning fire where possible, but the platoon sergeant breaks his gaze from the explosions and asks, "What else can be happening here?" When he disengages his working memory from the visually overloading stimulus and thus momentarily quiets his brain, his mind begins to process the events in light of other stored knowledge, such as a remembered report of a previous attack in which the enemy used gunfire and rockets as a diversion to support a larger attack from the opposite direction. With the insight that this first attack could be a diversion, the platoon sergeant informs the unit and wargames with the platoon leader where a second attack might occur. Such insight will not happen if leaders are myopically focused on the near fight to the extent that it prevents their cognitive abilities from engaging.

Once a leader achieves a state of comparative emotional calm, he permits his mind to sense patterns in the environment that otherwise might have been suppressed by stress or distraction. Neuroscience research explains what we all have sensed at one time or another—that the mind can know something about our surroundings before we are fully aware of it. Detecting subtle patterns is the job of a group of brain regions called the basal ganglia, which have connections to virtually every part of the brain.[41] The basal ganglia subconsciously process massive amounts of data and send signals that cause visceral, emotional responses to the body.[42] This is what happens when you walk out the door without your car keys and have a gut feeling that "I'm forgetting something. . . ."

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A leader can access this process during combat, but only if he is tuned in to listen for it. The brain can analyze the developing situation and compare the data with the lifetime of knowledge, experience, doctrine, and lessons that have accumulated in long-term memory. It will filter out extraneous information, discover relevant patterns of information, and, using emotions, alert the body that the prefrontal cortex should redirect its attention.[43] In this way, hunches are not just superfluous feelings, but expressions of powerful analytical processes hard at work.

A Model for Cognitive Battle

In *Your Brain at Work*, David Rock explains that the mental processes relevant to performing work are *understanding, recalling, deciding, memorizing,* and *inhibiting*.[44] His example involves a business leader who must complete a proposal by focusing on relevant information, remembering similar past proposals, selecting the best method to complete the proposal, committing applicable information to long-term memory, and blocking out mental processes not beneficial for the task. Military leaders must perform similar cognitive tasks when responding to a combat situation. The difficulty of their task is compounded because every battlefield is different, and every battlefield is deadly. Let's examine a typical combat engagement.

Understanding. Following the initial shock of an attack, *understanding* involves how a leader "creates maps in the prefrontal cortex that represent

new, incoming information and connects these maps to existing maps in the rest of the brain."[45] It means absorbing the relevant terrain (which is unanticipated terrain if the enemy initiated the attack) and overlaying it with pertinent data like population considerations, maneuverability requirements and restrictions, and friendly force disposition.The leader accepts and adjusts to his new environment as the arena in which he will fight, and then begins to form his new mental map. This is also the opportunity to sense patterns in the environment that may affect the decisions to come.

Recalling. In battle, *recalling* is the process of comparing the existing situation with the database of stored knowledge in the long-term memory networks. Think of it as looking into the cupboard to identify what ingredients are available to make dinner. This important mental process filters through all lessons, instruction, and experiences to determine what can be used to cope with the current situation. While being attacked from a building, for instance, the leader's mind may instantly make connections to the doctrine he learned in his early years. Then, the lessons learned from dozens of urban exercises reestablish their neural link to the prefrontal cortex and make themselves available for use. Maybe a phrase or piece of advice from a former instructor just pops into his head. Recalling is the brain's way of gathering the most relevant information in anticipation of making a complex decision.

(U.S. Army, SPC Andy Barrera)

A U.S. Army combat medic patrols a village in the Kharwar district of Logar Province, Afghanistan, 12 February 2011.

Deciding. A combat leader's brain engages in the *deciding* process when it chooses which recalled information will be most useful and applies it to the real-time world to build a new mental map. This is cognitive course of action development. Deciding brings together learned skills and past knowledge to form a response plan specific to the current scenario. Sometimes a leader firmly decides on a course of action; other times, the cumulative effect of the recalling process creates emotional hunches that point to a certain response. After deciding on a course of action, the brain shifts from conceptual analysis to specific application. The new mental map now occupies the working memory space and the prefrontal cortex engages to find detailed answers needed for execution. These include what route friendly forces will take, when and where they will engage, what fire control measures subordinate units need, what information must be passed higher, and so on.

Memorizing. David Rock describes *memorizing* as "holding maps in attention in the prefrontal cortex long enough to embed them in long-term memory."[46] Research shows that it is impossible for our brains to simultaneously hold multiple complex concepts in working memory without degrading accuracy.[47] (Imagine trying to write a text message while driving in England on the left side of the road.) In combat, rapidly comparing the details of multiple courses of action is quite a difficult task. Thus, it is important for leaders to move the mental map of a battle plan into long-term memory so the prefrontal cortex can reoccupy working memory. This allows the comparison of the plan with new ideas and emerging information.

