

Changing the Army's Mind: Achieving Cognitive Dominance for Multi-Domain Operations

A Monograph

by

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Abstract

Changing the Army's Mind: Achieving Cognitive Dominance for Multi-Domain Operations, by COL Daniel J. Herlihy, 72 pages.

Cognitive capability influences all aspects of soldier performance – physical, mental, and emotional. Despite its desire to achieve cognitive dominance for multi-domain operations (MDO), the Army has yet to fully develop and adopt the concepts of cognitive performance enhancement and optimization. Instead, soldiers serve in an “always on” culture of instantaneous communication, attempting to filter dozens of information streams and make rapid decisions while operating on too little sleep and without the benefit of cognitive performance education and training. As the *Army Modernization Strategy* prescribes even more complex tactics using increasingly sophisticated equipment, the Army must change its approach to cognitive performance to prevent adversaries from gaining the asymmetric advantage that they seek in the cognitive domain. This monograph describes the increasing demands on soldier cognitive performance, provides an overview of cognitive theory, and evaluates the Army's current approach to cognitive performance comparative to that of industry, allies, and adversaries. Finally, it outlines potential opportunities and threats associated with cognitive performance enhancement, and makes recommendations for DOTMLPF-P changes to promote a lasting culture of cognitive dominance across the Army.

Contents

Abstract	iii
Contents.....	iv
Acknowledgements	v
Abbreviations	vi
Figures.....	ix
Prologue.....	1
Introduction	3
Chapter 1 – Background.....	5
Chapter 2 – Review of Army Cognitive Performance Efforts	18
Chapter 3 – Competing Cognitive Performance Efforts	31
Chapter 4 – Opportunities for the US Army.....	41
Conclusion.....	55
Epilogue.....	59
Bibliography.....	61

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Abbreviations

ADP	Army Doctrine Publication
AFC	United States Army Futures Command
AI	Artificial Intelligence
ALSSKA	Applying Learning Science to Schoolhouse Skill and Knowledge Acquisition
AMS	Army Modernization Strategy
ARD	United States Army Resilience Directorate
ARI	United States Army Research Institute
ArmyU	Army University
CAC	Combined Arms Center
CAPL	Center for the Army Profession and Leadership
CCAIC	Cognitive and Communicative Arts Improvement Center
CGSC	Command and General Staff College
CJCS	Chairman of the Joint Chiefs of Staff
COP	Common Operating Picture
COTS	Commercial Off-The-Shelf
COVID-19	Coronavirus Disease, 2019
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
CWC	Chemical Warfare Convention
DARPA	Defense Advanced Research Projects Agency
DCG	Deputy Commanding General
DEVCOM-SC	United States Army Development Command – Soldier Center
DNSWG	Danish Special Warfare Group
DOD	Department of Defense
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership & Education, Personnel, Facilities, and Policy

FM	Field Manual
fMRI	Functional Magnetic Resonance Imaging
FORSCOM	United States Army Forces Command
H2F	Holistic Health and Fitness
JP	Joint Publication
LOE	Line of Effort
MASTR-E	Monitoring and Assessing Soldier Tactical Readiness and Effectiveness
MDO	Multi-Domain Operations
MEG	Magnetoencephalography
MHP	Maximizing Human Potential
MHP-RB	Maximizing Human Potential Review Board
ML	Machine Learning
MOMRP	Military Operational Medicine Research Program
MRDC	United States Army Medical Research and Development Command
NATO	North Atlantic Treaty Organization
NIBS	Non-invasive Brain Stimulation
PET	Positron Emission Tomography
PLA	Peoples Liberation Army
PME	Professional Military Education
R2	Ready and Resilient
R2C	Ready and Resilient Campaign
RDTE	Research, Development, Test, and Evaluation
TAC	Tactical Command Post
TCDS	Transcranial Direct Current Stimulation
TES	Transcranial Electrical Stimulation
TF	Task Force

THOR3	Tactical Human Optimization, Rapid Rehabilitation, and Reconditioning
TMTF	Talent Management Task Force
TNT	Targeted Neuroplasticity Training
TOC	Tactical Operations Center
TRADOC	United States Army Training and Doctrine Command
UFMCS	University of Foreign Military and Cultural Studies
USARIEM	United States Army Research Institute of Medicine
USASOC	United States Army Special Operations Command
USSOCOM	United States Special Operations Command
WRAIR	Walter Reed Army Institute of Research

Figures

Figure 1. Human Cognition and the Four Levels of Meaning. Created by author.	8
Figure 2. Yerkes-Dodson Law Visualization. Created by author.....	13
Figure 3. An Integrated Approach to Cognitive Dominance. Created by author.	41

Prologue

Colonel Jones rubbed his eyes and looked at his computer screen. Three out of four divisions still had not submitted their reports. “Is it too much to ask to get them in on time?” he muttered. Since pushing forward with the corps tactical command post (TAC) two days ago he had barely slept as they stayed on the move. Aside from dreading the rush to get the morning report to the commanding general (CG), he didn’t mind the lull.

As he waited for the reports, he absent-mindedly scanned through his 230 unread emails. For some reason he kept thinking of the news he had seen when they arrived in-country. “Could it really be true that the American public didn’t support the war?” he wondered. The knot in his stomach reminded him that he had skipped chow for a meeting and forgot to grab something after. “How many hours ago was that?” A message from a peer reminded him of Afghanistan in 2014 when they were majors together. Hard to believe that was over a decade ago. Funny, the generators outside sounded exactly the same.

Startled, he looked at his watch. He had dozed off, but no one seemed to notice. “Two hours late? The divisions are always late, but this is ridiculous. The corps report is due to the boss in an hour.” He was angry now, at himself for drifting off and at the divisions for being late. He fired off an email and started to get the division G3s on the phone when he finally realized that communications were down. The G6 had stepped out for some rest so he sent a runner to get him. In the meantime, maybe someone could get through to the main command post on the tactical satellite radio. He knew the soldiers had memorized the steps during the comms classes they received prior to the deployment, but that seemed like years ago and none of them could get it to work.

The CG would be walking in soon and Jones needed those reports. Just then he remembered he still had his local cell phone from the port. With any luck he could get a message through to the main command post. He tried dialing a few times, but no one picked up. In his

irrational, sleep-deprived state he had forgotten the G2's warning not to take the phones forward of Phase Line Silver due to enemy tracking capability. He also failed to recognize enemy jamming as the cause of the outage and part of a multi-domain attack. His cell activity provided the last data points needed by the enemy's sensors to complete the triangulation. "Why aren't they answering and where is the G6?" he shouted as the CG entered the tent. Neither of them heard the hypersonic round slam into their location.

Introduction

Cognitive capability underpins every task that soldiers perform, on and off the battlefield. It is the critical variable that supports all performance – physical, mental, and emotional. Army doctrine describes the importance of cognitive dominance, or gaining intellectual advantage over the enemy, in recent publications including the *2019 Army Modernization Strategy* and the *Multi-Domain Operations (MDO) 2028 Concept*.¹

Despite advances in cognitive science, and a general recognition of the importance of cognitive overmatch in MDO, the Army has yet to fully develop and embrace the concept of cognitive performance optimization. The US National Institutes of Health have invested over \$45.7 billion in brain research in the past decade, yet soldiers and leaders train and operate inside an “always on” cognitive performance culture of multi-tasking and connectivity.² Throughout the Army, leaders attempt to filter dozens of streams of information and make rapid decisions while operating on too little sleep with limited understanding of the principles of cognitive performance optimization. This culture is a recipe for cognitive defeat, not dominance.

In the interim, China and Russia share American desires to attain cognitive overmatch. Both nations seek biotechnical, neuroscientific, and artificial intelligence (AI) solutions to enhance human cognition to provide them an asymmetric operational advantage over the United States and its allies.³ Unfettered by the ethical norms of Western society, China and Russia

¹ US Department of the Army, TRADOC Pamphlet 525-3-1, *The US Army in Multi-Domain Operations 2028* (Washington, DC: US Government Publishing Office, 2018), C-10; US Department of the Army, *Army Modernization Strategy* (Washington, DC: US Government Publishing Office, 2019), 8, accessed October 21, 2020, https://www.army.mil/e2/downloads/rv7/2019_army_modernization_strategy_final.pdf.

² “RePORT,” *National Institute of Health Research Portfolio Online Reporting Tools*, last modified February 24, 2020, accessed January 21, 2021, <https://report.nih.gov/funding/categorical-spending#/>.

³ Elsa B. Kania, “Minds at War: China’s Pursuit of Military Advantage through Cognitive Science and Biotechnology,” *Prism* 8, no. 3 (2019): 82-101, 84; Lindsay Gorman et al., *A Silicon Curtain Is Descending: Technological Perils of the Next 30 Years, Reassessing 1989* (German Marshall Fund of the

actively leverage dual-use civilian and military research to achieve these ends.⁴ Both nations see the mind as the main battlespace in modern warfare and are taking steps to compete and dominate there.⁵

To ensure cognitive dominance in the future, the US Army must change its culture to incentivize cognitive excellence in ways that drive competition and innovation. This requires a deliberate approach rooted in education, training, technology, and hard work to replace outdated cognitive performance myths with science-based methods to ensure cognitive dominance. Until this happens, our adversaries may find the asymmetric advantage they seek in the cognitive domain.

This monograph describes the increasing demands on soldier cognitive performance, and provides an overview of cognitive theory and basic neuroscience. It evaluates the Army's current approach to cognitive performance comparative to the approaches of industry, allies, and adversaries. Finally, it provides an overview of potential opportunities and threats associated with cognitive performance enhancement, with recommendations for DOTMLPF-P changes to promote a lasting culture of cognitive dominance across the Army.

United States, 2019), 16, accessed January 15, 2021, <http://www.jstor.org/stable/resrep21249.16>.

⁴ Guillermo Palchik, Celeste Chen, and James Giordano, "Monkey Business? Development, Influence, and Ethics of Dual-Use Brain Science on the World Stage," *Neuroethics* 11 (April 2018): 111-114, 112; Royal Society, *Brain Waves Module 3: Neuroscience, Conflict and Security* (London: Royal Society, 2011), 7-9.

⁵ Kania, "Minds at War," 85; Jānis Bērziņš, "The West Is Russia's Main Adversary, and the Answer Is New Generation Warfare," *Sicherheit und Frieden (S+F) / Security and Peace* 34, no. 3 (2016): 171-176, 173, accessed January 19, 2021, <https://www.jstor.org/stable/26428998>.

Chapter 1 – Background

What is cognitive performance? According to US Army doctrine,

Cognitive capability is the ability to expand and integrate knowledge into decisions with an understanding of how values and beliefs influence a soldier's thoughts and ultimately his or her performance. It is the acquisition and demonstration of knowledge and understanding through processes such as memory, attention, problem-solving, decision-making, judgment, reasoning and learning.⁶

Said differently, soldier cognitive performance is the ability to observe, orient, decide, and act to produce the best possible outcome.⁷ Cognitive skill has always been important to success on the battlefield, and plays a critical role in deciding the outcome of battles and campaigns. Throughout time, all cultures celebrated soldiers and leaders who out-witted their opponents by recognizing and seizing opportunities to achieve victory. The battlefield of the future will offer similar opportunities, but with increasing complexity, fog, and friction.

The *Army Modernization Strategy (AMS)* addresses the evolving environment and introduces the concept of MDO.⁸ *AMS* outlines how MDO differs from previous operational concepts and requires higher levels of cognitive performance of its practitioners. *AMS* describes this across three lines of effort: how we fight, what we fight with, and who we are.⁹

The MDO concept requires leaders to recognize and exploit fleeting opportunities to achieve cross-domain convergence of effects against advanced adversary capabilities in a complex operational environment.¹⁰ Cognitive performance is critical; failure to achieve

⁶ US Department of the Army, *Army Field Manual (FM) 7-22, Holistic Health and Fitness* (Washington, DC: US Government Publishing Office, 2020), 9–3.

⁷ John A Boyd, *A Discourse on Winning and Losing* (Maxwell Air Force Base, AL: Air University Curtis E. LeMay Center for Doctrine Development and Education, March 2018), 384, accessed February 8, 2021, https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B_0151_Boyd_Discourse_Winning_Losing.PDF.

⁸ US Army, *Army Modernization Strategy*, 4–5.

⁹ *Ibid*, 1.

¹⁰ US Army, *The US Army in Multi-Domain Operations 2028*, iii.

convergence will limit joint force success. To win in multi-domain operations, the US Army is also fielding increasingly sophisticated systems along six modernization priorities that cut across all domains.¹¹ Not only do these advanced systems require higher intelligence and technical skill to operate and maintain, when combined with improved digital communication and networking capabilities, leaders will have access to more real-time data than ever before. Finally, the *AMS* and the *Army People Strategy* identify the American soldier as the centerpiece of the multi-domain operations concept.¹² Junior leaders and soldiers operate at the nexus of a myriad of real-time data and information sources, faced with increasing pressure to multi-task, prioritize, assess, decide, and act as opportunities and threats arise.

Bringing these three lines of effort together, the *Army Modernization Strategy* prescribes more complex tactics using increasingly sophisticated equipment, with higher demand for rapid decision-making based on expanded real-time inputs. Even without further analysis the problem is apparent: both the operating environment and warfighting systems are more complex, but the human brain is unchanged. Without significant investment in the cornerstone of the modernization strategy – the people that are the Army’s asymmetric advantage – optimal outcomes are unlikely.

The importance of cognitive capability extends far beyond MDO. Cognitive skill is necessary for success in current operations and for achieving positive training and readiness outcomes while modernizing the force. Pandemic-related budget challenges will likely increase the strain on leaders as they are pressed to do more with less.¹³ In this demanding environment it is imperative that the Army acknowledge how improved cognitive skills such as working

¹¹ US Army, *Army Modernization Strategy*, 6.

