Developing the Super Soldier: Enhancing Military Performance

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Developing the Super Soldier: Enhancing Military Performance

Edited by William G. Braun III, Stéfanie von Hlatky,
Kim Richard Nossal

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1

Introduction

William G. Braun III, Stéfanie von Hlatky, Kim Richard Nossal

Each year, partners from academia and the military join efforts to organize the Kingston Conference on International Security (KCIS). This conference is meant to inform debate and advance knowledge in the field of security and defence by identifying priorities in military affairs and convening world-class experts to engage with a series of common questions. The partners—the Centre for International and Defence Policy at Queen's University, the Strategic Studies Institute of the U.S. Army War College, the Canadian Army Doctrine and Training Centre, and the NATO Defense College—work together to develop a multifaceted program for what has become one of the leading international security conferences in North America.

In 2017, KCIS examined an issue of growing importance in contemporary military policy: how best to advance soldier performance to maintain a competitive advantage in the contemporary battlespace. Achieving successful outcomes in operations relies not only on sound military strategy and weapons, but also depends heavily on individual service members performing effectively across multidimensional roles. In the future, senior military leaders and defence officials will strive to develop what might be called "super soldiers"—in other words, developing and enhancing critical skills, from physical and cognitive abilities, to social, cultural and ethical understandings of the environment in which soldiers operate. The conference focused on how we might anticipate individual soldier enhancements required to maintain a competitive edge at the individual level of performance, pushing existing physi-

cal, cognitive, moral, and social boundaries to ensure unity of purpose, optimal physical and cognitive performance, resilience, and ethically applied fighting spirit. We know from recent scientific work that new technology can be used to push physical limits, but pushing the physical limits of members of the armed forces can be challenging. Most importantly, the conference focused on how the armed forces can balance military effectiveness with a stated commitment to reflect society's values and norms. A focus on technology often comes at the expense of considering abilities beyond those that are physical. Policymakers need to focus on all facets of the soldier: the physical, psychological, emotional, cultural, and social. Each facet presents unique ethical and cultural challenges for consideration.

Eight papers from the conference are reproduced here. The first three chapters focus on key elements of enhancing soldier performance: social cohesion, achieving cognitive dominance, and enhancing resilience.

H. Christian Breede's chapter explores the impact of soldier performance enhancement on social cohesion, particularly the defence and security implications of human performance enhancement applied to armed forces, and outlines the policies that need to be in place to ensure that soldiers, while receiving every advantage to fight and win on the battlefield, do not sacrifice the ability to *not* be a soldier when the fighting is over. Noting that soldier enhancement already strains the connection between soldiers and society, Dr. Breede worries that human performance enhancement (HPE) initiatives may have not only negative impacts on soldiers themselves, but also on society once the "enhanced" soldier returns to society. Focusing on Canada and the United States, he examines the various options for the implementation of HPE, and concludes that a one-size-fits-all implementation policy will not suffice. Rather, it should be the mission-set that determines what form the enhancement should take.

Jean Vettel and her colleagues at the U.S. Army Research Laboratory approach human performance enhancement from a different perspective. They focus on the likely transformation of burdens on soldiers, arguing that the physical burdens will soon be replaced by an immense cognitive burden. Their chapter discusses the importance of ensuring that enhancement technology must be adapted to individual soldiers and their needs, rather than trying to adapt humans to technology. Dr. Vettel and her colleagues argue that the changes in a human being's neural networks suggests that soldier performance in the cognitive space can be optimized through repetitive task-specific training, and

propose that the key will be to measure physiological signals from the brain network of an individual soldier that will be able to determine what kind of assistance that soldier needs to enhance capacity.

Psychological resilience—the capacity of individuals to tolerate adversity, or the process of adapting to or dealing with adversity—is a key element of human performance enhancement. James P. Picano examines prominent psychological methods used to select military personnel for high-risk, high-stress, non-routine missions. He concludes that resilience is in fact a highly limited resource for military personnel, and can easily be depleted. High operational tempo or poor leadership can sap resilience, as can ignoring those factors that sustain resilience, such as adequate sleep, exercise, rest, and replenishment. Paying attention to those factors that sustain resilience is as crucial as external factors such as social support and cohesion.

When we enhance the soldier, we change the soldier; this alters the military, which in turn invariably changes the society served by the armed forces. Human performance enhancement in the military raises a number of ethical issues. It raises issues of fairness and equity: who will receive enhancements? It raises questions of health and safety: will augmented and non-augmented military personnel pose a burden on society? And it raises the possibility of social disruption: what unanticipated human consequences may enhancement produce? Three chapters examine the ethical concerns and implications of developing the super soldier.

First, C. Anthony Pfaff examines the ethical implications of the use of medical technology to alter the human body and mind to increase soldier capability. In his view, the ethical complexity of augmentation can be readily seen by asking what the purpose of augmentation is: is it for enhancement—the achievement of an *unnatural* potential—or is it for optimization—using one's full potential? Is augmentation to be embraced for offensive or for defensive purposes? In addition, enhancement has implications for the individual. In his view, for enhancements to be moral, a number of moral issues need to be addressed. For example, there need to be rules about consent: the soldier who is receiving the enhancement must consent, a deep problem in an organization built on assumptions of the limited autonomy of the soldier. Enhancement needs to grapple with the problem of necessity and proportionality. In short, as the technologies of enhancement develop, the ethics of soldier enhancement must also evolve and policymakers in particular need to pay attention to the ethical implications of this evolving technology.

Like Dr. Pfaff, Jesse Kirkpatrick argues that enhancements will inevitably change the fighter, the military, and society, pointing out, for example, that enhancement may contest the identity of the soldier, challenge the core values of the military, and alter the concept of war. However, unlike Dr. Pfaff—who views enhancement as the achievement of a naturally unattainable goal—Dr. Kirkpatrick defines enhancement as a method of self-amelioration, focusing specifically on the ethics of bio-enhancement vis-à-vis soldier virtue. While the super soldier is typically viewed as a super killer, Dr. Kirkpatrick challenges that assumption and asks us to consider enhancement in the moral sphere. That is, can soldier enhancement be used to heighten a soldier's composure or increase his/her expression of sympathy? Bio-enhancement can be viewed as a shortcut to acquiring admirable traits of character, and that achievements should be made through natural dedication and hard work. This can have an impact on the relationship between those who are enhanced and those who are not.