For leaders in battle, memorizing is also the internalization of a plan. Focusing on the concept of an operation (planned or hasty) creates familiarity that allows execution without redundant analysis or reference to written notes. Memorizing is a form of rehearsal and wargaming for leaders, compelling them to review their plan from multiple angles and search for vulnerabilities or errors.

Inhibiting. Finally, *inhibiting* is the practice of selective focus, when one actively tries to not engage certain mental maps because they are irrelevant or counterproductive.[48] An American driver

in England should actively try to forget the mental perspective of driving on the right-hand side of the road. Working memory cannot juggle two competing complex concepts without diminished efficiency. As a combat example, consider a leader who has only Iraq deployment experience and was almost entirely engaged with IEDs. He spent the year concentrating on how to defeat IEDs and focused battle drills to respond accordingly. Now in Afghanistan, where the enemy in his particular region conducts exclusively small-arms and rocket attacks, the leader must suppress his learned tendencies, realign his mental perspective, and develop new neural connections that will help him properly frame and respond to the most likely threat.

Personalizing. To these, I add *personalizing*, which can apply to every moment of a leader's day. This is the application of leadership principles and personality attributes that will guide the organization to accomplish the mission effectively. There are many examples of leaders who, intentionally or not, seem to change their personality in combat. The emotional stress of the situation causes them to display different leadership traits than they demonstrated in training. Personalizing is the leader's conscious effort to prevent external influences from altering the foundation of character and leadership that she has consistently developed and that her subordinates have learned to expect.

Training for the Emotionally Stable Fight

"It therefore follows that the far object of a training system is to prepare the combat officer mentally so that he can cope with the unusual and the unexpected as if it were the altogether normal and give him poise in a situation where all else is in disequilibrium."[49]

Training for combat is about changing the brain. Decades of neuroscience research have firmly shown that the brain is highly adaptable and that repeated activities designed to create specific behaviors—like combat training—literally "change cellular structure and strength of connections between neurons."[50] At the rifleman level, training teaches soldiers to respond reflexively to situations that demand a spontaneous conditioned response, such as engaging an enemy fighter at close range. It is the same behavioral process that professional athletes apply to develop the fine-tuned motor skills needed in competition.

This learning process also applies to activities that demand higher cognitive ability, such as detailed planning for a combat operation or reacting to a complex attack. A way to train this capability would be to construct an exercise that requires leaders to undergo physical or fear-induced stress and then perform deliberate, time-constrained planning for an ambiguous situation.[51] This could be a simple

U.S. Army, SPC Evan D. Marcy

U.S. Army SPC Rosenquist engages enemy forces during a patrol near Contingency Operating Post Honaker Miracle, Afghanistan, 29 July 2009.

puzzle-solving activity or a complicated vignette-based planning exercise that incorporates combat systems. This "cognitive stress shoot" would allow leaders to discover their personal responses to stress and identify useful techniques to overcome the cognitive disabilities associated with it.[52]

Units should also structure training to present multiple streams of information and detectable patterns of enemy activity that will teach leaders what to look for. Historical battle accounts reveal that small changes in the environment, like a lack of regular street activity, can sound subconscious alarms. Constructing patterns in training and then altering them can teach leaders to listen to their hunches and be extra vigilant when "something doesn't feel right." Incorporating collateral battlefield elements, like a civilian populace, challenges leaders to cognitively analyze the situation and think beyond the battle drill.

On the individual level, leaders should develop personal cognitive battle drills that better prepare them for the mental challenges of combat. They should rehearse exactly what words they will use to report an initial contact and what guidance they anticipate issuing in the opening moments of a battle. These drills create neural circuitry that is familiar to the brain when the actual event happens, thus making it easier to execute with calm and confidence.

These drills serve as a personal routine that primes the individual to control stress, sense subconscious patterns, engage cognitive problem solving, and lead with emotional control. Then, by adding the element of physical danger or stress to the scenario, leaders can adapt to perform the cognitive thinking despite emotional distraction.[53] David Rock notes, "People who succeed under pressure have learned to be in a place of high arousal but maintain a quiet mind, so that they can still think clearly. Over time and with practice, this capacity can become an automatic resource. The brain can be wired to deal better with emotions."[54] This adaptation will develop mental fitness for leaders that may prove to be crucial in the unit's future battles.

Leaders must learn where they should position themselves on the battlefield to facilitate their cognitive responsibilities. Despite mission, terrain, or movement technique, leaders must discern what position allows them to survey all aspects of the fight.[55] As much as possible, they should directly observe their soldiers and get information real time without compromising their ability to keep a macro view. Conversely, soldiers expect to see their leaders at the proverbial "front" and cannot respect leaders who are never among them. Finding this balance is part of what makes command an art.