¹² *Ibid*, iv.

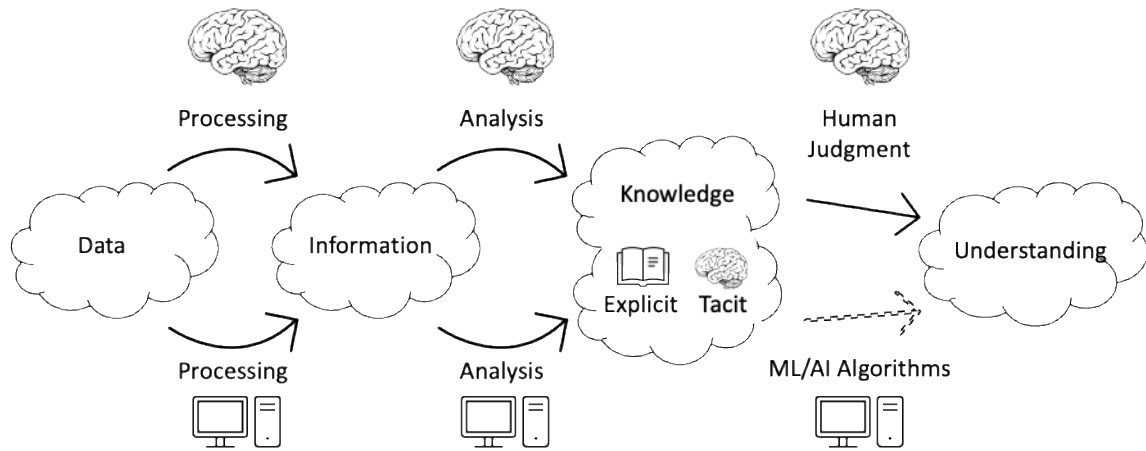
¹³ Paul McLeary, “CJCS Milley Predicts DoD Budget ‘Bloodletting’ To Fund Navy,” *Breaking Defense*, last modified December 3, 2020, accessed January 1, 2021, <https://breakingdefense.com/2020/12/cjcs-milley-predicts-dod-bloodletting-to-fund-navy-priorities/>.

memory, attentional focus, metacognition, and decision-making could increase the odds of positive outcomes in stressful situations. It is also important that the Army learn how potential cognitive performance improvements could contribute to successful battle rhythms across the Army and translate to winning in operational settings. The adoption of effective cognitive performance measures will place the US Army in a position of decisive dominance on the battlefields of the future.

Definitions

Further discussion of cognitive dominance requires the definition of several terms for common understanding. First, reviewing the four levels of meaning from *Army Doctrine Publication (ADP) 6-0, Mission Command*, is beneficial to understanding the role of human cognition as part of the knowledge management process. The four levels are commonly referred to as data, information, knowledge, and understanding. *ADP 6-0* describes data as “unprocessed observations detected by a collector of any kind.” *ADP 6-0* further defines information as “data that has been organized and processed in order to provide context for further analysis.” Knowledge is “information that has been analyzed and evaluated for operational implications.” Knowledge may be divided into tacit and explicit knowledge, with tacit knowledge representing an individual’s “personal store of knowledge gained from experience” and explicit knowledge representing information such as “doctrinal publications, orders, and databases.” The human cognitive process – to date not fully replicated by any computer algorithm – synthesizes tacit and explicit knowledge to generate understanding. *ADP 6-0* defines understanding as “knowledge that has been synthesized and had judgment applied to comprehend the situation’s inner relationships, enable decision making, and drive action.”¹⁴ Figure 1 illustrates this relationship.

¹⁴ US Department of the Army, *Army Doctrine Publication (ADP) 6-0, Mission Command* (Washington, DC: US Government Publishing Office, 2019), 2–4.



The human brain and computers can process data and analyze information to generate knowledge. Machine learning (ML) and artificial intelligence (AI) algorithms may approximate understanding with relative sophistication, but only the human brain can achieve deep and intuitive understanding that incorporates saliency and emotion.

Figure 1. Human Cognition and the Four Levels of Meaning. Created by author.

Note that human cognition is the primary source of rich, contextual understanding – a capability that computers do not yet possess. Despite advancements in artificial intelligence (AI) and machine learning (ML), current AI (commonly called “narrow AI”) has its limitations. Narrow AI can expedite analysis, predict trends, and efficiently automate sophisticated systems but its expertise is often confined to a single domain and cannot be applied broadly to generate understanding.¹⁵ “General AI,” a hypothetical capability that does not yet exist, is required to complete tasks more akin to thinking like the human brain. In short, there is no substitute for the human mind in applying judgment to create nuanced understanding that factors in emotions, metaphors, and abstraction. While AI may increasingly complement this process, the human brain will remain the critical node for the foreseeable future.

It is also important to draw a distinction between performance optimization and enhancement, as these terms have different meanings and implications. Cognitive performance optimization refers to techniques and technologies which “help individuals and teams maintain

¹⁵ Paul Scharre, Michael C. Horowitz, and Robert O. Work, *ARTIFICIAL INTELLIGENCE: What Every Policymaker Needs to Know* (Center for a New American Security, 2018), 3-4, 4, accessed December 17, 2020, <http://www.jstor.org/stable/resrep20447.4>.

peak performance” whereas performance enhancement “involves accelerating or amplifying individual and team performance beyond existing peak capabilities.”¹⁶

Cognitive Neuroscience Primer

In addition to terminology, an understanding of cognitive neuroscience is essential to informing the discussion of cognitive performance. In fact, leading cognitive scientists such as David Rock ascertain that understanding brain function is one of the best ways to improve cognitive performance.¹⁷ With that in mind, the following paragraphs summarize basic neurological models and theories most closely related to cognitive performance in the military context. For the sake of brevity, the descriptions are conceptual in nature and the reader is advised to consult the source documents for greater details where desired.

The human brain is one of the greatest mysteries of the universe, and the subject of countless studies of science, medicine, and philosophy through the ages. In recent years, technologies such as positron emission tomography (PET), functional magnetic resonance imaging (fMRI), and magnetoencephalography (MEG) have given researchers greater insight into the workings of the human mind than ever before.¹⁸ The data collected through studies using these technologies continues to produce numerous advances in neuroscience and cognitive psychology.

Modern studies of cerebral biology reveal that while the human brain is infinitely complex, cognition is thought to primarily occur in a handful of areas of the brain. Cognitive

¹⁶ Tad Brunye et al., “A Review of US Army Research Contributing to Cognitive Enhancement in Military Contexts,” *Journal of Cognitive Enhancement* 4, no. 4 (December 2020): 453-468, 455, accessed December 9, 2020, <https://doi.org/10.1007/s41465-020-00167-3>.

¹⁷ David Rock, *Your Brain at Work: Strategies for Overcoming Distraction, Regaining Focus, and Working Smarter All Day Long* (New York, NY: Harper Business, 2020), 1.

¹⁸ Daniel Levitin, *The Organized Mind* (New York, NY: Dutton, 2015), 39-40.

science includes study of the relationships and neurochemistry of the prefrontal cortex, attentional filters, the insula, and the limbic system among other areas.¹⁹ A brief description of each follows.

Cognitive scientists identify the prefrontal cortex as the center of the system the brain uses to focus attention and make conscious decisions. Dr. Daniel Levitin describes this as a “central executive network” that includes the prefrontal cortex, cingulate, and basal ganglia regions of the brain.²⁰ Together the neurons of this central executive network are responsible for complex problem solving, risk analysis, and reflection.²¹ The central executive network is responsible for deliberate thinking and decisions, commonly referred to as “system two thinking” by Dr. Daniel Kahneman and others.²²

The limbic system lies at the opposite end of the spectrum and is generally associated with feeling and reacting instead of thinking.²³ The limbic system plays a key role in what Kahneman refers to as “system one thinking,” and is the hub of automatic activities the brain accomplishes with seemingly little or no effort.²⁴ The limbic system includes brain regions such as the amygdala and hippocampus which track emotions and drive the majority of human behavior, often unconsciously.²⁵ The limbic system is the origin of the “fight, flee, or freeze” reaction, with the amygdala as the trigger point for this powerful emotional response.²⁶ It is

¹⁹ Ibid., 45.

²⁰ Ibid., 46.

²¹ Andrew Steadman, “Neuroscience for Combat Leaders,” *Military Review* 91, no. 3 (June 2011): 50-61, 51.

²² Daniel Kahneman, *Thinking, Fast and Slow* (New York, NY: Farrar, Straus and Giroux, 2013), 21.

²³ Rand Swenson, “Chapter 9: Limbic System,” Review of Clinical and Functional Neuroscience - Swenson, Dartmouth Medical School, 2006, accessed December 17, 2020, https://www.dartmouth.edu/~rswenson/NeuroSci/chapter_9.html.

²⁴ Kahneman, *Thinking, Fast and Slow*, 20.

²⁵ Rock, *Your Brain at Work*, 103.

²⁶ Daniel Goleman, Richard E. Boyatzis, and Annie McKee, *Primal Leadership: Unleashing the Power of Emotional Intelligence* (Boston, MA: Harvard Business Review Press, 2013), 28.

constantly assessing stimuli as threats or rewards and taking action to minimize the former and increase the latter.²⁷ To identify and assess potential threats and rewards, the limbic system relies on sensory cortices such as the auditory cortex and the visual cortex. The frontal lobe of the brain serves as an “attentional filter” that monitors environmental change through complex connections to the sensory cortices and limbic system.²⁸ When a strong enough threat or reward is detected, the insula-cingulate network acts as a neural switchboard to focus the limbic system or central executive network for assessment and action.²⁹

The relationships among these regions of the brain are as important to understand as their individual function. Each has unique capabilities and limitations which impact cognitive performance. Notably, the limbic system automatically functions all the time and though it can be influenced by the central executive system, it cannot be turned off.³⁰ The limbic and central executive systems also share resources and compete for attention in your consciousness. When the limbic system is at a high state of arousal, the chief executive network is limited in its ability to function. Conversely, focusing deeply on a task using the prefrontal cortex requires filtering out distractions from the limbic system. This zero-sum relationship thus requires us to draw our attention away from one thing to focus on another.³¹ The balancing act between the limbic and central executive regions helps explain why emotional arousal levels play a critical role in shaping cognitive performance.

²⁷ Rock, *Your Brain at Work*, 105.

²⁸ Levitin, *The Organized Mind*, 47.

²⁹ *Ibid.*, 41–42.

³⁰ Kahneman, *Thinking, Fast and Slow*, 28.

³¹ Levitin, *The Organized Mind*, 39.

Optimal Arousal Levels

Levels of emotional arousal directly impact cognitive performance. The Yerkes-Dodson Law, first hypothesized by scientists Robert M. Yerkes and John Dillingham Dodson in 1908, provides a basic model for this phenomenon.³² Yerkes-Dodson describes a “sweet-spot” of arousal – not too low, and not too high – associated with peak performance.³³ While current conceptualizations of the arousal-performance relationship go well beyond the work of Yerkes and Dodson, the link between arousal levels and cognitive performance remains undeniable. Good coaches recognize how arousal levels impact performance and succeed in calming or pumping up a team as needed during competition.³⁴ The right level of arousal, or stress, causes the brain to release just the right mix of neurochemicals to generate the alertness and intense focus required for optimal performance.³⁵ Too little leaves us flat, and too much creates counterproductive levels of stress, anxiety, or disengagement.³⁶

³² Rock, *Your Brain at Work*, 62.

³³ *Ibid.*, 69.

³⁴ Phil Stieg, “Information Overload,” *This is Your Brain*, April 3, 2020, 5:50, accessed September 9, 2020, <https://thisisyourbrainwithdrphilstieg.libsyn.com/information-overload>.

³⁵ Rock, *Your Brain at Work*, 64.

³⁶ *Ibid.*, 62.

Yerkes-Dodson Law Visualization

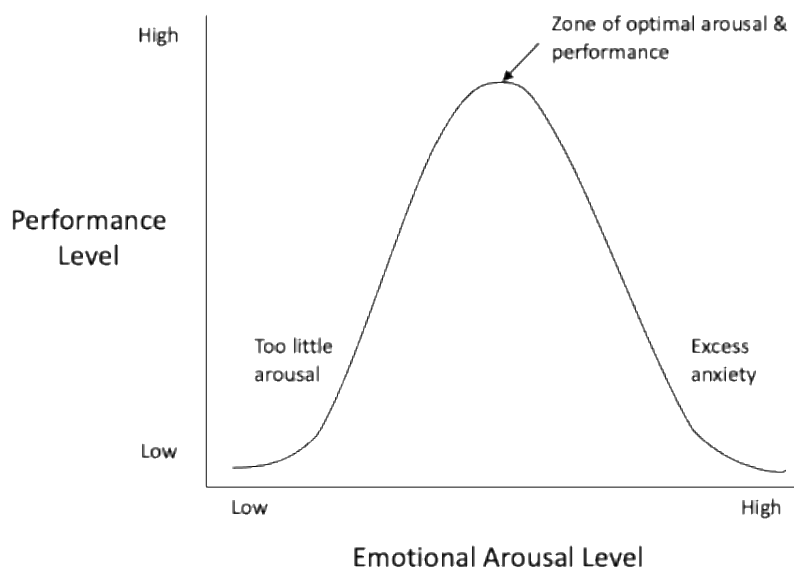


Figure 2. Yerkes-Dodson Law Visualization. Created by author.

The highest levels of limbic system arousal produce an occurrence psychologist Daniel Goleman refers to as an amygdala hijack by commandeering rational brain centers for immediate action.³⁷ The amygdala ignites powerful emotional responses associated with threats and rewards, and is capable of instantly shutting out the prefrontal cortex and central executive region of the brain.³⁸ Leaders may be familiar with this phenomenon in combat situations where physical threats incite powerful emotional reactions, but similar states of amygdala hijack can also occur under conditions of work stress and information overload.³⁹

Effects of Multitasking

Science shows there are limitations on the number and complexity of operations the brain can process at any given time. These limitations have direct impacts on cognitive performance.