We often consider the responsibility soldiers and the military have to their society. Much less talked about is the responsibility society has to its military, which is exactly what James Ness and Steve Kornguth address in their chapter. As a society, we have a responsibility to ensure that soldiers are not harmed intentionally or through ignorance, and to ensure that the mental and physical wellness of its military personnel from the time of accession to a normalized old age should be preserved. One message that permeated the conference was the need to consider the soldier in his/her own right, and Drs. Ness and Kornguth echo this sentiment in their chapter: the needs of the soldier are not synonymous with the needs of the group. Like Dr. Pfaff, Drs. Ness and Kornguth also question the veracity of informed consent in the military for two main reasons. First, since future implications and consequences are not clear, it is difficult to imagine that soldiers can provide informed consent, which can only take place with knowledge and understanding of potential adverse future outcomes. Moreover, soldiers in the military are necessarily subject to higher authority, a given that is incompatible with informed consent. He also identifies three concerns about enhancement: when physical or structural modifications to healthy humans results in long-term non-reversible changes; when long-term cognitive, psychological, or behavioural changes are induced by physical modifications; and when long-term adverse consequences occur from the modifications experienced by the soldier from army directives. The ethical use of augmentation, they argue, involves a cost-benefit analysis.

Jason Dozois, a narrative director and writer with Eidos Montréal, a video gaming firm, was one of the keynote speakers at KCIS 2018. He describes himself as the conference's "video game guy," and in his keynote address he provided a perspective on soldier performance enhancement from the gaming industry. His most recent game project, "Deus Ex: Mankind Divided," gives players the opportunity for social interaction, moral decision making, and negotiation. Set in a dystopian future world, the game pivots around terrorism and transhumanism. The aim is to stop an upcoming terrorist attack, with the main character as an augmented individual. The game is unique because the gameplay is not all violence and can be won without anyone being killed. His chapter in this volume takes the analysis further, suggesting that the game highlights real-world considerations in war relating to perceptions and narratives. The "us versus them" story between the natural and augmented populations highlights the human tendency to gravitate to tribalism in times of stress. Mr. Dozois's chapter speaks to the idea of micro-tribes and the danger of having an overly niched and therefore split society. In his view, the war of power over the narrative is the war of the twenty-first century. As he put it, software simulations that are well developed, implemented, and tested will help the super soldier learn the culture of tomorrow's military, not only in mind and body, but also in spirit.

We conclude with a reflection on the future of human performance enhancement in the armed forces. Ryan Anderson, a researcher with the Centre for International and Defence Policy, argues that replacing the usual military mantra of "mission first, people always" with a new mantra, "people first, mission always," would serve to prioritize the individual in the decision-making process. He argues that the current posture on human enhancement falls short in two ways. First, it overstates the effectiveness of physical and cognitive enhancements by portraying technology as the best and only way to achieve more desirable outcomes in military operations. Continuing down this path not only misrepresents the factors that will lead to effective and sustainable outcomes in contemporary warfare, but also significantly overlooks the cultural, social, ethical, and policy implications that human performance enhancement entails.

Second, both civilian policymakers and military leaders have to consider the various ethical and practical challenges posed by the application of physical and cognitive performance enhancement. Ignoring these challenges risks not only the outcomes of military operations,

but the well-being of service members themselves. In short, we need to think more holistically about the future of human performance enhancement, the cultural, psychological, and ethical implications that need to be further explored before we fully embrace the notion of the super soldier.

2

Capability and Connection: Social Cohesion and Soldier Performance Enhancement in Canada and the United States

H. Christian Breede

Introduction

The impact of technology upon the conduct of war is a well trodden field of study to say the least. History is fertile ground for examples of human ingenuity applied to the process of killing one another. From major developments, like the adoption of the horse, the invention of the machine gun, or the development of nuclear weapons, to the more mundane, like the invention of the stirrup, technology has been and continues to be developed and applied to the act of killing.

Until recently, and with but a few exceptions, technology has been limited to the idea of producing equipment that people use. That equipment is then either replaced when damaged (or killed or wounded) or set aside when the fighting is over. However, in recent decades, the science behind the technology of improving a soldier's lot on the battlefield has moved beyond the idea of simply creating better equipment and has turned to looking at the soldiers themselves and trying to improve upon *them*, over and above the education and training they re-

ceive. In effect, increasing effort is being placed on creating soldiers whose performance exceeds natural limits. Whereas soldiers are most certainly human, this effort has become known as human performance enhancement. However, with few exceptions,[1] little policy attention has been paid to potential implications of these advances.[2]

The differences between two of Marvel comics' most popular superheroes—Captain America and Iron Man—capture the primary dichotomy facing research into improving the survivability and effectiveness of soldiers today. Where Iron Man puts on a suit of armour—essentially an exo-skeleton, Captain America has been enhanced in ways that go beyond simply donning and doffing equipment. Which way is better suited to maintaining the connection between the soldier and society? The plot lines of the comics—and now movies—provide some clues that are entirely fantasy, however, the idea of enhancing soldiers is not only the realm of science fiction, nor is it an entirely new reality.

Attempts at human performance enhancement (or HPE) have been recorded as early as the turn of the last millennium in the field of traditional Chinese medicine (TCM). According some TCM practitioners, the origin of one of the most common acupuncture points, Stomach-36 (located just below one's kneecap), is from early attempts to maximize the performance of soldiers. Stomach-36 is traditionally known as *su san li*. This term translates into "leg 3-mile" and the story goes that on marches, soldiers would either rub or even receive acupuncture on this point and would be able to march farther (apparently three additional miles!). Efforts at HPE have been around for a long time.

Today, medical research is providing opportunities to leverage developments for enhancement rather than just rehabilitation. Since the Second World War, advances in medicine have increased survival rates for wounded soldiers to the point that what once would have resulted in soldiers dying of wounds, now sees them live and in need of

1. Max Michaud-Shields, "Personal Augmentation—The Ethics and Operational Considerations of Personal Augmentation in Military Operations," *The Canadian Military Journal* 15, no. 1, (2014): 24–33; Stéfanie von Hlatky and H. Christian Breede, "Harder, Better, Faster, Stronger: The Making of the Future Soldier" (11 November 2015) at www.opencanada.org/features/harder-better-faster-stronger-making-future-soldier/; *idem*. "Putting the Human Back in Human Performance Enhancement" *Vanguard* (9 May 2017) at www.vanguardcanada.com/2017/05/09/putting-the-human-back-in-human-performance-enhancement/
2. Brad Allenby, "The Implications of Emerging Technologies for the Law of War" *Public Affairs Quarterly* 27, no. 1 (2015): 57.

rehabilitation. However, these same rehabilitative technologies can be leveraged for the enhancement of otherwise healthy soldiers too. Consider the example of Oscar "The Blade Runner" Pistorius.[3] Pistorius, a double-leg amputee with specialized prosthetics, was able to compete with runners with natural legs in the 2012 Olympic Summer Games in London.[4] This begs the question: at what point will prosthetics outperform natural limbs?

This chapter delves into the defence and security implications of this question and explores what policies need to be in place to ensure that soldiers, while receiving every advantage to fight and win on the battlefield, do not sacrifice the ability to *not* be a soldier when the fighting is over. In short, what forms of HPE are suitable and which forms should be avoided? What are the costs to not only the soldier, but society in general, if HPE is not carefully applied? I suggest that certain forms of HPE are not only suitable for the soldier, but are, in fact, desirable. However, I also contend that the distinction is not clear, nor is policy, on what forms of HPE should be developed for our soldiers within the context of maintaining the connection between the soldier and the society that they are to defend.