Most importantly, all leaders have a responsibility to build a database of professional knowledge that will assist them in creating insight during stressful situations. They do this by studying doctrine, seeking instruction from mentors, being self-critical about performance, recording new ideas, participating in thought exercises, discussing related concepts with peers, and reading professional works. A solid knowledge of history (long-term memory) will provide the prefrontal cortex (and working memory) with a vast array of tactical options from which to generate new solutions for the current fight. Coupled with an ever-expanding collection of personal experiences, a thorough knowledge of the military profession will enable leaders to find creative answers on the complex battlefield.

Recommended Changes

The concept of brain-based combat leadership deserves attention in both military professional development courses and unit-level education and training programs. Teaching leaders what they will physiologically experience will better prepare them to maintain emotional stability and to effectively lead others during combat. The Army's Center for Enhanced Performance (ACEP) provides such instruction; it also conducts biofeedback testing to give soldiers direct feedback about their performance under various stressors.

The Army Training and Doctrine Command should consider the following recommendations to deepen the NCO and officer corps' institutional knowledge regarding the application of neuroscience to combat leadership:

- Develop a block of instruction for sergeants and above that teaches the fundamentals of brain function in combat, cortical energy management, stress reduction, cognitive control, and leadership in stressful situations. This will give them a working knowledge of the topic areas to assist them during school training and at home station.
- Provide instruction to soldiers and officers attending the Warrior Leader Course, Basic Noncommissioned Officer Course, Maneuver

Advanced Noncommissioned Officer Course, Basic Officer Leadership Course, and the Captains Career Course.

- Provide instruction and practical exercises to deploying units during home-station preparation.
- Broaden the ACEP program's scope to target company and field grade-level decision making in combat. Fund an expansion of the ACEP program to include teams that can visit deploying units and teach the fundamentals of brain-based combat leadership and help plan training to maximize unit cognitive development.

Conclusion

"The test of fitness to command is the ability to think clearly in the face of unexpected contingency or opportunity."[56]

Combat involves a wide range of events, dangers, and sensory inputs that can easily overwhelm the unprepared mind. The first job of every soldier, regardless of rank, is to maintain his composure and react reflexively to the threat as required. Leaders, however, must go beyond the conditioned response to combat that we train on the live-fire range. They must "zoom out" to adopt a macro-level view of the battle, quickly analyze the events occurring, decide on an appropriate response, coordinate complex systems, and then apply the appropriate leadership skills to accomplish the mission. These brain functions are among the most sophisticated processes that we humans can perform. Leaders who do not protect their own cognitive function during combat will find themselves short of the biological resources necessary to win, and can place themselves and others at risk. In this sense, knowing *how to think* could be a combat leader's most valuable tool. ***MR***