³⁷ Goleman, Boyatzis, and McKee, *Primal Leadership*, 28.

³⁸ Rock, *Your Brain at Work*, 106; Mark Goulston, *Just Listen: Discover the Secret to Getting Through to Absolutely Anyone* (New York, NY: American Management Association, 2010), 15–16.

³⁹ Goulston, *Just Listen*, 16; Rock, *Your Brain at Work*, 67.

First, the brain is limited in the number of conscious tasks that can be accomplished simultaneously.⁴⁰ Holding attentional focus requires allocation of neural resources in the prefrontal cortex that prevents the brain from effectively focusing on two things at once.⁴¹ When multitasking, our brains are instead forced to transition rapidly from topic to topic. This task-switching consumes limited metabolic resources in the brain.⁴²

From a neurochemistry perspective, task switching engages the sympathetic nervous system which produces the stress hormone cortisol and negatively impacts adrenaline and dopamine levels in ways that scramble our thinking.⁴³ Switching between tasks also requires high amounts of oxygenated glucose, which, once depleted, degrades both cognitive and physical performance.⁴⁴ The impact is so profound that some researchers believe a constant string of interruptions – text, email, radio traffic, chat windows – may produce an effect similar to temporarily lowering your IQ.⁴⁵

Science also shows that multitasking increases decision-making risk. A 2009 Stanford University study claims that heavy media multitaskers – those who score one standard deviation higher than the mean on a multitasking index – suffer degraded memory, learning, and cognitive function.⁴⁶ While factors such as age and fatigue could contribute to this degradation, the study suggests that habitual multitasking may ironically impair an individual’s ability to accomplish

⁴⁰ Ibid., 33.

⁴¹ Levitin, *The Organized Mind*, 39.

⁴² Ibid., 98.

⁴³ Ibid., 96.

⁴⁴ Ibid., 98.

⁴⁵ Ibid., 36.

⁴⁶ Eyal Ophir, Clifford Nass, and Anthony D. Wagner, “Cognitive Control in Media Multitaskers,” *Proceedings of the National Academy of Sciences* 106, no. 37 (September 15, 2009): 15,583-15,587, 15,583.

occasional multitasking.⁴⁷ Simply put, habitual multitasking makes one worse at nearly everything, even multitasking.

Difficulty in doing two or more tasks at the same time is illustrated in the example of driving in an unfamiliar part of town while holding a conversation with a passenger and listening to the radio. After a missed turn, the driver instinctively pauses the conversation and turns down the radio to focus on correcting course. The example shows that we are intuitively aware of the challenges of doing two things at once.⁴⁸ By choosing to multitask we accept degraded performance. This degradation is commonly referred to as “dual task interference” or the “psychological refractory effect,” and is well-documented in research.⁴⁹

Despite these pitfalls, multitasking is routinely praised in military culture. Leaders are celebrated for their ability to juggle multiple balls, respond immediately to text, chat, and email, and maintain situational awareness while solving problems in a rapidly changing environment. The very tools Army leaders use and how they use them thicken the “fog of war” in combat as well as in garrison. As the Stanford study illustrates, the Army’s misplaced faith in the illusion of multitasking guarantees a generation of leaders who are less capable of achieving critical periods of focus in an information saturated environment.⁵⁰ This does not bode well for achieving and maintaining the cognitive dominance required for successful MDO.

Cognitive Endurance

Another neurological limitation is the cumulative toll of decision-making and attentional filtering on cognitive performance. Simply put, the brain has limited resources available for data

⁴⁷ Ibid., 15,585.

⁴⁸ Levitin, *The Organized Mind*, 11.

⁴⁹ Harold Pashler, “Attentional Limitations in Doing Two Tasks at the Same Time,” *Current Directions in Psychological Science* 1, no. 2 (April 1992): 44-48, 45.

⁵⁰ Ophir, Nass, and Wagner, “Cognitive Control in Media Multitaskers,” 15,585.

processing. Cognitive actions such as making a decision, resisting an impulse, or ignoring a distraction require metabolic resources to complete, and drain our cognitive energy over time.⁵¹ This fact is true for any decisions that do not rely on habits or heuristics.⁵² Environments filled with trivial choices and distracting information exhaust our minds and dull our cognitive abilities as the brain does not instinctively distinguish or prioritize decisions by level of importance.⁵³

Decision Quality

The third and final limitation discussed here relates to decision quality. When making decisions our brains are often inundated with information and knowledge which must be synthesized into understanding and then acted upon. Studies show an optimum number of factors should be considered when making a decision and that too few, or too many, degrade performance. This is known as “optimal complexity theory.”⁵⁴ Due to limits on working memory, humans struggle to hold more than three to five pieces of knowledge in mind while synthesizing understanding.⁵⁵ Furthermore, attempting to consider more than ten factors degrades performance.⁵⁶

Interestingly, many people desire more inputs than are optimal for decision-making. This is shown in decision-making experiments where subjects often continue to ask for more information after exceeding the optimal level of complexity, degrading their performance through

⁵¹ Rock, *Your Brain at Work*, 8–9.

⁵² S. Thomas Christie and Paul Schrater, “Cognitive Cost as Dynamic Allocation of Energetic Resources,” *Frontiers in Neuroscience* 9 (August 24, 2015): 289, accessed December 15, 2020, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4547044/>.

⁵³ Levitin, *The Organized Mind*, 6–7.

⁵⁴ *Ibid.*, 308.

⁵⁵ Nelson Cowan, “The Magical Mystery Four: How Is Working Memory Capacity Limited, and Why?,” *Current Directions in Psychological Science* 19, no. 1 (2010): 51-57, 56.

⁵⁶ Naresh K. Malhotra, “Information Load and Consumer Decision Making,” *Journal of Consumer Research* 8, no. 4 (March 1982): 419-430, 427.

information overload.⁵⁷ This is of particular concern to the military, where leaders accustomed to information supremacy in Iraq and Afghanistan expect an abundance of information to support their decision-making. This information addiction may cause commanders to delay unnecessarily while waiting for more information that ironically would degrade the quality of their decision.⁵⁸

In short, cognitive theory helps describe how many things we can process simultaneously, the number of things we can process sequentially, and the quality of the work when there is outside interference. Institutionally and culturally, the US Army must understand these limitations, take steps to mitigate their impacts, and deliberately inculcate a positive perception of cognitive performance. However, an approach focused solely on cognitive theory is unlikely to optimize cognitive behavior. The human brain is constantly changing under the influence of emotions, social dynamics, memories, stress, and other factors that theory alone cannot predict, and algorithms cannot fully replicate. Thus, the science of cognitive theory requires artful application to successfully shape cognitive behavior. And while computers may be good at science, art is still an inherently human endeavor. As such, a successful approach to cognitive performance optimization and enhancement must include human social-emotional considerations along with science and technology efforts.

⁵⁷ Levitin, *The Organized Mind*, 310.

⁵⁸ Alexander Kott, *Battle of Cognition: The Future Information-Rich Warfare and the Mind of the Commander* (Westport, CT: Praeger Security International, 2008), 205.

Chapter 2 – Review of Army Cognitive Performance Efforts

The study of cognitive performance is not new to the military, and there are numerous stakeholders interested in improving servicemember cognitive skills. While this is generally positive, the volume and diversity of current efforts threatens their success. Without effective coordination, multiple organizations using different definitions and assessments for cognitive performance will compete for limited resources while pursuing means that may not be mutually supportive. To ensure cognitive dominance, the Army must take steps to synchronize these efforts toward a central goal. The following paragraphs examine prominent initiatives related to cognitive dominance to illustrate the breadth and depth of the challenge.

US Army Futures Command (AFC)

Of the many programs and offices involved in cognitive performance research, AFC’s “Maximizing Human Potential (MHP) for MDO Sprint Team” is perhaps the most comprehensive and ambitious. The AFC CG established and prioritized this effort in 2019 based on the understanding that the performance of soldiers and leaders is the most critical factor in the success or failure of future operations. The MHP effort ultimately seeks to optimize blended formations of systems and humans with the right cognitive, physical, and emotional attributes for MDO.⁵⁹ To achieve this goal, MHP is systematically identifying the future performance requirements for soldiers and leaders to dominate the environment and threat in MDO, and codifying that in a new MHP Concept, currently in development and slated for completion by the end of FY21.⁶⁰

⁵⁹ Kirsten Smith, “Maximizing Human Potential for Multi-Domain Operations (MHP for MDO) Sprint Team Follow-Up Brief” (prepared for CG, US Army Futures Command, September 17, 2020), 3.

⁶⁰ *Ibid.*, 4.

The MHP effort involves dozens of organizations across the Army and DOD, and is well-connected to the research community. It is also closely linked to AFC’s “Ignite Initiative,” which seeks to inspire and expand the Army’s mindset of innovation and collaborative action.⁶¹ Outside the research and innovation community, the nascent MHP team is still developing adequate awareness and buy-in across the operational force and the broad range of Army and DOD stakeholder groups. It is also in the process of implementing a governance framework, which includes a review board co-chaired by the AFC and TRADOC deputy commanding generals (DCGs) to advocate for, guide, and prioritize the full range of DOTMLPF-P equities to solve MHP problems.

The US Army Combat Capabilities Development Command Soldier Center (DEVCOM-SC), is also part of the AFC enterprise. Within DEVCOM-SC, the “Cognitive Science and Applications Team” focuses exclusively on the optimization of individual soldier and small-unit perception, cognition, and interaction through innovative science and technology.⁶² This twelve-person team is comprised of psychologists, neuroscientists, and researchers with expertise in cognitive science and neurophysiological research approaches. The team partners with the Tufts University Center for Applied Brain and Cognitive Sciences on cutting-edge research and development to monitor, predict, and optimize soldier and small-unit performance.⁶³

Current Cognitive Science and Application Team lines of effort include monitoring and enhancing performance under stress, adapting technology to optimize the human-computer interface, and applying learning science to enhance training and skill retention.⁶⁴ Individual

⁶¹ Thomas Branding, “New Team Focusing on Emerging Technologies for Future Wars,” *Army News Service*, last modified October 29, 2020, accessed March 18, 2021, https://www.army.mil/article/240345/new_team_focusing_on_emerging_technologies_for_future_wars.

⁶² Marianna Eddy, “Cognitive Science and Applications Team Overview” (US Army Combat Capabilities Development Command - Soldier Center, September 23, 2020), 3.

⁶³ *Ibid.*, 5.

⁶⁴ Author Discussion with Dr. Marianna Eddy, US Army Combat Capabilities Development Command Soldier Center, MS Teams, December 8, 2020.

projects vary from the use of neuropriming and neurostimulation techniques for performance enhancement, to the optimization of augmented reality design and other projects as part of the “Monitoring and Assessing Soldier Tactical Readiness and Effectiveness” (MASTR-E) Program.⁶⁵

Initiated in 2018 in partnership with the 82d Airborne Division at Fort Bragg, North Carolina, the MASTR-E Pilot Study sought to characterize behavioral and physiological measures to assess the tactical performance of soldiers during sustained training.⁶⁶ Building on that foundation, the FY20-24 MASTR-E Program is one of DOD’s largest cognitive performance efforts and includes multiple studies designed to monitor, predict, and optimize soldier performance.⁶⁷ While much of the research will take years to yield results, the MASTR-E Team is gaining momentum on a number of initiatives that may shape soldier cognitive performance in the near term. For example, the neurostimulation for soldier performance enhancement study is experimenting with the use of non-invasive brain stimulation (NIBS) to enhance soldier lethality, situational awareness, skill acquisition, and decision-making. By studying the effects of both laboratory-grade and commercial/off-the-shelf (COTS) NIBS devices, the study seeks to develop guidelines and recommendations on the use of NIBS in training and operations.⁶⁸

Another example is a one-year study with 10th Mountain Division using COTS wearable technology to collect soldier data for both COVID 19 symptom and overall performance monitoring and modeling.⁶⁹ As part of the ongoing study, over 530 soldiers from 4th Battalion,

⁶⁵ Eddy, “Cognitive Science and Applications Team Overview,” 9.

⁶⁶ Erika Hussey and John Ramsay, *Monitoring and Assessing Soldier Tactical Readiness and Effectiveness (MASTR-E): Identifying the Readiness States and Traits of Tactical Mastery* (Natick, MA: US Army Combat Capabilities Development Command Soldier Center, April 27, 2020), 5.

⁶⁷ *Ibid.*, 34.

⁶⁸ Marianna Eddy, “MASTR-E BC6 Quad Chart” (US Army Combat Capabilities Development Command Soldier Center, March 17, 2021).

⁶⁹ Craig Fox, “Smart Technology Helps Fort Drum Soldiers Become the Best That They Can Be,” *NNY360*, accessed December 28, 2020, [https://www.nny360.com/news/jeffersoncounty/smart-technology-](https://www.nny360.com/news/jeffersoncounty/smart-technology-20)

31st Infantry Regiment, wear a smart watch, ring, and heartrate monitor to collect data such as body temperature, respiratory rate, heartrate, sleep, and activity levels.⁷⁰ This data allows unit medical personnel to rapidly screen for signs of COVID-19 and other illnesses to limit soldier exposure and disease transmission.⁷¹ Using COTS athlete management software along with the sensors, the project aims to provide small unit leaders with recommendations to improve physical training, sleep, and cognitive performance strategies.⁷² The study includes use in both training and deployed environments. Initial results are promising, and the final report is scheduled to be complete on 31 August 2021.⁷³

Like most DEVCOM-SC programs, the 10th Mountain Division MASTR-E study is closely integrated with multiple partners from across DOD, academia, and industry. Most notably, the US Army Medical Research and Development Command's "Military Operational Medicine Research Program" (MOMRP) is funding the wearable technology research effort. Also part of the AFC enterprise, the MOMRP manages a collaborative network of research partners from DOD, other federal agencies, academia, and industry to drive research aimed at improving the health, readiness, and performance of service members.⁷⁴

The MOMRP biomedical enhancement, fatigue management, and psychological health and resilience portfolios have direct ties to cognitive performance. These programs are led by US

[helps-fort-drum-soldiers-become-the-best-that-they-can-be/article_b5c891a2-4d2a-559a-97f3-6c4ed87a0b54.html](https://home.army.mil/drum/index.php/about/news/news-archives-october-2020/sensored-success).