I begin with the assumption that soldier-enhancement has the potential to undermine an already tenuous connection between soldiers and society. Indeed, this connection is already strained.[5] Beginning

3. Brendan Burkett, Mike McNamee, and Wolfgang Potthast, "Shifting Boundaries in Sports Technology and Disability: Equal Rights or Unfair Advantages in the Case of Oscar Pistorius," *Disability & Society* 26, no. 5 (2011): 643–654.
4. Cole Morton, "London Olympics 2012: Oscar Pistorius Finally Runs in Games After 5-Year Battle" *The Telegraph* (4 August 2012) at www.telegraph.co.uk/sport/olympics/athletics/9452280/London-2012-Olympics-Oscar-Pistorius-finally-runs-in-Games-after-five-year-battle.html
5. Janja Vuga and Jelena Juvan, "Work-Family Conflict Between Two Greedy Institutions—the Family and the Military," *Current Sociology* 61, no. 7 (2013): 1058–1077; Andrew J. Bacevich, *Breach of Trust: How Americans Failed Their Soldiers and Their Country*. (New York: Metropolitan Books, 2013); Pierre Diagle, "Special Report On the Homefront: Assessing the Well-being of Canadian Military Families in the New Millennium," (Ottawa: DND/CAF Ombudsman, 2013); H. Christian Breede, "Summary and Implications: The Will to War" in *Going to War? Trends in Military Interventions* ed. Stéfanie von Hlatky and H. Christian Breede (Montréal & Kingston, McGill-Queen's University Press, 2016), 213–232; Lolita M. Burrell, Gary A. Adams, and Carl Andrew Castro, "The Impact of Military Lifestyle Demands on Well-Being, Army, and Family Outcomes," *Armed Forces & Society* 33, no. 1 (2006): 43–58; and Mady W. Segal, "The Military and the Family as Greedy Institutions," *Armed Forces and Society* 13, no. 1 (1986): 9–38.

with a summary of what has been done to date on the topic of human performance enhancement, I present a theoretical framework that will define key concepts and present cohesive and comprehensive typologies of soldier-boosting initiatives. Using a systems analysis method, this chapter will define and discuss several *capability zones* for different degrees of enhancement implementation, illustrating both the costs and benefits as well as the trade-offs inherent in boosting performance. The intent is two-fold. First, I hope to raise awareness of this emerging, yet important issue and second, provide some initial guidance for both policy and future research regarding the best way to balance short-term battlefield success with long-term societal concerns, and to do so in an informed and well-considered manner.

Literature

Recent scientific advancements and technological developments are starting to take elements from science fiction and make them a reality. The exoskeletons of Robert Heinlein's *Starship Troopers* (1959) are now being actively pursued in the United States by the Defense Advanced Research Projects Agency (DARPA).[6] More controversial, however, are the advancements in biotechnology that are starting to see the genetically modified soldiers of Richard Morgan's *Black Man* (2007) realized.[7]

Although different in many ways, exoskeletons and bioengineering form two ends of the spectrum of human performance enhancement. The proposed research puzzle examines how the implementation of HPE affects the soldier-society connection and how to leverage science and technology (S&T) innovations despite major ethical, moral, political, and legal constraints. Put simply, the science and technology of HPE has gotten ahead of HPE policy design: indeed, there is no policy to date.[8] In light of recent research that examines the intersection of war, technology, and what it means to be a part of society,[9] this project seeks

6. Peijiang Yuan, Tianmiao Wang, Fucun Ma, and Maozhen Gong, "Key Technologies and Prospects of Individual Combat Exoskeleton," *Advances in Intelligent Systems and Computing*, no. 214 (2014): 305–316.
7. M. E. Abalaka and F. O Okafor, "The Blend between Biology and Genetic Engineering—Overview of Human Strides in Molecular Genetics," *Innovative Journal of Medical and Health Science* 2, no. 1, (2012): 25–30.
8. Allenby, 57; von Hlatky and Breede, "Putting the Human Back in Human Performance Enhancement."
9. Christopher Coker, *Warrior Geeks: How 21st Century Technology is Changing the Way We Fight and Think About War* (London: Hurst Publishing, 2013); idem., "The Collision of

to continue the conversation by fully examining the impacts of HPE upon how soldiers and society connect and what guidance to policy can be introduced to retain that connection, which is crucial in modern democratic states, such as Canada.

Studies have touched on the broader social implications of enhancement, ultimately coming down against the idea as a whole[10] or they have simply explored the S&T behind performance enhancement whether biological[11] or mechanical.[12] However, consistent with the argument that existing S&T is being leveraged for new military applications,[13] this research project seeks to explore how the existing field of enhancement and rehabilitative S&T can be responsibly applied within militaries such as the Canadian Armed Forces.

Such policy-oriented work has yet to be done. Previous research, which has blended the science with the sociology, such as Brad Allenby's 2015 article for *Public Affairs Quarterly*, although rightly raising the alarm, makes few concrete recommendations beyond revisiting the

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Modern and Post-Modern War" in *The Oxford Handbook of War: Oxford Handbooks in Politics & International Relations,* ed. Julian Lindely-French and Yves Boyer (Oxford: Oxford University Press, 2012), 57–68; and idem., *The Warrior Ethos: Military Culture and the War on Terror* (London: Routledge, 2007).

10. Jonathan Pugh, Guy Kahane, and Julian Savulescu, "Cohen's Conservatism and Human Enhancement," *Journal of Ethics* 17 (2013): 331–354; Thomas Douglas, "Human Enhancement and Supra-personal Moral Status," *Philosophy Study*, no. 162 (2013): 473–497; Michael Gross, "Military Medical Ethics: A Review of the Literature and a Call to Arms," *Cambridge Quarterly of Healthcare Ethics* 22, no. 1 (January 2013): 92–109; Cynthia Forlini, Wayne Hall, Bruce Maxwell, Simon M. Outram, Peter B. Reiner, Demitris Repantis, Maartje Schermer, and Eric Racine, "Navigating the Enhancement Landscape: Ethical Issues in Research on Cognitive Enhancers for Healthy Individuals," *EMBO Reports* 14, no. 2 (2013): 123–127; and Kate Fox, "Ethical Considerations for Engineers Working in Cybernetic Implants," Unpublished Manuscript, 2013.
11. Kimberly Urban and Wen-Juo Gao, "Performance Enhancement at the Cost of Potential Brain Plasticity: Neural Ramifications of Nootropic in the Healthy Developing Brain," *Frontiers in Systems Neuroscience,* no. 8 (May 2014): 1–10; Irene Tracy and Rod Flower, "The Warrior in the Machine: Neuroscience Goes to War," *Nature Reviews Neuroscience* (2012): 1–10; and Abalaka and Okafor.
12. Yuan et al., Jason Gibson, James McKee, Gregory Freihofer, Seetha Raghaven, and Jihua Guo, "Enhancement in Ballistic Performance Composite Hard Armor Through Carbon Nanotubes," *International Journal of Smart and Nano Materials* 4, no. 4 (January 2014): 212–228; and Daniel Bertrand, "Implementation of the Soldier Systems Technology Roadmap: Two Years Down the Road," *Canadian Textile Journal* 130, no. 4 (2013): 38–44.
13. Michael C. Horowitz, "Coming Next in Military Tech," *Bulletin of Atomic Scientists* 70, no. 1 (2014): 54–62.

laws of war.[14] This study makes a unique contribution by examining ways in which HPE could be responsibly implemented, enhancing military capability while still maintaining the critical connection between the soldier and society.