NOTES

1. Evian Gordon, Ph.D., quoted in David Rock, *Your Brain at Work: Strategies for Overcoming Distraction, Regaining Focus, and Working Smarter All Day Long* (New York: HarperCollins, 2009), 105.
2. Rock, 107.
3. According to Columbia University, Program for the Imaging and Cognitive Sciences, "Functional MRI is based on the increase in blood flow to the local vasculature that accompanies neural activity in the brain." It allows scientists to observe what regions of the brain are activated in response to presented stimuli or during episodes associated with disorders like seizure activity and PTSD. Columbia University, Program for the Imaging and Cognitive Sciences, <http://www.fmri.org/fmri.htm> (8 March 2010). Other research methods used to map neural pathways include chemical tracing of neurotransmitters and cerebral interruption using surgical lesions. Joseph LeDoux, *The Emotional Brain: The Mysterious Underpinnings of Emotional Life* (New York: Simon & Schuster, 1996), 155.
4. Rock, *Your Brain at Work,* 57.
5. It is important to note that the theory of a "limbic system" is a contested topic in the arena of neuroscience because the term implies that there is one consolidated system that governs the emotional activities of the brain. Such a system has never been unequivocally proven. Therefore, I follow conventional science by using the term "limbic system" as a collective label for the processes that occur among the brain regions that independently influence fear response, memory recall, bodily reactions, and others.
6. Jonah Lehrer, *How We Decide* (New York: Houghton Mifflin Harcourt, 2009), 100.
7. American Health Assistance Foundation, <http://www.ahaf.org/alzheimers/about/understanding/anatomy-of-the-brain.html, April 2010> (14 March 2010).
8. Rand Swenson, M.D., Ph.D., *Review of Clinical and Functional Neuroscience*, chap. 11, online resource, Dartmouth Medical School, <http://www.dartmouth.edu/~rswenson/NeuroSci/chapter_11.html, 2006> (15 March 2010).
9. Ibid., chap. 9, <http://www.dartmouth.edu/~rswenson/NeuroSci/chapter_9.html>.
10. In this case, the optic nerves transmit visual data to the visual thalamus, which sends the information along two pathways to the amygdala. The quicker of the two is a direct link from the thalamus to the amygdala, resulting in rapid but less-detailed information about the threat. LeDoux refers to this system as "The Low Road." This is the instant that your mind recognizes a curved, slender object on the trail at your feet and springs your body into evading action. The slower data pathway routes the information from the thalamus, first through the frontal cortex, and then to the amygdala. This is "The High Road," termed so because the frontal cortex analyzes the data in detail and makes a more precise appraisal of the threat. If the object at your feet is not a snake but a stick, then this is the moment you consciously realize your error, laugh at yourself, and continue hiking. But of course, "It is better to have treated a stick as a possible snake than not to have responded to a possible snake." LeDoux, *The Emotional Brain*, 163-66.
11. Swenson, *Review of Clinical and Functional Neuroscience*, chapter 11.
12. Brian Wandell, "Looking into the Brain," podcast lecture, Stanford University, 29 April 2008, downloaded 26 February 2009.
13. Ibid.
14. Lehrer, *How We Decide*, 152.
15. John Case, David Rock, "Neuroscience in the Workplace," 18 February 2007, podcast (7 April 2009).
16. David Rock, *"Your Brain at Work*—David Rock's new book,*"* 8 October 2009, podcast (9 October 2009).
17. Joseph LeDoux, "Fearful Brains in an Anxious World," podcast, The New York Academy of Sciences: Science and the City Podcast, 21 November 2008 (7 February 2010).
18. Laurence Gonzales, *Deep Survival: Who Lives, Who Dies, and Why* (London: W.W. Norton, 2003), 229.
19. Lehrer paraphrase of Antonio Damasio description of the mind's reaction to danger. Jonah Lehrer, *Proust Was a Neuroscientist* (New York: First Mariner, 2008), 19.
20. Brigadier General S.L.A. Marshall, U.S. Army, Retired, *Men Against Fire: The Problem of Battle Command in Future War* (Alexandria: Byrrd, 1947), 48.
21. J.F.C. Fuller, as quoted in Marshall, *Men Against Fire*, 71.
22. Bruce K. Siddel, *Sharpening the Warrior's Edge: The Psychology & Science of Training* (Belleville: PPCT Research Publications, 1995).
23. LeDoux, *The Emotional Brain*, 175.
24. Ibid.
25. Dave Grossman, Loren W. Christensen, *On Combat: The Psychology and Physiology of Deadly Conflict in War and in Peace* (USA: PPCT Research Publications, 2004), 88.
26. Ibid.
27. Ibid., 320.
28. Ibid., 321.
29. Rock, *Your Brain at Work*, 112.
30. Rock,*"Your Brain at Work,"* podcast.
31. Gonzales, *Deep Survival*, 44.
32. Paraphrase from General Patton's speech to the Third Army in England, 5 June 1944, published by Charles M. Province (Random House, 1988), 32.
33. Malcolm Gladwell (New York: Little, Brown, 2005), 208.
34. Ibid.
35. Rock, *"Your Brain at Work,"* podcast.
36. Lehrer, 130.
37. Ibid.
38. Ibid.
39. Ibid.
40. Rock, *Your Brain at Work*, 40.
41. Ibid., 81.
42. Lehrer, *How We Decide*, 23.

43. Ibid., 38.
44. Rock, *Your Brain at Work*, 34.
45. Ibid., 34.
46. Ibid.
47. Ibid., 23.
48. Ibid., 34.
49. Marshall, 116.
50. Committee on Opportunities in Neuroscience for Future Army Applications, National Research Council, *Opportunities in Neuroscience for Future Army Applications* (Washington, DC: National Academies Press, 2009), 20, <http://www.nap.edu/catalog.php?record_id=12500> (19 May 2009).
51. It is important to note that exercise-induced stress is not the same as fear-induced stress. Fear-induced stress amplifies the effects of heart rate, blood pressure, and breathing and can severely impact the individual's ability to react with cognitive control. Accompanying combat skills with physical exertion, however, has proven to significantly improve the individual's ability to cope with fear-induced stress. Grossman, *On Combat*, 44.
52. The traditional term "stress shoot" refers to a shooting exercise where soldiers participate in a physically stressful activity (e.g. pulling a weighted stretcher or sprinting) then immediately transition to a shooting exercise. The goal is to train the soldier to fire his weapon accurately despite the hindering effects of stress.
53. The use of Simunitions©, for example, has greatly improved military and law enforcement professionals' conditioning to combat. The effect of having to feel "real pain" in the training scenario creates a higher level of fear-induced stress than training exercises that do not incorporate physical pain. Grossman, *On Combat*,36
54. Rock, *Your Brain at Work*, 115.
55. Major Thomas Siebold, U.S. Army, email to author, 3 May 2010.
56. Marshall, 117.