⁷⁰ Mike Strassner, "'Sensored' For Success : Fort Drum Soldiers participate in performance optimization research," *US Army and Fort Drum News*, accessed December 28, 2020, <https://home.army.mil/drum/index.php/about/news/news-archives-october-2020/sensored-success>.

⁷¹ MAJ Adam Cucchiara, *Project Polar Unit Report* (Camp Dwyer, Afghanistan, 4-31 Infantry Battalion, November 2, 2020) 1.

⁷² *Ibid.*, 2.

⁷³ *Ibid.*, 4.

⁷⁴ US Department of the Army, "Program Overview: Science to Service Member," Military Operational Medicine Research Program, accessed December 28, 2020, <https://momrp.amedd.army.mil/overview/program-overview>.

Army Medical Research and Development Command (MRDC) subordinate laboratories such as the Walter Reed Army Institute of Research (WRAIR) and the US Army Research Institute of Environmental Medicine (USARIEM), all of which are, like MOMRP, subordinate organizations of AFC. The programs involve multiple partners across the United States Army Special Operations Command (USASOC) and TRADOC to explore various interventions, such as neuropharmacology, stimulant use, and far-forward neurostimulation to enhance vigilance and recuperative sleep among other outcomes.⁷⁵ These programs appear to be well-integrated with AFC's MHP Sprint Team and represent approximately 15% of the overall MRDC Science and Technology investment portfolio across FY23-27.⁷⁶

WRAIR also conducts research directly related to soldier cognitive performance. Many of WRAIR's brain research efforts center on the prevention, identification, and treatment of traumatic brain injuries which directly impact cognition. Other cognitive research includes the development and testing of cognitive flexibility tools to improve attention and decision-making as well as leader tools to improve cognitive function.⁷⁷ Finally, the WRAIR Sleep Research Center conducts extensive research on the cognitive and physiological impacts of sleep loss and circadian misalignment.

Effective sleep management and fatigue mitigation have important roles to play in establishing cognitive dominance by allowing for greater situational awareness, better decision-making, and shortened reaction times.⁷⁸ The WRAIR Behavioral Biology Branch leads multiple

⁷⁵ Bruce Syvinski, "Medical Capabilities Development and Integration Requirements Overview: Army Medical S&T Deep Dive" (US Army Futures Command, November 2, 2020), 145–176.

⁷⁶ *Ibid.*, 16.

⁷⁷ US Department of the Army, *Investigator's Dispatch: Far-Forward Behavioral Health* (Fort Detrick, MD: Walter Reed Army Institute of Research, September 2020), 2, accessed December 28, 2020, https://www.wrair.army.mil/sites/default/files/2020-09/WRAIR_Dispatch_Far_Forward_Behavioral_Health.pdf.

⁷⁸ US Department of the Army, *Sleep Dispatch: Fighting Soldier Fatigue and Enhancing Cognitive Dominance* (Fort Detrick, MD: Walter Reed Army Institute of Research, June 2019), 3, accessed January 4, 2021, https://www.wrair.army.mil/sites/default/files/2019-06/Behavioral_Health_and_Sleep.pdf.

sleep-related efforts focused on transcranial electrical stimulation (TES) to enhance recuperative sleep, stimulant use, and other pharmacological interventions to improve soldier performance through better fatigue management.⁷⁹ While soldiers in combat are unlikely to have optimal sleep patterns, WRAIR research seeks to maximize the effectiveness of limited sleep, enhance alertness in critical periods, and educate leaders on practical fatigue management strategies to improve and sustain cognitive performance.

Like WRAIR, the USARIEM partners with the MOMRP and others to conduct research related to soldier cognitive performance. For example, USARIEM has several ongoing efforts aimed at examining the neuroanatomical, chemical, and physiological effects of peripheral nerve stimulation and its impacts on performance of soldier tasks, such as marksmanship. Additional studies are exploring the effectiveness of a variety of tools and techniques for cognitive training, cognitive resilience, and cognitive re-set. These efforts aim to provide the Army with evidence-based guidance on the efficacy and use of approaches for optimizing and enhancing brain health and performance.⁸⁰ USARIEM scientists are also working to develop predictive models of resilience to be used by Army leadership and medical professionals to identify factors (biologic, physiologic, demographic, genomic, and psychologic) that can be manipulated through nutritional, training, or other interventions to improve training outcomes and reduce injuries.⁸¹ Other current efforts, in collaboration with Massachusetts Institute of Technology (MIT) and MIT Lincoln Laboratory, are exploring the use of sensor-based technologies to monitor changes in

⁷⁹ Ibid., 5–7.

⁸⁰ Tracey Smith, email message to author, March 17, 2021.

⁸¹ US Department of the Army, “Military Performance Division,” *US Army Research Institute of Environmental Medicine*, last modified February 10, 2021, accessed March 18, 2021, <https://www.usariem.army.mil/index.cfm/research/divisions/mpd>.

neurological state during training and operational activities to reduce injury risk and improve training and mission outcomes.⁸²

US Army Training and Doctrine Command (TRADOC)

Multiple TRADOC programs address aspects of assessing and improving soldier cognitive performance. FM 7-22, *Holistic Health and Fitness (H2F)*, published by the US Army Center for Initial Military Training provides the most complete look at cognitive performance in Army doctrine and is representative of the Army's culture of prioritizing physical performance above cognitive performance. The bulk of the manual focuses on aspects of physical fitness, leaving just two chapters to mental and sleep readiness. Most telling is the physiology chapter which almost exclusively describes the physical effects of exercise, and only includes a cursory look at the central nervous and neuroendocrine systems.⁸³

The H2F program does, however, include valuable concepts and exercises for coaching and improving cognitive performance. This includes strategies for attention control, achieving optimal arousal levels, stress control, and emotional performance.⁸⁴ Even so, manpower limits the H2F performance team's ability to address cognitive performance optimization across the operational army. Per Army doctrine, H2F staffing for a brigade combat team includes forty-five providers, therapists, trainers and specialists focused on physical performance, compared to only five dedicated to cognitive performance.⁸⁵ Unless H2F cognitive performance staffing is increased, significant cognitive gains at the tactical level are unlikely.

⁸² Brian A. Telfer, Kate Byrd, and Paula P. Collins, "Open Body Area Network Physiological Status Monitor," *Lincoln Laboratory Journal* 24, no. 1 (2020): 76–92.

⁸³ US Department of the Army, Army Field Manual (FM) 7-22, *Holistic Health and Fitness* (Washington, DC: US Government Publishing Office, 2020), 4-1.

⁸⁴ *Ibid.*, 9–4, 9–9.

⁸⁵ *Ibid.*, 1–7.

The US Army Combined Arms Center (CAC) also owns multiple cognitive performance efforts inside TRADOC. Army University (ArmyU), in partnership with DEVCOM SC, is studying cognitive science-based learning strategies to improve learning speed and retention of training tasks. Two examples are the “Applying Learning Science to Schoolhouse Skill and Knowledge Acquisition” (ALSSKA) research project and a pilot version of the US Army Master Gunner Course that incorporates an adaptive tutoring system.

The ALSSKA is a collaborative project that includes applied research with the Sabalauski Air Assault School at Fort Campbell, Kentucky, in 2021-2022. The fourteen month-long program includes an assessment of the current learning environment, development and implementation of tailored cognitive science-based learning strategies, and subsequent assessment of their effectiveness. Similar programs are being considered or implemented with the US Army Airborne School at Fort Benning and the US Army Advanced Airborne School at Fort Bragg.⁸⁶

Information generated by programs such as ALSSKA could be used to reshape longstanding individual training practices. Such changes are likely to yield positive results in a military setting; cognitive science-based learning methods such as interleaving, distributed practice, and adaptive tutoring are already showing value in the civilian sector.⁸⁷ To succeed in this effort, however, will require cultural change across TRADOC and the operational army.

The establishment of the Cognitive and Communicative Arts Improvement Center (CCAIC) is another noteworthy cognitive performance effort in the CAC portfolio. Planned for initial funding in Fiscal Year 2023 (FY23), the CCAIC will deliver cognitive performance programs to develop student and faculty critical and creative thinking skills.⁸⁸ This marks an

⁸⁶ Wade Elmore and Marianna Eddy, “Applying Learning Science to Schoolhouse Skill and Knowledge” (information paper, Army University, August 26, 2020), 1.

⁸⁷ Sanjay Sarma and Luke Yoquinto, “Cramming May Help for Next-Day Exams, but for Long-Term Memory, Spacing Out Study Is What Works,” *The Washington Post*, last modified November 30, 2020, accessed December 9, 2020, https://www.washingtonpost.com/health/memory-and-cramming-for-exams/2020/11/27/d395a838-29bd-11eb-8fa2-06e7cbb145c0_story.html.

important first step towards formalizing cognitive performance instruction through Army centers of excellence. The cadre of nine civilians includes three psychologists and four instructors responsible for teaching critical thinking and self-awareness to students and faculty at thirty-two TRADOC-supported schools.⁸⁹ Fully implemented, this effort will likely take several years to influence the TRADOC enterprise, the effectiveness of which will not be known for some time.

One additional organization inside CAC, the University of Foreign Military and Cultural Studies (UFMCS), already offers formal training aimed at cognitive performance and critical thinking. The “Critical Thinking for Red Team Practitioners Course” is an example of the UFMCS “Red Teaming Central” program and includes instruction on critical thinking, cognitive biases, and techniques to improve decision-making and avoid groupthink.⁹⁰ The curriculum covers essential neuroscience and cognitive psychology topics to educate leaders, increase self-awareness, and improve performance. Unfortunately, the Army eliminated funding for UFMCS and the Red Teaming University program, effective 1 October 2021.⁹¹ As of this writing it is unclear if any of the courses will be offered elsewhere inside TRADOC.

Through these and other programs, TRADOC significantly influences the Army’s cognitive performance culture, training approach, leader development and doctrine. As such, TRADOC will play a critical role in any potential changes to the Army’s cognitive performance culture.

⁸⁸ Howie Brewington, “Cognitive and Communicative Arts Improvement Center FY23-27 POM Requirement” (US Army Combined Arms Center, October 5, 2020), 3.

⁸⁹ *Ibid.*, 3–5.

⁹⁰ US Department of the Army, “University of Foreign Military and Cultural Studies / Red Teaming,” US Army Combined Arms Center, last modified October 23, 2020, accessed January 4, 2021, <https://usacac.army.mil/organizations/ufmcs-red-teaming>.

⁹¹ Bryce Hoffman, “US Army Moves To Close Red Teaming University,” *Forbes*, October 26, 2020, accessed January 4, 2021, <https://www.forbes.com/sites/brycehoffman/2020/10/26/us-army-moves-to-close-red-teaming-university/>.

Army Resilience Directorate (ARD)

The Department of the Army G-1 Army Resilience Directorate (ARD) is the Army's proponent for the Ready and Resilient Campaign (R2C), focused on enhancing the readiness and resilience of soldiers, units, and family members.⁹² Best known for its suicide prevention, substance abuse, and sexual harassment/assault prevention programs, the R2C also includes resources for cognitive performance improvement. The ARD Ready and Resilient Resource Guide from April 2020 provides a range of online training resources centered on many of the cognitive performance improvement techniques espoused in H2F doctrine. These include mindfulness, attention control, energy management, goal setting, and visualization.⁹³ The program also includes thirty-two Ready and Resilient (R2) Performance Centers at Army installations worldwide, staffed by experts in sports psychology, kinesiology, education, and other performance-related fields.⁹⁴ R2 Performance Centers and R2C training programs provide valuable resources for practical application of cognitive performance improvement strategies at the small unit level, but only when recognized and leveraged by the local chain of command.

⁹² US Department of the Army, Assistant Secretary of the Army for Manpower and Reserve Affairs and US Army G-1, "US Army Designates Army Resiliency Directorate, Promotes Force Readiness Through Personnel Resilience," *Army News Service*, accessed March 9, 2021, https://www.army.mil/article/114403/us_army_designates_army_resiliency_directorate_promotes_force_readiness_through_personnel_resilienc.

⁹³ US Department of the Army, G-1 Army Resilience Directorate, *Ready and Resilient Resource and Activity Guide* (Washington:DC, US Government Publishing Office, April 30, 2020), 11–17, accessed March 9, 2021, <https://www.armyresilience.army.mil/ard/images/pdf/leadership/ARD%20Ready%20and%20Resilient%20Resource%20Guide.pdf>.

⁹⁴ Thomas Brading, "R2 Performance Centers Look to Strengthen Overall Health of Soldiers," *Army News Service*, November 5, 2020, accessed March 10, 2021, https://www.army.mil/article/240619/r2_performance_centers_look_to_strengthen_overall_health_of_soldiers.