Karl Friedl, former director of the United States Army Medical Research and Materiel Command's Telemedicine and Advanced Technology Research Center, and now a researcher at the Oak Ridge Institute for Science and Education, has proposed a helpful framework through which to analyze soldier enhancements. Specifically, this study accepts his distinction between HPE, human performance optimization (HPO) and human-systems integration (HSI).[15] More recently, the United States Army's Natick Soldier Systems Center has favoured the term Personal Augmentation (PA) which covers four areas: the cognitive, the physiomechanical, the sensorial, and the metabolic.[16] Regardless, the distinction between optimization and enhancement is an important one and forms the foundation of the theoretical framework of this study, which will be more fully developed in the next section.

Focusing on the concept of enhancement, Friedl defines it as the technology that will "create superhuman capabilities that go beyond the normal biological range through the modification of human form and function."[17] A recent report by Lin, Mehlman, and Abney have defined enhancement more narrowly. Lin et al. define it as "a medical or biological intervention to the body"[18] for the purposes beyond simply improving health. According to this definition, vaccines and even drugs that improve cognitive function are excluded. Again, this distinction is important as it helps focus the study upon what is truly disruptive in terms of enhancing soldier performance beyond the limits that not only nature, but society as well, have thus far accepted.

Theoretical Framework

This chapter builds on the work of Lin et al. and Friedl, including HPO

14. Allenby, 63.
15. Karl E. Friedl, "Overview of the HFM-181 Symposium Programme: Medical Technology Repurposed to Enhance Human Performance." Paper presented at the RTO "Human Factors and Medicine Symposium," Sofia, Bulgaria, 5–7 October 2009.
16. Michaud-Shields, 25.
17. Friedl.
18. Patrick Lin, Maxwell J. Mehlman, and Keith Abney, "Enhanced Warfighters: Risk, Ethics, and Policy," (New York City: The Greenwell Foundation, 2013), 17.

and HSI as part of a comprehensive set of enhancements that impact upon the soldier as a system. Indeed, these can all have a deleterious effect upon the inclusion of soldiers in society upon their return from combat. For this chapter, HPO is defined as the optimization of human performance as the "strategies to sustain performance in the face of operational stressors that degrade it."[19] In essence, human performance optimization seeks to leverage the existing capabilities of the human body and maximize them without augmenting them in some artificial way. Training and education is a form of HPO and recent initiatives in both Canada and the United States have promoted the value of getting enough sleep, eating right, and exercise as ways in which to optimize human performance.[20]

Friedl further develops his taxonomy of human performance with what he calls human-systems integration. This category, as the name implies, focuses on the equipment that soldiers use and how those soldiers interact with that equipment. Friedl suggests that not only are the ways in which people interface with technology changing, but the very technology is starting to surpass a person's ability to control it. For example, modern aircraft design is capable of creating an airframe that can maneuver in a way that no human pilot could withstand.[21] A more common example, albeit in reverse, would be the typewriter and the rationale behind the placement of the keys. The now-standard "qwerty" keyboard (so named for the left-most six letters that appear just above the "home row") was designed to slow typists so as not to jam the arms of the typewriter keys. The typist's performance was purposely hobbled.

Technology has now advanced to the point that typing does not have such an upper mechanical limit, yet the qwerty keyboard persists. The capabilities of the technology and the capabilities of the operator do not always line up. Throughout most of history, the asymmetry tended to favour people; today, the asymmetry is reversed. The typewriter is being held back by the typists.

The example of the typewriter is instructive as it further illuminates the importance of broader cultural and indeed societal contexts in terms of how disruptive new technology can be. Allenby skillfully presents

19. Friedl.
20. Stephen Cooper, "How to Safely Enhance Your Performance," *Flight Comment*, no. 4 (2013): 8.
21. Friedl.

the impact of the railroad upon nineteenth century conflict and argues that this only occurred in light of other changes across society as well as other technological innovations—such as accurate timekeeping and the telegraph—that enabled the railroad's impact to be further increased. The same is true for the developments in science and technology we are seeing today—what Allenby calls the "Five Horsemen of emerging technologies." For Allenby, the question of soldier enhancement is part of a larger trend in the disruptive advancement of nanotechnology, biotechnology, robots, information and communications technology, and studies in cognition.[22]

Because of this broader social context, HPE may have long-lasting negative impacts upon the lives of the soldiers who have been "enhanced." However, such enhancements are for increasing the likelihood of survival and fighting effectiveness on the battlefield, which are by definition tactical concerns. How well a soldier fights is certainly a factor in the success of a given battle, campaign, or even a war. However, other factors play into the calculus of success. Although an individual soldier's survival on the battlefield has little to do with the campaign plan of that particular theatre of operations or the strategy of the government that placed that soldier in harm's way, as an aggregate, it most certainly does. However, that same soldier still needs to be able to return to society. To be sure, advantage is gained, but at what risk?

Given the contemporary security environment, small unit actions or what the Canadian Armed Forces (CAF) refers to as "adapted dispersed operations,"[23] in which small groupings of soldiers operate independently from one another over large distances, is seen as the norm. HPE can have a significant impact upon the success of this type of mission. The pressure to enhance the performance of soldiers will only increase in the coming decades; therefore, it is essential to test our proposed model given the salient policy implications.

This chapter frames the puzzle of human performance enhancement in two ways. First, rather than eschew the idea of enhanced soldiers outright on (often-times justified) ethical or moral grounds,[24] it seeks to engage with the idea of enhancing soldiers. Second, it examines what

22. Allenby, 54.
23. Andrew B. Godefroy. *Land Operations 2021: Adaptive Dispersed Operations—The Force Employment Concept for Canada's Army of Tomorrow* (Kingston: Directorate of Land Concepts and Design, 2007).
24. Jai Galliott and Mianna Lotz, *Supersoldiers: The Ethical, Legal, and Social Implications* (London: Routledge, 2015).

the societal implications are for civil-military relations following the enhancement of soldiers. Put simply, once the war is over, how do we—as a society—ensure our soldiers can stop being soldiers while still being afforded the real capability boosts that are needed to survive in the contemporary operating environment?