US Army Research Institute for the Behavioral and Social Sciences (ARI)

ARI focuses on developing innovative ways to assess and enhance soldier readiness and performance.⁹⁵ Partnered with ArmyU, ARI is involved in the development of individual assessments for use by the Army Talent Management Task Force (TMTF) and Center for the Army Profession and Leadership (CAPL) as part of the CSA's effort to modernize the Army's talent management processes. If used effectively, career-long assessments can help identify, recruit, train, and leverage the right talent in the right place at the right time for success as part of a human-system team in MDO. By identifying the right soldiers for the right teams in advance, career-long assessments set conditions for more efficient and effective talent management to the benefit of both the Army and the soldier. Furthermore, the analysis of aggregate career-long assessment data is likely to identify trends and best practices in training, team composition, and leader development that generate additional second- and third-order opportunities for cognitive performance optimization and enhancement.⁹⁶

While the potential benefits of an effective career-long assessment program are significant, implementation challenges remain. Within the research community there is debate on the number and type of assessments required along with concern that costly commercially available assessments may not relate well to Army applications. The key to a successful assessment program, says ARI's Dr. Angela Karrasch, is developing effective measures of complex cognitive skills consistent with military performance. Additional research is required to develop these measures and apply them across the force.⁹⁷ Finally, information management and privacy concerns are significant. Without a means to validate, share, and protect individual

⁹⁵ US Department of the Army, "ARI's History," US Army Research Institute for the Behavioral and Social Sciences, accessed December 23, 2020, <https://ari.altess.army.mil/history.aspx>.

⁹⁶ Author Discussion with Dr. LisaRe Babin, Army University, MS Teams, December 31, 2020.

⁹⁷ Author Discussion with Dr. Angela Karrasch, Army Research Institute, Fort Leavenworth, KS, March 5, 2021.

assessment information, the Army will struggle to establish a culture of continuous cognitive assessment and performance improvement.⁹⁸

Also based on ARI assessments and studies, the “Managing Complex Problems” website offers skill-building interactive exercises for Army leaders seeking to improve strategic thinking and problem-solving skills. While the site is focused primarily on complex problem-solving and design-style thinking skills, it provides multiple videos, exercises, and references related to reflective thinking, mindfulness, visualization, and communication techniques.⁹⁹

Defense Advanced Research Projects Agency (DARPA)

DARPA is a prolific supporter of research related to the human brain, artificial intelligence, and biotechnology as part of its mission to invest in breakthrough technologies vital to national security.¹⁰⁰ A founding partner of the National Institute of Health’s “Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Working Group,” DARPA plays a key role in the multi-billion dollar “Brain 2025 Initiative” directed by President Barack H. Obama in 2013.¹⁰¹ Well-integrated with academia and private research, DARPA plays an important role in leveraging innovative science and technology to solve military problems.

In summary, the US Army has numerous organizations with interests in cognitive performance optimization and enhancement. These efforts include medical research, combat systems development, training, doctrine, education, and talent management. The AFC MHP effort seeks to synchronize many of these efforts, and must continue to develop and implement

⁹⁸ Author Discussion with Dr. LisaRe Babin, Army University, MS Teams, December 31, 2020.

⁹⁹ US Department of the Army, “Managing Complex Problems,” Landing Page, US Army Research Institute for the Behavioral and Social Sciences, 2020, accessed December 23, 2020, <http://aratsg.com/public/MCP2020/index.html>.

¹⁰⁰ US Department of Defense, “About DARPA,” Defense Advanced Research Projects Agency Website, accessed January 22, 2021, <https://www.darpa.mil/about-us/about-darpa>.

¹⁰¹ National Institutes of Health, *BRAIN 2025: A Scientific Vision* (Bethesda, MD: US Department of Health and Human Services, June 2014), accessed January 21, 2021, <https://braininitiative.nih.gov/strategic-planning/brain-2025-report>.

strategies to increase buy-in from the operational force. Greater unity of command, focus, and synchronization are needed to fully leverage innovative science-based solutions to achieve cognitive dominance. Until that occurs, the Army will see pockets of excellence but only limited overall gains.

Chapter 3 – Competing Cognitive Performance Efforts

In the meantime, the US Army is not the only organization trying to boost cognitive performance. Professional sports teams, private industry, allied militaries, adversaries, and others are pursuing strategies of cognitive performance optimization or enhancement.

Professional Sports

For over a century, psychologists asserted that sports performance can be enhanced through cognitive and sports psychology approaches. Sports psychology gained popular appeal in the 1970s and became firmly established world-wide by the beginning of the twenty-first century.¹⁰² Today professional sports teams often employ psychologists on staff to boost individual and team performance through cognitive science-based methods.¹⁰³

Mastery of a sport requires a combination of motor skills and cognitive expertise similar to that required for tactical military tasks. As such, cognitive performance concepts in professional sports have a corollary in military applications. Army *H2F* doctrine incorporates many sports psychology skills and techniques as recommended ways to increase soldier mental readiness and cognitive abilities. These strategies include relaxation, visualization, self-talk, goal setting, and biofeedback to enhance cognitive and physical performance.¹⁰⁴ These methods are also highlighted by the Army R2C.¹⁰⁵

¹⁰² “Sports Psychology History - IResearchNet,” *Psychology*, n.d., accessed January 7, 2021, <http://psychology.iresearchnet.com/sports-psychology/sports-psychology-history/>.

¹⁰³ Leonard Zaichkowsky, “Sport Psychology: A Primer for Educators,” *The Journal of Education* 187, no. 1 (2006): 1-8, 2.

¹⁰⁴ US Army, FM 7-22, 9-1; Zaichkowsky, “Sport Psychology,” 5.

¹⁰⁵ US Department of the Army, “I Want to Optimize My Performance,” Army Ready and Resilient, Army Resilience Directorate, accessed March 10, 2021, <https://www.armyresilience.army.mil/ard/R2/I-Want-to-Optimize-My-Performance.html>.

The efficacy of self-management is documented in numerous studies conducted in the late twentieth century.¹⁰⁶ Despite the potential benefits, few sports psychology practices are incorporated into Army training at the small-unit level. This may be attributed to the association of these skills with mental readiness and a subtle negative connotation tied to mental health topics in general. The lack of adoption could also be due to the nascent nature of the H2F regime and its disproportionate focus on physical performance. Underutilization of resources and training offered by Army R2 Performance Centers is likely another contributor. Regardless of the cause, the Army is not keeping pace with professional sports in its efforts to maximize cognitive performance.

Industry

Recent years have also seen an increase in commercial efforts aimed at improving cognitive performance. Much of this is in partnership with academia, but an increasing number of neuroscientists are working in private industry.¹⁰⁷ Elon Musk's Neuralink project is one of these initiatives and promises to deliver implantable electronic brain-computer interfaces as a means to provide brain control over computer applications to solve paralysis, blindness, hearing loss or other disabilities.¹⁰⁸ Not all commercial applications are high tech, with many neuroscientists now working as leadership coaches and espousing many of the same principles of the Army's H2F and R2C programs.¹⁰⁹ An increasing number of organizations such as the NeuroLeadership Institute

¹⁰⁶ Chris P. Neck and Charles C. Manz, "Thought Self-Leadership: The Influence of Self-Talk and Mental Imagery on Performance," *Journal of Organizational Behavior* 13, no. 7 (December 1992): 681–682.

¹⁰⁷ Nic Fleming, "How Neuroscience Is Breaking Out of the Lab," *Nature* 563, no. 7729 (October 31, 2018): S29–S31, accessed January 19, 2021, <https://www.nature.com/articles/d41586-018-07201-7>.

¹⁰⁸ Antonio Regalado, "Elon Musk's Neuralink Is Neuroscience Theater," *MIT Technology Review*, August 30, 2020, accessed October 22, 2020, <https://www.technologyreview.com/2020/08/30/1007786/elon-musks-neuralink-demo-update-neuroscience-theater/>.

¹⁰⁹ Fleming, "How Neuroscience Is Breaking Out of the Lab," S30.

offer cognitive science-based executive development to enhance corporate leadership skills and affect cultural change in private industry.¹¹⁰ The Army could benefit from partnering with these companies to capitalize on readily available commercial training as part of a diverse strategy to shift the Army's cognitive performance culture.

Sister Services

Across DOD, the air force and navy are also pursuing cognitive performance enhancement initiatives with objectives similar to those of the Army. Notable air force efforts include 56th Fighter Wing cognitive performance enhancement for F35 pilots to successfully integrate next-generation aircraft capabilities as part of the air-sea battle operational environment.¹¹¹ To maximize fighter pilot performance, the 56th Fighter Wing uses a multi-disciplinary team of healthcare providers, physical therapists, strength coaches, and cognitive specialists similar to the Army's H2F model.¹¹²

The 56th, however, appears more advanced in the integration of cognitive performance training than comparable Army programs. The one-year F35 training program incorporates sixteen academic hours, eight individual sports psychology coaching sessions, and twenty-four "mind gym" training sessions that combine cognitive training with physical strength and conditioning. The curriculum includes many of the previously mentioned self-management skills and techniques, and provides mental foundations, tools, and skills for improved cognitive performance. The training is designed to accelerate and improve the quality of cognitive processes for perception of and reaction to events in the operational environment.

¹¹⁰ "Making Organizations More Human Through Science," NeuroLeadership Institute, accessed February 12, 2021, <https://neuroleadership.com/>.

¹¹¹ Christopher Hubbard and Justin Foster, "Performance Psychology Summit Line Community Panel," (presented at 2020 Performance Psychology Summit, MS Teams, November 12, 2020).

¹¹² *Ibid.*; US Army, FM 7-22, 1-7.

Results are difficult to quantify, but the 56th cadre report improved pilot confidence and flight performance since the mental performance training program's inception, and the team is collecting data to quantify these observations. The 56th Training Squadron commander, Lt. Col. Christopher Hubbard, notes the greatest challenges with the program are allocating adequate training time and staffing for mental performance in a demanding training schedule.¹¹³ When facing personnel and budget shortages, all services will be challenged to commit adequate resources to cognitive performance without quantifiable evidence to justify the cost.

Navy cognitive performance improvement efforts are incorporated as part of the "Warrior Toughness" program, which focuses on the development of sailor spiritual, mental, and physical strength.¹¹⁴ The Navy implemented the curriculum across all enlisted and officer accessions programs in 2018 after reviewing recent accidents aboard *USS Fitzgerald* and *USS John S. McCain*.¹¹⁵ The program uses mindfulness and sports psychology techniques of goal setting, self-talk, visualization, and energy management as methods for improving emotional regulation and cognitive performance.¹¹⁶

The implementation of Warrior Toughness marks a significant investment in cultural change across the navy, the results of which are thus far difficult to quantify. Anecdotally, US Navy clinical psychologist CAPT Melissa Lauby notes that sailors successfully responding to the fire aboard *USS Bonhomme Richard* in July 2020 referenced the benefits of Warrior Toughness training and principles on multiple occasions during after-action debriefings.¹¹⁷ Additional time

¹¹³ Hubbard and Foster, "Performance Psychology Summit Line Community Panel."

¹¹⁴ Michael Bernacchi et al, "Warrior Toughness: Making the Mind, Body, Soul Connection," *US Naval Institute*, July 2019, accessed January 7, 2021, <https://www.usni.org/magazines/proceedings/2019/july/warrior-toughness-making-mind-body-soul-connection>.

¹¹⁵ Hiller Lauby, "Navy Warrior Toughness Program," (presented at 2020 Performance Psychology Summit, MS Teams, November 12, 2020).

¹¹⁶ "Bernacchi et al, "Warrior Toughness."

¹¹⁷ Lauby, "Navy Warrior Toughness Program."

and analysis are required to judge the effectiveness of the program, but Warrior Toughness marks the largest-scale attempt yet at changing cognitive performance culture across the US armed services.

A number of units inside the United States Special Operations Command (USSOCOM) have human performance enhancement initiatives that include cognitive performance as part of their portfolio. USASOC's Tactical Human Optimization, Rapid Rehabilitation, and Reconditioning (THOR3) program is representative of these efforts. Formally implemented in 2010, the program focuses on optimizing the physical and mental performance of special forces operators as well as rehabilitating and preventing injuries.¹¹⁸ Despite its stated goal of improving mental performance, a closer look at the program shows that it focuses primarily on physical performance and conditioning. A 2013 RAND report cites a lack of knowledge, funding, equipment, personnel, and assessment tools to adequately measure and improve cognitive performance as part of the otherwise successful THOR3 program.¹¹⁹ Similarly, a 2016 report by the US Army Public Health Center gives sole focus to the physical domain in its evaluation of the program, and publicly available THOR3 training materials do not mention mental performance at all.¹²⁰ As with the H2F program, opportunities exist to expand and improve on cognitive performance efforts inside USSOCOM.

¹¹⁸ Tyson Grier et al., *Evaluation of the Tactical Human Optimization, Rapid Rehabilitation, and Reconditioning Program (THOR3)* (Aberdeen Proving Ground, MD: US Army Public Health Center, January 19, 2018), 7, accessed January 14, 2021, <https://apps.dtic.mil/dtic/tr/fulltext/u2/1045367.pdf>.

¹¹⁹ Terrence K. Kelly et al., *An Assessment of the Army's Tactical Human Optimization, Rapid Rehabilitation and Reconditioning Program* (Santa Monica, CA: RAND Arroyo Center, 2013), accessed August 17, 2020, <https://www.jstor.org/stable/10.7249/j.ctt3fgzpw.10>.

¹²⁰ Grier et al., *Evaluation of the Tactical Human Optimization, Rapid Rehabilitation, and Reconditioning Program (THOR3)*; Christi Logan, *THOR3 10 Week Program* (Fort Bragg, NC: US Army John F. Kennedy Special Warfare Center and School, November 2012), accessed January 14, 2021, <http://specialforcesrecruiter.com/wp-content/uploads/2018/06/THOR3-10-Week-Program.pdf>.