Several assumptions need to be made clear in order to properly carve out exactly how this chapter is addressing the issue of HPE. First, what is HPE? Although briefly touched on above, HPE deserves some sustained engagement as it is often found alongside related concepts like human performance optimization (HPO) and human system integration (HSI).[25]

The final category offered by Friedl and the subject of this research project is the category of human performance enhancement (HPE). For Friedl, methods and technologies related to HPE "create superhuman capabilities that go beyond the normal biological range through the modification of human form and function."[26] Interestingly—and problematically as well—this is where science and technology have another acute dual-use problem. As demonstrated by the example of Pistorius described earlier, rehabilitative technologies such as prosthetics can also be leveraged for enhancement. The technology exists, but the long-term repercussions of their uses in non-rehabilitative scenarios—such as in the enhancement of soldiers—are under-explored. Frequently eschewed on moral, ethical, and legal grounds, the possibility of HPE being used remains and discussion is still needed on what do with the science and technology and how best to implement it to ensure that soldiers have every advantage in combat.

Friedl makes an interesting remark in his overview of the field, suggesting that "HPE studies present special ethical problems because adverse effects may only emerge from long term study…to weigh against the possible discovery of tactical advantage."[27] This statement deserves engagement and emphasis. HPE—and this chapter argues certain forms of HPE—can have long-lasting negative impact upon the lives of the soldiers who have been "enhanced." Conversely, such enhancements are for increasing the likelihood of survival and fighting effectiveness on the battlefield which are by definition tactical concerns.

That being said, this consideration does not diminish the salience of

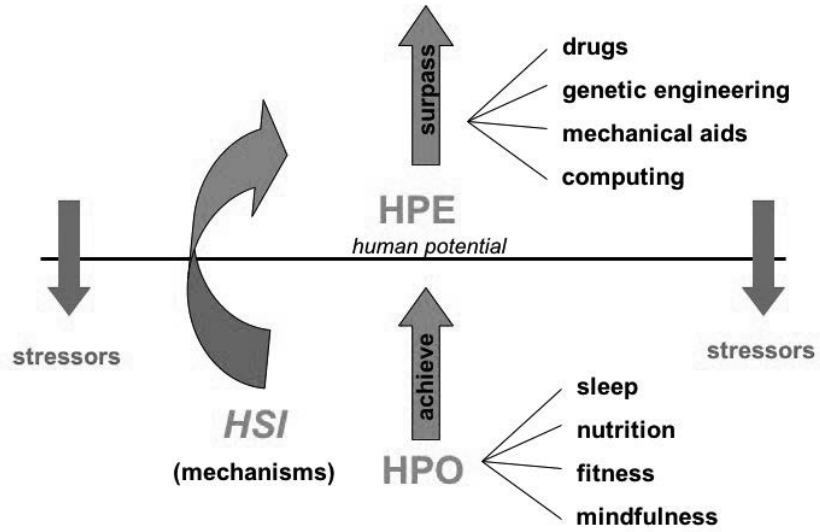
25. Friedl.
26. Ibid.
27. Ibid.

the problem. Indeed, given the contemporary security environment, small unit actions or what the Canadian Armed Forces refers to as "adapted dispersed operations" in which small groupings of soldiers operate independently from one another over large distances, is seen as the norm. HPE can have a significant impact upon the success of a mission. Tactical outcomes will have increased influence on strategic ones.

The three categories of optimization, integration, and enhancement offered by Friedl are informative and an excellent point of departure for this project. Unlike Friedl, this project sees the category of human-systems integration (HSI) as part of HPE and HPO. In fact, HSI is at times the mechanism through which both HPO and HPE are realized. For that reason, this project suggests a slightly refined taxonomy. Figure 2.1 presents a proposed map of sorts for human performance.

In this chapter, I propose two categories of HPE: (1) invasive and (2) non-invasive. This subdivision is helpful in framing the exploration and assessment of what technologies currently exist and what technologies are emerging in terms of how they can influence the connection between the soldier and the citizen. For this project, invasive HPE are

Figure 2.1 The Human Performance Map



Source: Author's compilation.

those enhancements which cannot be removed after application. This would include such technologies as performance-enhancing drugs, embedded computers, and prosthetics, to name but a few. Non-invasive, on the other hand, includes wearable computers, exoskeletons, and other paraphernalia. In short, invasive enhancements are permanent or have permanent effects while non-invasive enhancements are—by and large—temporary.

Based on this new taxonomy, the mechanistic role of human-systems integration is clear. HSI not only involves non-invasive technologies like exoskeletons, but also includes more invasive (and therefore permanent) technologies like embedded computing devices. It is this very permanence that is of greatest concern for this project. Should an enhancement be irreversible, the ability for those enhanced soldiers to integrate back into society once they cease to be soldiers is further jeopardized.

Method

This chapter employs a form of systems analysis,[28] not only to assess the various qualitative costs and benefits surrounding the issue of HPE for soldiers, but also to visualize the trade-offs that will need to be considered as part of the implementation decision. Four scenarios are examined: (1) a status quo scenario which eschews HPE implementation, (2) a limited implementation to include only optimization strategies for soldiers, (3) a non-invasive implementation policy and finally, (4) a scenario in which the full range of enhancements are employed. By using a spider chart,[29] capability zones are visualized for all four scenarios that can then be compared in order to assess the specific trade-offs in cohesion, capability, leverage, and cost.

As this is a new area of policy analysis, precise metrics are hard to come by and this project represents a first step towards a more comprehensive assessment. With this in mind, measures of cost, cohesion, capability, and leverage are broad estimates only. For example, one of the more developed non-invasive systems that is being considered is the Tactical Assault Light Operator Suit (TALOS) for which per unit costs are as yet unknown. However, research and development costs

28. Richard L. Kugler, *Policy Analysis in National Security Affairs: New Methods for a New Era* (Washington: National Defense University Press, 2006), 234–35.
29. Ibid., 235.

have been earmarked for this project to the tune of US$80 million.[30] In short, such enhancements are expensive. Of the four factors, cost is the only negative factor. While cohesion, leverage, and capability can be thought of as net benefits, the factor of cost needs to be taken as a negative. In this case, the lower the cost, the better and for visualization purposes, a value near the hub of the spider diagram represents a high cost while as the value moves farther out, this represents a lowering of financial cost.

The capability increases are equally hard to quantify, but also rather clear in that enhancements will impact across the full range of military capabilities. Enhancements will improve a soldier's individual ability to acquire and engage targets, and survive on the modern battlefield. Moreover, enhancements will enable soldiers to increase dispersion—effectively cover larger distances on a soldier-for-soldier basis—as well as persistence—meaning they can stay on the battlefield for longer periods of time. As enhancement increases, so will capability.

The concept of leverage speaks to the idea that as technologies are developed, such as the exoskeletons that comprise TALOS, such technologies will be able to be leveraged for other uses—either within the military or for society in general. The compact-disc random operating memory (CD-ROM) is but one example of such leveraging of technology. Developed by the US military as a way in which to store large amounts of data in an easily accessible format for cruise-missile guidance systems, the CD-ROM quickly found its way into civilian society as a way in which to store a variety of data from music, to video games, to photos and became commonplace in the 1990s. Similar leverage will be likely with soldier-enhancements. Indeed, the bio-hacking community in many respects may be leading the way on several enhancement fronts.

The final factor is cohesion, a critical guiding factor since the cohesion of soldiers with their society is seen as both vulnerable and important. Soldiers, who are dislocated from their communities and feel separate from their society and are seen as such by foreign policy decision makers, create pressures on the state that can have adverse effects. Put simply, all soldiers will (hopefully) face the prospect of transitioning to civilian life at some point and how they have been enhanced (or not)

30. Jeremy Diamond and Barbara Starr, "U.S. Military On Its Way to Getting Its Iron Man," *CNN Politics*, (6 October 2015) at www.cnn.com/2015/10/06/politics/special-operations-iron-man-talos-suit/index.html?sr=fb100615special-operations-iron-man-talos-suit0648PMVODtop&linkId=17729930

will directly impact the success of that transition. Indeed, as the Ombudsman for the Canadian Armed Forces indicated in 2013, soldiers are faced with three major stressors on transition to include mobility (frequent moves and postings), separation (from loved ones while deployed), and risk (the assumption of unlimited liability), which all combine to strain a soldier's connection to society.[31] To this we propose to add a fourth—enhancement.

However, before conducting the systems analysis for the various enhancement options facing militaries, the existing policies within Canada and the United States were surveyed. The results of this survey begin the findings for this project.

Findings and Discussion

The State of the Policy in Canada and the United States

Enhancement policy for Canada and the United States are varied in both depth and breadth. In conducting this survey, we were able to find several policy statements from the United States Department of Defense, as well as some documents from the Canadian Department of National Defence.

Within the United States security community, policy documents appear to take the distinction between optimization and enhancement seriously. Despite the multitude of organizations and agencies devoted to the study of how best to boost soldier performance, most documents focused on optimization to include education[32] and those documents that make reference to enhancement simply do so either vaguely or in terms of on-going research and development.[33] Optimization, not en-

31. Pierre Daigle, *On the Homefront: Assessing the Well-being of Canadian Military Families in the New Millennium* (Ottawa: National Defence and Canadian Forces Ombudsman, 2013), http://publications.gc.ca/collections/collection_2013/dn-nd/D74-15-2013-eng.pdf
32. United States Army Combined Arms Center, "The Human Dimension White Paper: A Framework for Optimizing Human Performance." 9 October 2014, at usacac.army.mil/sites/default/files/documents/cact/HumanDimensionWhitePaper.pdf; United States Army Training and Doctrine Command, "The U.S. Army Learning Concept" 20 January 2011, at www.tradoc.army.mil/tpubs/pams/tp525-8-2.pdf; and United States Army "The United States Army's Ready and Resilient Campaign," (1 March 2013), at csf2.army.mil/supportdocs/r2ccampaignplan.pdf
33. United States Army Training and Doctrine Command, "The U.S. Army Operating Concept: Win in a Complex World 2020–2040," (21 October 2014), at www.tradoc.army.mil/tpubs/pams/tp525-3-1.pdf

hancement, is what is being fielded at this time.

Canada's Directorate of Land Concepts and Design (DLCD) and Defence Research and Development Canada (DRDC) have started looking at performance enhancement to some extent. DLCD's focus is on how a future fight would unfold and how technology could shape those outcomes. Specifically, the report seems to propose general ways in which non-invasive enhancements like wearable computers will enhance the warfighter. However, the document stops short of specifics and is very much a forecast. Indeed, wearable "tech" has had only limited implementation in recent years. What the document does clearly articulate is a need for enhanced capability due to adaptive dispersed operations (ADO). ADO suggests that soldiers will be operating in smaller groups over larger distances—effectively doing more with less.[34] This scenario would place demands on the soldier's ability to communicate and move on modern battlespace and enhancements—whether non-invasive or invasive—would have a clear role here.

A more recent DRDC report took a more focused look at enhancement but again stopped short of implementation policy. Rather, the document was focused on how DRDC—specifically the Toronto lab within DRDC—could improve its own internal processes to better address research into the field of HPE. In short, the document was an internally focused examination of the S&T of HPE and offered little in the way of implications for the warfighter.[35] Like the United States, the focus of implementation is upon optimization, not enhancement, despite continued research and development.

This brief review illustrates a major trend in the way in which enhancement is being addressed in both Canada and the United States. In both cases, enhancement is being forecasted as a way in which to address what is referred to as the future security environment. Whether at TRADOC or DRDC, these organizations are examining enhancement in the context of what soldiers may be required to do. With this in mind, we propose a series of scenarios of our own, but more specifically focused on how enhancement would be implemented.

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34. Godefroy, 24.
35. Peter Tikuisis, Fred Buick, Andrea Hawton, Justin Hollands, Allan Keefe, Peter Kwantes, David R. Mandel, Donna Pickering, Stergios Stergiopoulos, Megan Thompson, and Afzal Upal, *Futuristic Outlook on Human Centric S&T* (Toronto: Defence Research and Development Canada, 2013).

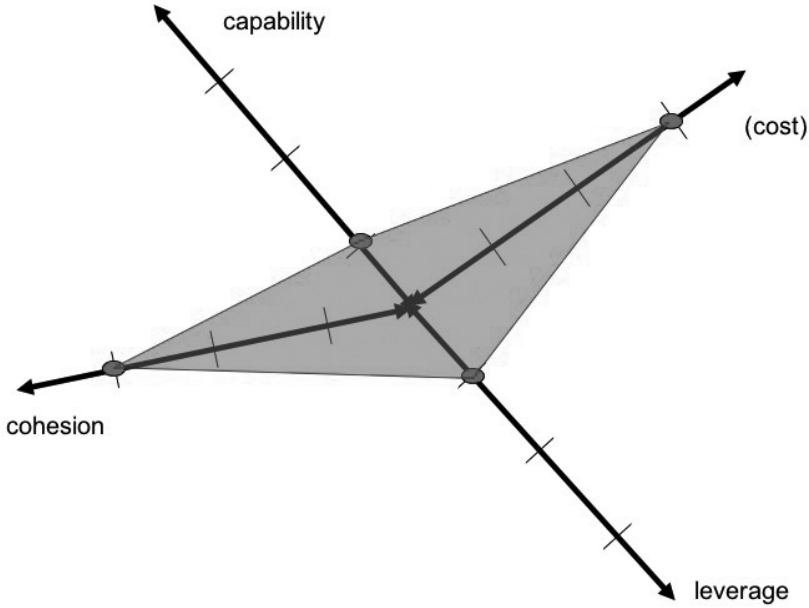
Capability Zones for HPE

What is clear from the review of the various polices developed thus far within the United States and Canada is that these policies do not address the trade-off between implementation and cohesion. Put simply, the existing policies do not address how implementation of enhancement will impact soldiers' ability to remain a part of their society while serving and subsequently transitioning to civilian life after serving.