Allies

Numerous US allies have interest in cognitive performance enhancement, to include multiple NATO members.¹²¹ Dr. Kate Colvin, Lead Tactical Performance Psychologist at NATO Special Operations Headquarters, recently reported that cooperation among all NATO allies in this field is strong. The Danish Special Warfare Group (DNSWG) is typical of allied programs and mirrors the US approach of looking at cognitive performance as part of overall human performance optimization efforts. The DNSWG Human Performance Optimization Program Lead, 1LT Anders Kilen, PhD, cites challenges similar to those facing US military efforts, namely, data analysis, program synchronization, and allocation of adequate resources to cognitive performance optimization.¹²²

Adversaries

While the Army partners with the previously-discussed organizations, not all cognitive performance enhancement efforts are as collegial. The conduct of US adversaries in the cognitive domain is troubling, most notably that of near-peer competitors China and Russia. China, in particular, emphasizes research and development aimed at creating an operational advantage through advances in neuroscience, AI, and biotechnology as part of ongoing military-civil fusion efforts.¹²³ This should concern the US and its allies for several reasons.

First, influential Peoples Liberation Army (PLA) leaders such as MG He Fuchu, the vice-president of the PLA's Academy of Military Science place strong emphasis on military preparation for a future operating environment that extends into new virtual domains. According

¹²¹ Gareth W, "Hacking Brains: Enhancing Soldier Cognitive Performance," *Wavell Room: Contemporary British Military Thought*, June 25, 2020, accessed January 19, 2021, <https://wavellroom.com/2020/06/25/hacking-brains-enhancing-soldier-cognitive-performance/>.

¹²² Kate Colvin and Anders Kilen, "Performance Psychology Summit Line Community Panel," (presented at 2020 Performance Psychology Summit, MS Teams, November 12, 2020).

¹²³ Kania, "Minds at War: China's Pursuit of Military Advantage through Cognitive Science and Biotechnology," 83.

to He, these domains include the information domain and the “domain of consciousness,” and will require “mental/cognitive dominance” for success.¹²⁴ Elsa Kania, a senior fellow and China expert at the Center for a New American Security, observes that these concepts are now frequently discussed in PLA writings, along with the concept of human and artificial intelligence fusion.¹²⁵

This interest is backed with billions of yuan in funding for brain research as part of the “China Brain Project,” launched in 2016.¹²⁶ The initiative is a prime example of civil-military fusion efforts with close collaboration among the Chinese Academy of Medical Sciences, the Academy of Military Medical Sciences, and multiple universities.¹²⁷ The project focuses on research into cognitive function with applied science in the areas of treating neurodegenerative diseases and the integration of the brain with artificial intelligence.¹²⁸ Chinese efforts include significant research in clustered regularly interspaced short palindromic repeats (CRISPR) gene editing in both animals and humans.¹²⁹ The use of CRISPR remains a topic of global ethical debate, even as Chinese scientists have already taken the unprecedented step of editing human embryos in ways that may enhance cognitive function.¹³⁰

¹²⁴ Ibid., 85.

¹²⁵ Ibid., 85–86.

¹²⁶ Ibid., 89.

¹²⁷ David Cyranoski, “Beijing Launches Pioneering Brain-Science Centre,” *Nature* 556, no. 7700 (April 5, 2018): 157–158, accessed 15 January, 2021, <https://www.nature.com/articles/d41586-018-04122-3>.

¹²⁸ Olivier Dessibourg, “Primate Labs Give Us an Edge, Says China’s Brain Project Chief,” *NewScientist*, September 7, 2016, accessed January 15, 2021, <https://www.newscientist.com/article/mg23130900-800-primate-labs-give-us-an-edge-says-chinas-brain-project-chief/>.

¹²⁹ Elsa B. Kania and Wilson VornDick, “China’s Military Biotech Frontier: CRISPR, Military-Civil Fusion, and the New Revolution in Military Affairs,” *China Brief* 19, no. 18 (October 8, 2019), accessed January 14, 2021, <https://jamestown.org/program/chinas-military-biotech-frontier-crispr-military-civil-fusion-and-the-new-revolution-in-military-affairs/>.

¹³⁰ Antonio Regalado, “China’s CRISPR Twins Might Have Had Their Brains Inadvertently Enhanced,” *MIT Technology Review*, February 21, 2019, accessed January 14, 2021, <https://www.technologyreview.com/2019/02/21/137309/the-crispr-twins-had-their-brains-altered/>.

This lack of adherence to ethical standards common among researchers in the West is concerning, especially as China attempts to attract international neuroscientists to work there under less regulation.¹³¹ Dr. Pu Muming, chief of the China Brain Project, openly touts the large-scale use of non-human primates for brain research as an advantage over the United States, Japan, and Europe.¹³² The direct involvement of the Chinese Communist Party in brain research ensures that scientists studying neurological disease in the rapidly aging Chinese population also provide People's Liberation Army leaders with the scientific horsepower to pursue their strategy of cognitive dominance.¹³³ Together, these factors create a loosely-regulated, well-funded research environment with a national sense of urgency for dual-use neurological research breakthroughs.

Similar to China, Russia also sees the mind as the main battlespace in modern warfare.¹³⁴ Russia shares China's questionable ethics and cognitive dominance research interests, however, the Russian approach relies heavily on undermining adversary cognitive processes through psychological warfare and other means.¹³⁵ Ubiquitous false Russian narratives place high cognitive loads on their adversaries and require increased information filtering which consumes cognitive resources and degrades the speed and quality of decisions over time. By sowing doubt and creating confusion, Russian misinformation need only temporarily cloud the enemy's judgment to cause hesitation and provide an advantage for Russian activities.¹³⁶

¹³¹ Palchik, Chen, and Giordano, "Monkey Business? Development, Influence, and Ethics of Dual-Use Brain Science on the World Stage," 112.

¹³² Dessibourg, "Primate Labs Give Us an Edge, Says China's Brain Project Chief | New Scientist."

¹³³ Palchik, Chen, and Giordano, "Monkey Business? Development, Influence, and Ethics of Dual-Use Brain Science on the World Stage," 112–113; Kania, "Minds at War: China's Pursuit of Military Advantage through Cognitive Science and Biotechnology," 86.

¹³⁴ Bērziņš, "The West Is Russia's Main Adversary, and the Answer Is New Generation Warfare," 173.

¹³⁵ Gorman et al., *A Silicon Curtain Is Descending*.

¹³⁶ James K. Wither, "Making Sense of Hybrid Warfare," *Connections* 15, no. 2 (Spring 2016): 73-87, 82.

Russian forces also continue to show interest in the use of incapacitating agents to degrade the cognitive function of their adversaries. During the 2002 hostage situation in Moscow's Dubrovka Theater, Russian special forces released a fentanyl derivative into the ventilation system to manipulate the consciousness of approximately 50 Chechen separatists and 750 Russian hostages. In addition to causing the separatists to lose consciousness, the action resulted in the overdose deaths of around 125 hostages with others experiencing permanent disability.¹³⁷ While this action drew international condemnation and renewed debate over the effectiveness and applicability of international law, such as the 1993 Chemical Weapons Convention (CWC), Russian officials largely viewed the operation as a success.¹³⁸

Neurology and biochemistry experts such as Dr. James Giordano, chief of neuroethics at Georgetown University Medical Center, are concerned that advances in neuroscience and technology provide actors such as Russia and China with opportunities to exploit gaps in existing treaties, international laws, and supranational conventions governing the use of chemical and biological agents.¹³⁹ This includes the use of CRISPR gene editing and nanotechnology to enhance neural structures in their own soldiers while creating novel neuroweapons to degrade the cognitive function of their adversaries.¹⁴⁰

While adversaries such as Russia and China are likely to cross ethical lines unpalatable to Western cultures, there are long-term implications of their activities. The consequences of exploiting neuropharmacological agents, gene editing, and biotechnology for short-term cognitive

¹³⁷ Mark Wheelis, "'Nonlethal' Chemical Weapons: A Faustian Bargain," *Issues in Science and Technology* 19, no. 3 (2003): 74-78, 74.

¹³⁸ Peter Baker and Susan B. Glasser, "90 Hostages Killed in Moscow Theater," *The Washington Post*, October 26, 2002, accessed January 19, 2021, <https://www.washingtonpost.com/wp-srv/articles/A21613-2002Oct26.html>.

¹³⁹ Joseph DeFranco, Diane DiEuliis, and James Giordano, "Redefining Neuroweapons: Emerging Capabilities in Neuroscience and Neurotechnology," *Prism* 8, no. 3 (2019): 48-63, 51.

¹⁴⁰ *Ibid.*, 52-53.

gains are largely unknown but likely significant. In light of this threat, the US military has an opportunity to build a solid foundation for cognitive dominance that does not cross ethical boundaries and builds long-term resilience and readiness across the Army. As with building physical dominance, science can assist, but human effort and perseverance will be required to succeed.

Chapter 4 – Opportunities for the US Army

The allure of leap-ahead technology and revolutionary advances in neuroscience garners much of the attention related to military cognitive performance initiatives. While these efforts are important, the US military must also capitalize on practical, near-term opportunities to achieve cognitive dominance. Quick wins are readily available with modest investment and can set conditions for future advances. The paragraphs below provide indirect and direct approaches to cognitive performance enhancement and optimization. Indirect approaches affect cognition through dietary intervention, sleep modification, physical exercise, pharmacology, and resilience training. Direct approaches “immediately target the structural or functional mechanisms and processes underlying learning, perception, cognition, or emotion.”¹⁴¹ Figure 3 shows how both approaches are required to effectively enhance and optimize cognitive performance.

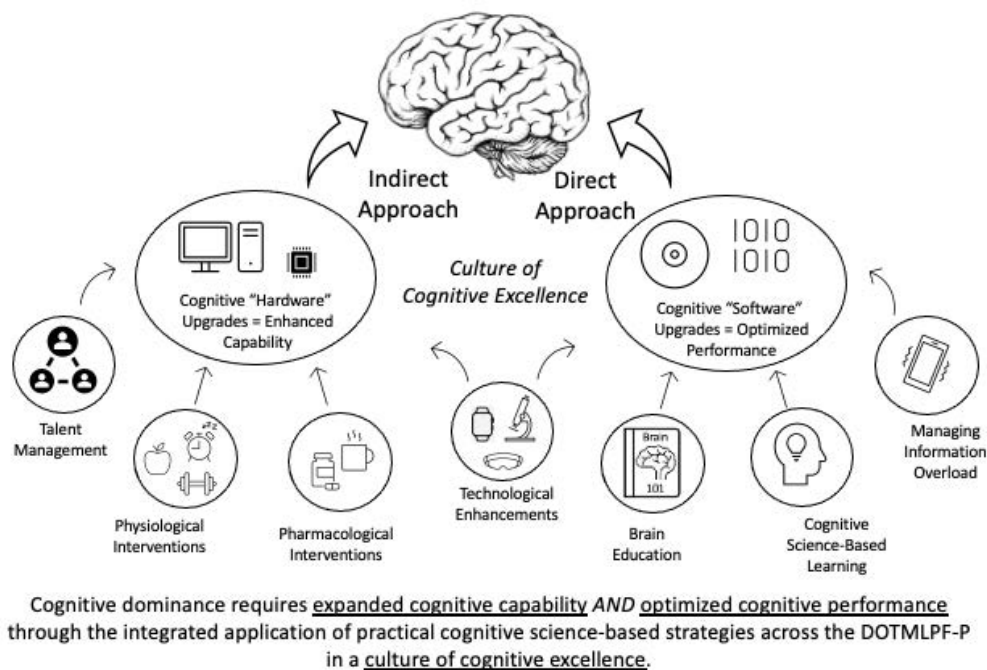


Figure 3. An Integrated Approach to Cognitive Dominance. Created by author.

¹⁴¹ Brunye et al., “A Review of US Army Research Contributing to Cognitive Enhancement in Military Contexts,” 3; Author Discussion with Dr. Wade Elmore, Army University, MS Teams, December 9, 2020.

Cognitive Hardware Upgrades – An Indirect Approach

Cognitive performance optimization implies that we are maximizing our cognitive abilities within existing limitations. Enhancement of the brain and the physiological systems necessary for cognition allows us to surpass those limitations. Using a computer analogy helps visualize cognitive enhancement. Enhancing performance requires a hardware upgrade to increase cognitive capacity and capability. The paragraphs that follow provide four ways to improve the Army's cognitive performance hardware. Software upgrades come after.

Talent Management.

“First Who... Then What.”

– Jim Collins, *Good to Great*

In his bestselling book, *Good to Great*, Jim Collins famously talks of “getting the right people on the bus, the wrong people off the bus, and the right people in the right seats” as the first step to building a winning organization.¹⁴² In the same way, identifying, recruiting, assessing, and retaining the right people may be the Army's best opportunity to increase the collective cognitive operating capacity of the force.

Studies show that cognitive ability is largely hereditary, implying that individuals are born with predispositions towards specific cognitive performance levels.¹⁴³ By combining neuroimaging technologies, statistical tools, and traditional cognitive assessments it is possible to identify traits such as neural flexibility, skill expertise, and risk-taking tendencies.¹⁴⁴ These tools provide the Army an opportunity to identify and optimize the application of individual cognitive

¹⁴² James C. Collins, *Good to Great: Why Some Companies Make the Leap...and Others Don't*, 1st ed. (New York, NY: HarperBusiness, 2001), 13.

¹⁴³ Stephen Gerras and Leonard Wong, *Changing Minds in the Army: Why It Is So Difficult and What to Do About It* (Carlisle, PA: US Army War College, October 2013), 9.

¹⁴⁴ Royal Society, *Brain Waves Module 3*, 29–30.

traits as part of an information-age career-long assessment and talent management program. Doing so requires increased resourcing for research, development, and implementation of the requisite assessments. The Army must also take a coordinated approach to solving privacy and data management challenges for the program to achieve its full potential. By fostering a culture of assessment, the Army stands to realize a significant upgrade to its “cognitive hardware” by ensuring the right people are in the right seats on the bus throughout their careers.

Physiological Interventions.