In order to more fully explore this gap, systems analysis[36] was employed as described earlier and a series of spiderweb charts were created that capture four different implementation scenarios (Figures 2.2–2.5). Figure 2.2 captures the capability space of a status quo scenario. This means that policy goes unchanged and soldiers remain only

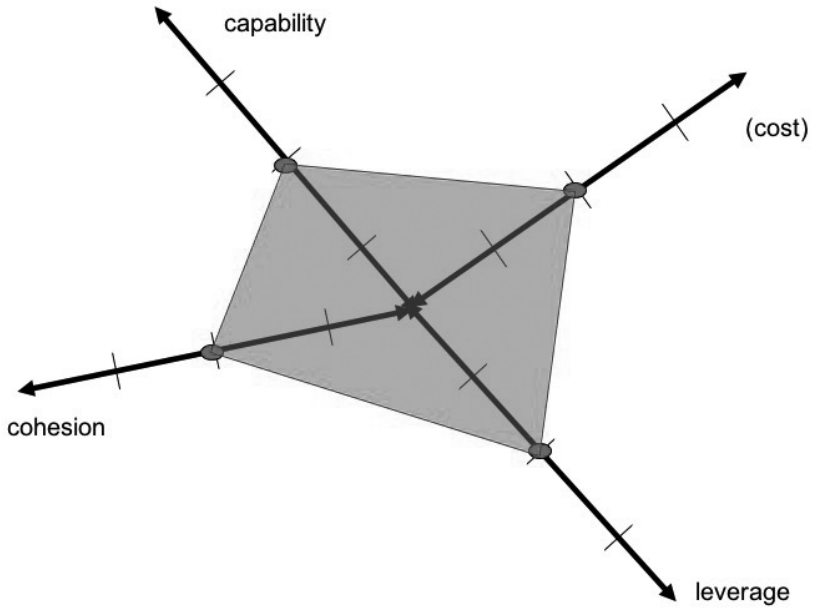
36. Kugler, *Policy Analysis in National Security Affairs*, 234–35.

Figure 2.2 Status Quo



Source: Author's compilation.

Figure 2.3 Optimize

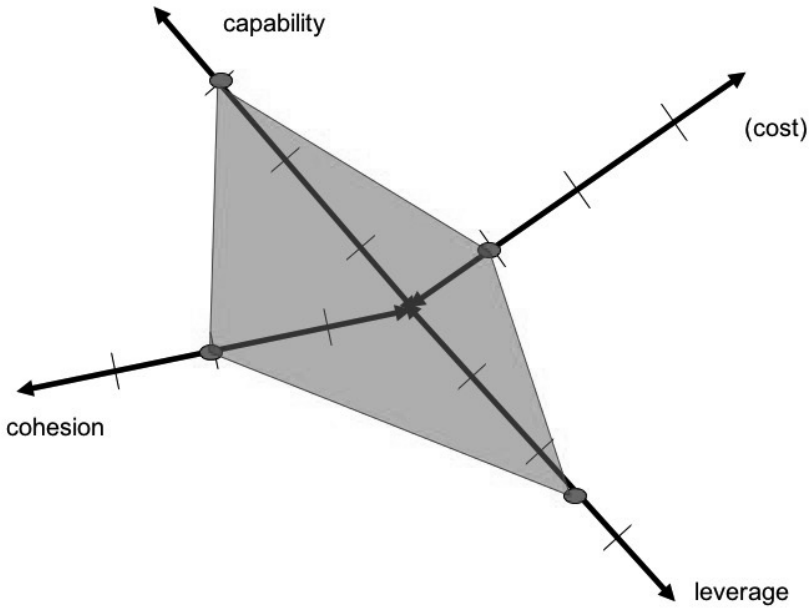


Source: Author's compilation.

minimally optimized. In this scenario, costs are minimal and the cohesion is maintained. However, technology leverage is also minimal and the soldier enjoys no additional capability increase beyond what is afforded by traditional technologies. In this scenario, cohesion is the privileged factor.

Figure 2.3 represents a scenario in which optimization technologies are fully implemented. This—in keeping with the framework for this project—sees performance optimized but not exceeding human potential. In this scenario, the capability space is characterized by moderate costs, a slight drop in cohesion, some technological leverage and a modest boost in capability. A scenario in which non-invasive enhancement is implemented is presented in Figure 2.4. In this scenario, enhancements such as wearable computers and exo-skeletons are fielded that give soldiers performance in excess of human potential. In this

Figure 2.4 Non-Invasive



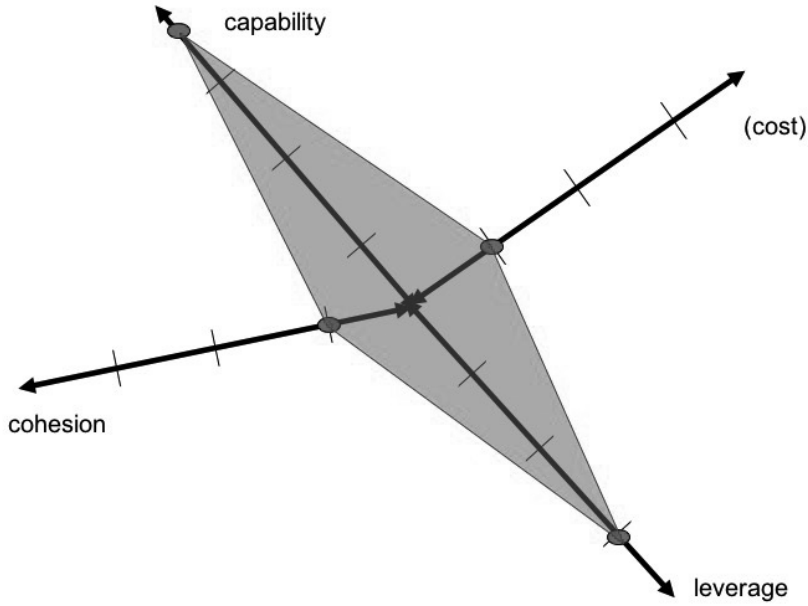
Source: Author's compilation.

scenario, non-invasive enhancements have high costs, but do provide a substantial boost in capability. Moreover, these enhancements offer significant technological leverage. Most importantly, cohesion is rated as moderate and is no different from optimization.

Figure 2.5 represents the capability space associated with full implementation of invasive enhancements to include the full range of biological, cognitive, and physiological enhancements. Where non-invasive enhancement was the proverbial Iron Man suit, invasive enhancement is Captain America. In this scenario, costs, capability, and technological leverage are all assessed as high; however, cohesion is very low as invasively enhanced soldiers are no longer able to fully reintegrate into a society that is largely unenhanced.