“Everybody wants to be a bodybuilder, but don’t nobody want to lift no heavy ass weight.”

– Ronnie Coleman, professional bodybuilder and eight-time Mr. Olympia.

Modern science affirms multiple ways to enhance cognitive capacity through physical training, nutrition, and sleep management. These methods are reflected in Army H2F doctrine and the “Performance Triad Strategy,” yet sleep management and nutrition guidelines lack wide acceptance across the force.¹⁴⁵ The reasons for this are varied, but may include cultural bias, misinformation, and lack of education.

Exercise. The Army espouses the psychological as well as physiological benefits of physical exercise, and studies confirm that chemicals produced in the brain during endurance exercise have neuroprotective effects and can improve learning and memory.¹⁴⁶ FM 7-22 lists improved concentration, memory, and mental agility as cognitive benefits of exercise.¹⁴⁷ Because physical fitness is already a cultural imperative in the Army, further discussion is not required.

¹⁴⁵ US Department of the Army, *The Performance Triad Guide* (Washington, DC: Government Printing Office, n.d.), accessed February 12, 2021, <https://ireland.tricare.mil/Portals/66/P3%20Guide.pdf>.

¹⁴⁶ Christopher Bergland, “Scientists Discover Why Exercise Makes You Smarter,” *Psychology Today*, October 11, 2013, accessed August 6, 2020, <http://www.psychologytoday.com/blog/the-athletes-way/201310/scientists-discover-why-exercise-makes-you-smarter>.

¹⁴⁷ US Army, FM 7-22, 13–5.

Nutrition. Similarly, the Army recognizes the importance of proper nutrition in support of “optimal physical and cognitive function.”¹⁴⁸ Even so, soldiers often associate Army nutritional concepts with physical strength, body mass, and energy levels instead of mental function or mood. For example, tactical leaders are familiar with the physical effects of dehydration, however the negative impact of mild dehydration on cognitive function is likely less commonly known outside the medical and research communities. Reinforcing nutrition education and best practices provides another opportunity to enhance the cognitive hardware of the force.

Sleep. “The key to achieving and sustaining cognitive dominance is to ensure that Soldiers sleep as much as possible – and always sleep more than the enemy.”¹⁴⁹ This quote from the WRAIR *Sleep Dispatch* makes a bold, yet simple claim about the importance of sleep for cognition. Army H2F doctrine similarly states that “[c]ognitive ability and readiness vary as direct function of the amount of sleep obtained.”¹⁵⁰ Even so, research shows that over sixty-two percent of soldiers are chronically sleep-restricted, averaging fewer than six hours sleep per night whether in garrison or deployed.¹⁵¹

Of the physiological interventions available to enhance cognitive performance, sleep management may hold the most untapped potential for Army application. Despite science that shows the benefits of sleep, Army culture perpetuates the myth of “super soldiers” who can perform for days on end without sleep. Prominent courses such as Ranger School put soldiers in sleep-deprived environments for training purposes, creating a perception that soldiers can forego sleep without ill effect. Deliberate cultural change through aggressive education and training is required for the Army to make meaningful progress on sleep management.

¹⁴⁸ Ibid., 8–1.

¹⁴⁹ US Army, *Sleep Dispatch*, 3.

¹⁵⁰ US Army, FM 7-22, 11–1.

¹⁵¹ US Army, *Sleep Dispatch*, 3.

As the Army seeks to change these behaviors, wider adoption of wearable technology could increase soldier and leader awareness while building the habits and practices required to enhance performance in the cognitive and physical domains. Studies by WRAIR and DEVCOM-SC with 10th Mountain Division soldiers show that COTS wearable technology such as watches, rings, or bands can be used to drive behavioral changes at the individual and organizational level.¹⁵² The Army should prioritize near-term investment in this area as a quick, visible means to demonstrate commitment to enhancing cognitive performance.

Pharmacological Interventions.

“Without my morning coffee I’m just like a dried-up piece of roast goat.”

– Johann Sebastian Bach, *Baroque Composer*.

Stimulant use is pervasive in the Army. At the high end, medical providers prescribe drugs such as dextroamphetamine to aviators for sustaining cognitive performance and alertness on long missions. More commonly, soldiers consume caffeine – the most-widely used drug in the world – to aid their individual performance.

While opportunities exist for further research and ethical debate on the use of cognitive performance-enhancing drugs such as modafinil (Provigil), methylphenidate (Ritalin), and various amphetamine mixes (Adderall), caffeine use is largely without controversy in Western society.¹⁵³ Even so, excessive caffeine consumption produces unwanted side effects including insomnia, anxiety, increased blood pressure, and heart palpitations.¹⁵⁴ To reliably enhance

¹⁵² Cucchiara, *Project Polar Unit Report*, 3.

¹⁵³ Paul Scharre and Lauren Fish, *Human Performance Enhancement* (Washington, DC: Center for a New American Security, 2018), 8, accessed January 19, 2021, <http://www.jstor.org/stable/resrep20411>.

¹⁵⁴ Yolanda Arrington, “The Science Behind Why You Should Stop Chugging so Many Energy Drinks,” DOD News, Defense Media Activity, December 28, 2016, accessed January 19, 2021, https://www.army.mil/article/180140/the_science_behind_why_you_should_stop_chugging_so_many_energy_drinks.

cognitive performance, a deliberate approach to stimulant use is required to achieve optimal levels of arousal without negative health consequences.

The “2B-Alert” application is one novel approach to optimizing caffeine usage that has potential for use across the Army. Currently in development by WRAIR in collaboration with the Biotechnology High Performance Computing Software Applications Institute, 2B-Alert uses machine learning, sleep history, and personal data to predict cognitive function during periods of sleep loss and develop a caffeine dosing schedule to maximize alertness during desired time windows.¹⁵⁵ Integrated with wearable technology, applications such as 2B-Alert could provide cognitive enhancement in a safe, cost-effective way at scale across the Army if fully fielded and incorporated into training.

Technological Enhancements.

“220, 221. Whatever it takes.”

– Michael Keaton as Jack Butler in *Mr. Mom*.

Multiple efforts across the Army and DOD are exploring technology-based means of cognitive enhancement. These techniques vary widely in their levels of development, methods of application, and cost but should be considered as part of the Army’s cognitive dominance strategy. Neurostimulation for performance enhancement is a promising technological approach for possible near-term Army use.

Neurostimulation research is underway by the Army, DARPA, and other agencies. Transcranial electrical stimulation (TES) enhances brain signals to mimic brain waves found during deep, restorative sleep to improve sleep quality.¹⁵⁶ Thus, use of TES in an austere, sleep-deprived environment could allow soldiers to gain more restorative effects from brief periods of

¹⁵⁵ US Army, *Sleep Dispatch*, 6; “2B-Alert Web,” Biotechnology HPC Software Applications Institute, Version 2.0, accessed January 21, 2021, <https://2b-alert-web.bhsai.org/2b-alert-web/login.xhtml>.

¹⁵⁶ Author Discussion with Dr. Tina Burke, WRAIR, MS Teams, December 10, 2020.

sleep to enhance cognition. Ongoing studies by the WRAIR Sleep Research Center, partnered with DARPA and Teledyne Scientific LLC, are assessing the effectiveness of a fieldable TES device to make the most of limited sleep periods and improve fatigue management.¹⁵⁷

Transcranial direct-current stimulation (TCDS) is another method already in use by Olympic athletes and undergoing testing within DOD. Unlike TES, TCDS works by increasing energy in the brain to promote neural activity and alter brain connections to improve motor performance and cognition. Initial testing by navy special operators shows that TCDS can improve training efficiency, and air force studies show increased vigilance and enhanced cognition under fatigue through the use of TCDS.¹⁵⁸ The DARPA Targeted Neuroplasticity Training (TNT) program is researching other methods of peripheral nerve stimulation to enhance neuroplasticity at optimal points during cognitive skills training. For example, a USARIEM study funded as part of this program is focused on understanding the influence of peripheral nerve stimulation strategies on learning of marksmanship skills.¹⁵⁹ The MASTR-E neurostimulation for soldier performance enhancement study is a similar effort to characterize COTS and laboratory-grade NIBS effects on soldier performance.¹⁶⁰

For the Army, continued integration of programs such as MASTR-E with DARPA and academic research is critical to identifying near-term technological opportunities for cognitive enhancement. The Army should also continue to pursue efforts directed at achieving brain/AI interface to keep pace with near peer competitors. However, recognizing budgetary constraints,

¹⁵⁷ US Army, *Sleep Dispatch*, 9.

¹⁵⁸ Scharre and Fish, *Human Performance Enhancement*, 9.

¹⁵⁹ US Department of Defense, “TNT Researchers Set Out to Advance Pace and Effectiveness of Cognitive Skills Training,” Defense Advanced Research Projects Agency, April 26, 2017, accessed January 21, 2021, <https://www.darpa.mil/news-events/2017-04-26>.

¹⁶⁰ Eddy, “MASTR-E BC6 Quad Chart.”

privacy concerns, and ethical limitations, those measures should remain secondary to the less controversial and readily executable lines of effort previously outlined.

Cognitive Software Upgrades – A Direct Approach

Better computer hardware does not necessarily enhance performance in its own right. Upgraded software and user knowledge are generally required to maximize the potential of new hardware. In this context, cognitive software – how we use our minds – provides a direct approach to cognitive performance enhancement. At optimal performance, cognitive software performs to the limit of the hardware’s operating capacity. As such, both direct and indirect approaches – upgraded hardware *and* software – are required to achieve the highest levels of cognitive performance.

Brain Education and Self Awareness.

“It’s only by knowing your brain that you can change it.”

– Dr. David Rock, Researcher and cofounder of the NeuroLeadership Institute.

Cognitive psychologists and neurologists agree that optimizing individual cognitive performance starts with understanding how the brain works. A basic understanding of brain function sets the stage for metacognition, or “thinking about thinking” as described in Army leadership doctrine. Army doctrine describes metacognition as important for complex problem-solving and adaptive thinking, but provides little insight on how to develop and improve metacognitive processes.¹⁶¹ Moreover, the scant writing on metacognition in Army doctrine focuses on leaders in a complex problem-solving context and disregards opportunities for broader application across the force. As observed by Andrew Steadman in his 2011 thesis on applying

¹⁶¹ US Department of the Army, Army Field Manual (FM) 6-22, *Leader Development* (Washington, DC: US Government Publishing Office, 2015), 5–2.

neuroscience to enhance cognitive performance in the Army, metacognition “has not descended to the tactical level as a desirable leader trait and training concept.”¹⁶²

Universal training and education on basic brain science and metacognition sets the foundation to achieve peak cognitive performance when complemented by an individual’s ability to observe brain processes in real time.¹⁶³ This is accomplished through mindfulness, or paying close attention to the present moment, on purpose and without judgment.¹⁶⁴ Multiple neuroscience and psychology studies show the benefits of mindfulness are significant, and include improved cognitive control and decision-making.¹⁶⁵ While recognized in Army H2F coaching, the concepts of mindfulness and mindful awareness lack widespread understanding and adoption across the force.

Brain science, metacognition, and mindful awareness must be integrated into professional military education (PME) to optimize soldier cognitive performance across the Army. The Applied Critical Thinking course offered by UFMCS offers a start point for curriculum content and could be leveraged by nascent Cognitive and Communicative Arts Improvement Center efforts to impact leader PME in the near term. Similar to some aspects of the navy’s Warrior Toughness Curriculum, these topics must also be tailored to skill and experience level, taught across all initial entry training pipelines, and customized based on career-long assessment results.

Cognitive-Science Based Learning.

“But every time you learn something new, *you change the brain.*”

– Brown, Roediger, and McDaniel in *Make it Stick: The Science of Successful Learning*.

¹⁶² Andrew Steadman, *Applying Neuroscience to Enhance Tactical Leader Cognitive Performance in Combat* (master's thesis, US Army Command and General Staff College, December 16, 2011), 24.

¹⁶³ Rock, *Your Brain at Work*, 87.

¹⁶⁴ US Army, FM 7-22, 13–3; Rock, *Your Brain at Work*, 89–90.

¹⁶⁵ Rock, *Your Brain at Work*, 89–96.

FM 7-22 defines cognitive load as “the amount of information a Soldier can memorize to learn something new.” The manual further separates cognitive load into three types: intrinsic, extraneous, and germane. Intrinsic cognitive load is the information held in short-term working memory. Extraneous cognitive load arises from how external information is presented. Finally, germane cognitive load is the goal of learning and represents an individual’s comprehension, application and coordination of information. It is essential that soldiers be able to maximize germane load, manage intrinsic load, and minimize extraneous load to achieve cognitive dominance.¹⁶⁶

Increasing germane load is accomplished through effective education and training to achieve greater long-term comprehension of durable knowledge. Training is ubiquitous in the Army, however, recent developments in cognitive science show that many of the Army’s training techniques may fail to produce durable, lasting comprehension required for recall when it is needed most. Cognitive science shows that repetitive drills, rote memorization, and re-reading are not as effective as people commonly believe.¹⁶⁷ Research in academic situations and with athletes attempting to master motor skills such as hitting a baseball reveal that changing how instruction and training is provided greatly influences quality and durability of the learning.¹⁶⁸ Adoption of cognitive science-based learning methods such as spaced practice, interleaving, and adaptive tutoring provide the Army with low-cost opportunities to maximize the effectiveness of education and training to improve cognitive performance.

¹⁶⁶ US Army, FM 7-22, 9-3-9-4.

¹⁶⁷ Peter C. Brown, Henry L. Roediger III, and Mark A. McDaniel, *Make It Stick: The Science of Successful Learning* (Cambridge, MA: The Belknap Press of Harvard University Press, 2014), 9.

¹⁶⁸ Sarma and Yoquinto, “Cramming May Help for Next-Day Exams, but for Long-Term Memory, Spacing Out Study Is What Works,” *The Washington Post*, November 30, 2020, accessed December 9, 2020, https://www.washingtonpost.com/health/memory-and-cramming-for-exams/2020/11/27/d395a838-29bd-11eb-8fa2-06e7cbb145c0_story.html

Cognitive science-based learning strategies also reduce extraneous cognitive loads to promote more effective learning. Controlling the setting, limiting distractions, and tailoring instruction to soldier learning preferences can result in more effective task mastery.¹⁶⁹ Dr. Wade Elmore, an applied cognitive and brain science expert at ArmyU, sees opportunity for adaptive tutoring technology to increase durable learning in this way.¹⁷⁰ Studies show that intelligent tutoring platforms using machine learning and computer algorithms to deliver customized instruction outperform all other methods, including human tutors.¹⁷¹ Applied across the Army, intelligent and adaptive learning technology could raise cognitive performance levels through a tailored approach to enhanced learning and skill development.

To achieve these ends, cognitive science-based learning methods and technology must be adopted throughout Army training and incorporated into Army training doctrine. Increasing the quantity and quality of durable knowledge and skills embedded in soldier long-term memory is a powerful way to optimize cognitive software for peak performance.

Managing Information Overload.

“A man with one watch knows what time it is; a man with two watches is never sure.”

– Dr. Daniel Levitin in *The Organized Mind*.

While cognitive science-based learning methods and technologies can assist with optimizing germane and extrinsic loads, managing intrinsic cognitive load requires a different approach. Considering the limits on working memory and the metabolic costs associated with switching attention from one item to the next, there are clear benefits to the efficient management of intrinsic cognitive load. Army doctrine recognizes this and asserts in *FM 7-22* that soldiers

¹⁶⁹ US Army, FM 7-22, 9–3.

¹⁷⁰ Author Discussion with Dr. Wade Elmore, Army University, MS Teams, December 9, 2020.

¹⁷¹ James A. Kulik and J.D. Fletcher, “Effectiveness of Intelligent Tutoring Systems: A Meta-Analytic Review,” *Review of Educational Research* 86, no. 1 (March 2016): 42-78, 67.

who optimize intrinsic load are able to process and complete complex tasks more effectively.¹⁷² The manual goes on to offer task simplification, learning cues, and memory cues as ways to improve intrinsic load but stops short of a more comprehensive approach.

Offsetting the effects of information overload requires a fundamental change to the Army's "always on" culture of communication and information management. The expectation that soldiers, and leaders in particular, are always available for instantaneous communication degrades intrinsic cognitive performance through frequent interruptions, distractions, and emotional arousal.¹⁷³ Education on the effects of multi-tasking, distraction, frequent interruption, and information overload as part of an Army-wide brain science education initiative is the first step in achieving change, but more work is required.

As highlighted by Dr. Daniel Levitin, prominent research by Daniel Kahneman and Amos Tversky shows that people are unable to ignore irrelevant information.¹⁷⁴ In terms of optimal complexity theory, extraneous information degrades decision-making. One novel solution described by the UK Royal Society, an independent scientific academy, suggests military and law enforcement use of cognitive load monitoring systems based on EEG biomarkers to alert individuals as they show signs of cognitive overload. This awareness would allow the user to consciously alter their state of emotional arousal and behavior to focus on the most critical problems and avert an amygdala hijack of cognitive function.¹⁷⁵ Such innovations must be accompanied by improved information and knowledge management practices to reduce the amount of mental bandwidth required to locate and filter information, thus preserving limited metabolic resources for the synthesis of information into knowledge.

¹⁷² US Army, FM 7-22, 9–3.

¹⁷³ Rock, *Your Brain at Work*, 131.

¹⁷⁴ Levitin, *The Organized Mind*, 311.

¹⁷⁵ Royal Society, *Brain Waves Module 3*, 38–39.

Information management and knowledge management are not new concepts for the Army. They are found in doctrine and used as buzzwords in conversation, often in the context of electronic files or databases. At the tactical level, however, the opportunity to apply information theory to enhance organizational effectiveness is often subsumed by urgent day-to-day tasks. Multiple Army systems of record require significant user input at the company, troop, and battery level for knowledge management purposes at echelons above brigade – requirements that ironically often prove disruptive to small-unit operations. Additional effort to streamline information and knowledge management systems is necessary to alleviate information overload and boost cognitive performance.

Effective time management provides another opportunity to reduce mental friction and boost cognitive performance. Time is a limited resource and the demands of daily operations often test leader time management skills. Despite this, time management techniques are not taught in professional military education below the senior service college level. Some leaders acquire effective time management practices through self-development, while others do not. As a result, many leaders are not aware of cognitive science-based best practices for time management and execute daily schedules that promote sub-optimal cognitive performance.

For example, company and battalion commanders holding “night court” nonjudicial punishment hearings at the end of the duty day may unknowingly make important decisions at a time of day when the cumulative effect of daily decision-making has degraded their cognitive abilities. Conversely, leaders may inadvertently spend their most productive hours answering email or executing low-level tasks instead of maximizing their cognitive resources to accomplish complex tasks and make decisions. These basic examples illustrate why time management education must be included in the Army’s cognitive dominance curriculum.

In summary, achieving cognitive dominance requires both “hardware” and “software” upgrades to increase mental capacity and performance. Expanded cognitive capacity alone does

not beget improved performance without the knowledge, skills, and external systems necessary for individuals to maximize their cognitive potential. To succeed, the Army must adopt a culture of cognitive dominance that emphasizes the importance of both direct and indirect approaches to cognitive performance enhancement and invests in the education, training, and technology required to do so.

Conclusion

“So goes the culture, so goes the company.”

– Simon Sinek, *Leaders Eat Last*

Cognitive capability is the foundation of individual and collective performance in all domains. As the US Army prepares for MDO, establishing cognitive dominance is essential to successfully compete with near-peer adversaries seeking asymmetric advantages across multiple domains. Recognizing this, the Army must establish a culture of cognitive performance optimization and enhancement to dominate and win in the information age. Cultural change requires a concerted effort across the DOTMLPF-P to incentivize cognitive excellence in a way that drives competition and innovation.

The following DOTMLPF-P recommendations provide a starting point to promote a lasting culture of cognitive dominance across the Army:

Doctrine

Additional emphasis should be placed on cognitive performance throughout Army doctrine. Writing by near-peer competitors already includes the mind as a primary domain for competition and modern warfare. Adding the cognitive domain to US Army doctrine could highlight its importance and help prioritize actions required for cognitive dominance.

Organization

The Army requires additional professionals to teach and coach soldiers and leaders on cognitive performance. Organizational changes across both the operational and the institutional army are necessary. First, the Army should increase the authorization for H2F staff to include additional cognitive enhancement specialists, sports psychologists, and cognitive science personnel. Each brigade should also be assigned a cognitive science professional commensurate with the brigade surgeon to manage cognitive performance optimization and enhancement efforts.

Second, the Army must incorporate cognitive performance professionals throughout TRADOC to promote the institutional culture change required to implement cognitive science-based learning and training practices. This will require cognitive science professionals to teach instructors, conduct curriculum reviews, and advise leadership on practical methods for enhanced cognitive outcomes. The CCAIC concept is a good start, but must be expanded to incorporate cognitive specialists into every level of institutional training and PME. Finally, additional R2 Performance Centers and expanded staffing should be considered to provide increased resources for cognitive skill training without detracting from ARD suicide prevention, sexual assault/harassment prevention, and substance abuse prevention programs.

Training

All levels of Army training should adopt cognitive science-based learning strategies to maximize long term retention of durable knowledge. Methods such as interleaving, spaced practice, and recall can be implemented immediately with little to no additional cost or time requirements. Use of intelligent and adaptive learning systems should be expedited as part of all skill level training. Cognitive performance experts in the brigade H2F teams should advise leaders on the development of small unit training strategies. Additionally, the Army should immediately leverage commercially available training opportunities through organizations such as the NeuroLeadership Institute and leading academic institutions. While limited in scale compared to PME, opportunities to attend courses such as the Massachusetts Institute of Technology's *Neuroscience for Leadership* would provide leaders with new perspectives on building a culture of individual and organizational cognitive performance enhancement.¹⁷⁶

¹⁷⁶ "Neuroscience for Leadership," *MIT Management Executive Education*, Massachusetts Institute of Technology Sloan School, accessed February 19, 2021, <https://executive.mit.edu/course/Neuroscience-for-Leadership/a056g00000URaZXAA1.html>.

Materiel

Two approaches to materiel fielding are required for cognitive dominance. The first approach is to improve the user interface of new technology to promote improved cognitive performance and prevent information overload. Army modernization efforts must be fully integrated with MHP LOE 2 – Optimize Human-System Performance and associated efforts to accomplish this. The second approach is the rapid acquisition and fielding of available and emerging COTS technology to enhance individual soldier cognitive and physical performance. Widespread acquisition of COTS wearable technology and professional coaching software could allow leaders across the Army to monitor and improve the collective performance of their soldiers. Funds should be allocated for COTS and rapidly available neurostimulation technology such as TES and TCDS to improve fatigue management and neuroplasticity. Finally, wearable cognitive load monitoring systems should be prioritized for further research and fielding to help leaders improve self-regulation skills as the Army assumes a culture of cognitive excellence.

Personnel

Adoption of an effective career-long assessment program is critical to cognitive performance enhancement efforts. This begins with recruit neuro-screening to identify individual cognitive traits, skills, and tendencies as part of an information-age talent management program. The Army must prioritize research to develop measures of complex cognitive skills and apply that research to assess, track, and develop soldiers throughout their careers. Action must be taken to address privacy concerns while allowing use of assessment data to enhance individual and collective cognitive performance. The Army must build a culture of continuous assessment and improvement by regularly measuring and rewarding strong cognitive performance. Individual and collective cognitive improvement incentives should be considered as a means to drive excellence.

Facilities

Adequate facilities must be available for use by expanded H2F performance and R2C team members focused on cognitive performance. This may include allocation of space for mind gym activities that combine physical exercise with cognitive tasks as well as classroom and administrative space for classes, coaching, and assessments.

Policy

The Army requires a senior leader champion for cognitive performance to drive cultural change and ensure implementation of all lines of effort across the DOTMLPF. The level of engagement required will likely be similar to that required for ACFT transition. As an interim step, the US Army Forces Command (FORSCOM) DCG should co-chair the Maximizing Human Potential Review Board (MHP-RB) to ensure synchronization with the operational army. The MHP-RB is currently co-chaired by the AFC DCG and TRADOC DCG, without a FORSCOM representative. Defining common cognitive performance terminology is necessary to ensure unity of action. All references to cognitive performance should avoid the use of terminology such as mental health or behavioral health to avoid any unintended stigma that may be associated with such terms. Finally, the Army must foster and lead a discussion on the ethics of cognitive performance enhancement via technological and pharmacological means. Without dialogue on this issue, the Army may miss opportunities for cognitive enhancement, or worse, find itself taking steps beyond what is acceptable to the American people.

It is only through a deliberate approach rooted in education, training, technology, and hard work that the US Army can establish a lasting culture of cognitive dominance. While it may be tempting to bet on technological advances, a more diversified and fundamental approach is required to reduce risk in a time of funding challenges and operational uncertainty. US adversaries will continue to seek an asymmetric advantage in the cognitive domain, but will have to overcome the determination, creativity, and grit of the American Soldier to achieve it.

Epilogue

Colonel Jones rubbed his eyes and looked at his computer screen. Three out of four divisions still had not submitted their reports. “Is it too much to ask to get them in on time?” he muttered. Since pushing forward with the corps TAC two days ago he had barely slept as they stayed on the move. Thankfully the transcranial electrical stimulation halo he received prior to deploying still worked. It made two hours of sleep feel like four, and that made all the difference. “How did we ever operate without these things?” he thought. Aside from dreading the rush to get the morning report to the CG, he didn’t mind the lull.

As he waited for the reports, his smart watch reminded him it was time to fuel up and caffeinate. Since he started using the 2B-Alert app a few years ago he always planned his daily rhythm and caffeine schedule to maximize his alertness at key times of the day, and he needed to be alert to compile the corps report for the CG. While he ate, Colonel Jones scanned his email for urgent items. The rules and alerts he had configured made it a quick task. One email reminded him of the news he had seen when they arrived in country. He felt himself getting agitated at the story just as his watch buzzed to notify him of his heightened level of emotional arousal. Using a mindful awareness technique taught at the battalion pre-command course, he reframed it as enemy misinformation and one of the reasons the United States had to win. That brought his focus back to the fight. A message from a peer reminded him of Afghanistan in 2014 when they were majors together. Hard to believe that was over a decade ago. Even harder to believe how much the battlefield had changed since then. Funny, the generators outside sounded exactly the same.

He looked at his watch as the caffeine did its work and the glucose from the snack fueled his brain. “Thirty minutes late?” One or two of the divisions were always late, but not all of them. He tried to send a quick email reminder and started to get the division G3s on the phone when he realized that communications were down. The G6 had stepped out for some rest, but in his

absence the team could still get through to the main command post on the tactical satellite radio. The new cognitive science-based pre-deployment comms training was the best he had ever received, and he knew he could personally put the radio into operation if needed. In minutes the RTO had the corps chief of staff on the radio at the main command post, and Colonel Jones learned that the enemy had jammed all other means of communication.

The CG would be walking in soon, but Colonel Jones made the call without hesitation. “Attention in the TAC. Jump TAC in two-zero minutes. Move to alternate location Bravo. Complete comms discipline.” The plan went into motion as rehearsed and while the team packed Colonel Jones had an insight. “If we do this right, the enemy won’t know we jumped,” he thought. “When they fire on this location we have an opportunity.” The CG agreed. Colonel Jones told the main command post to start lining up multi-domain assets to converge for the strike.

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