Figure 2.6 represents a side-by-side comparison of both the extreme capability spaces and the moderate capability spaces. The extreme case (on the right) is the contrast between doing nothing (as illustrated in

Figure 2.5 Invasive



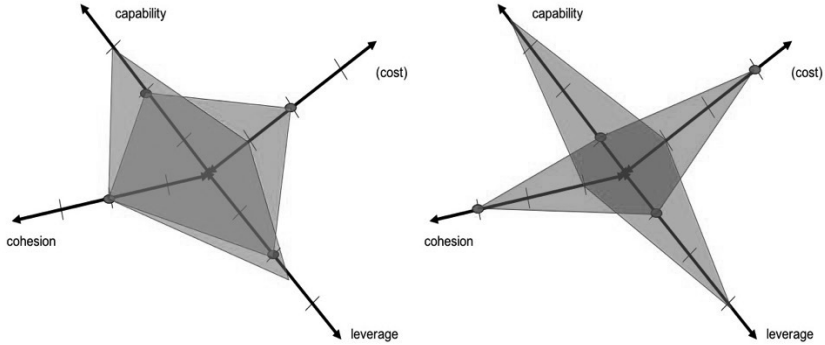
Source: Author's compilation.

Figure 2.2) and adopting a fully invasive enhancement policy (Figure 2.5). On the left-hand side is the moderate case where both the optimization (Figure 2.3) and non-invasive enhancement (Figure 2.4) are contrasted. Particularly in the extreme case there is a clear trade-off between cohesion and capability which—when compared to the moderate case—is somewhat tempered.

Clearly, how enhancement policy is implemented will alter the cohesion, cost, leverage, and capability of the soldier and the technology. However, whether optimization or enhancement is pursued and what form the enhancement takes is an important policy decision. It goes beyond simply the availability and viability of augmentation S&T.

One obvious assumption of the analysis thus far is that of a static society. In order to fully understand the impact of technology, one needs to understand as well how that technology also changes society to in-

Figure 2.6 Focused Comparison

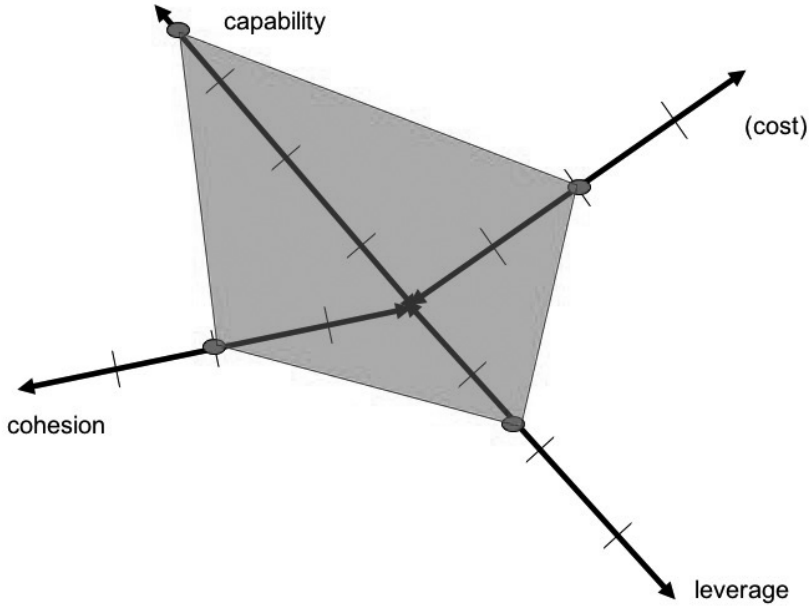


Source: Author's compilation.

clude attitudes, perceptions, and even economics.[37] With this in mind, taking the most extreme option of the implementation of invasive soldier enhancement (Figure 2.5) and reapplying it against a society where augmentation is either already occurring or at least accepted, we can forecast that the capability space changes again and in fact begins to resemble those of the more moderate options (Figures 2.3 and 2.4). Figure 2.7 represents this application. Such a scenario—where personal augmentation is both accepted and widely pursued—is not just a possibility, relegated to the pages of science fiction. Rather, several philosophers—in what they call transhumanism—argue that as technology advances, such concepts as invasive human enhancement will in fact become commonplace[38] and is gaining traction. This shift suggests that over time the enhancement of soldiers may become less financially costly and more socially acceptable—thereby reducing the risk of eroded cohesion.

37. Allenby; and Morton Winston and Ralph Edelbach, *Society, Ethics & Technology* (Boston: Wadsworth, 2011).
38. Max More, "H+: True Transhumanism," Metanexus.net 9 February 2009) at www.metanexus.net/print/essay/h-true-transhumanism; Nayef Al-Rodhan, "Future Wars: Reshaping the Ethics and Norms of War," *The Wilson Quarterly* 39, no. 3 (2017): 2; idem., *The Politics of Emerging Strategic Technologies: Implications for Geopolitics, Human Enhancement and Human Destiny* (New York: Palgrave, 2011); Teemu Arina, Olli Sovijärvi, and Jaakko Halmetoja, *Biohacker's Handbook*, (2017) at biohackingbook.com/

Figure 2.7 Invasive Tomorrow



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Conclusion

Accepting the assumption that the connection between soldiers and their society is important, and after examining the various capability spaces offered by the implementation options for HPE, it is clear that a one-size-fits-all implementation policy is likely not sufficient. Rather, the demands of the future security environment and, more specifically, the particular mission-set that soldiers may find themselves in from time to time should play a role in what form the enhancement should take.

Optimization would seem to have the least amount of soldier-society risk associated with it and would be a suitable choice for broad-based implementation today and in many respects, this is what many militaries—Canada and the United States included—are pursuing. Enhancement begins to erode or at least challenge the cohesion but the capabil-

ity boost offered by such implementation cannot be ignored and under certain situations, may off-set the risk to cohesion. Especially with invasive enhancements, such implementation should be carefully managed, focused on those who need it the most, and who face missions where failure would have substantial strategic consequences. Implementation of non-invasive enhancements (and in extreme circumstances invasive enhancement) would be more suited to Special Operations Forces, as but one example.

That being said, over time the risks to social cohesion may reduce as augmentation gains more and more acceptance to the point where potential recruits coming to the military may be doing so *already* enhanced, forcing militaries to address this question from the opposite direction. Rather than question whether to enhance or not, militaries may need to figure out if they want to retain certain enhancements that recruits already have.

Implementation policy for both optimization and enhancement of human performance requires a holistic appreciation of the trade-offs in terms of capability and leverage on the one hand, and the cohesion and cost on the on the other. Despite the real and relevant ethical challenges posed by enhancement, the capability boost offered by such enhancements coupled with an increased desire for Western militaries to do more with less—both in terms of financial costs and in terms of the lives of soldiers—demands that both enhancement and optimization be considered together. That, and the fact that society's changes alongside advances in technology has quickly moved this debate from the pages of a science fiction novel to that of an emerging scholarly debate. It now needs to make the next leap: to policy discussion.

3

The Quantified Soldier: Using Brain Networks to Enhance Future Operations[1]

Jean M. Vettel, Amar R. Marathe, Evan C. Carter, Gregory M. Gremillion, Jason S. Metcalfe, and Javier O. Garcia

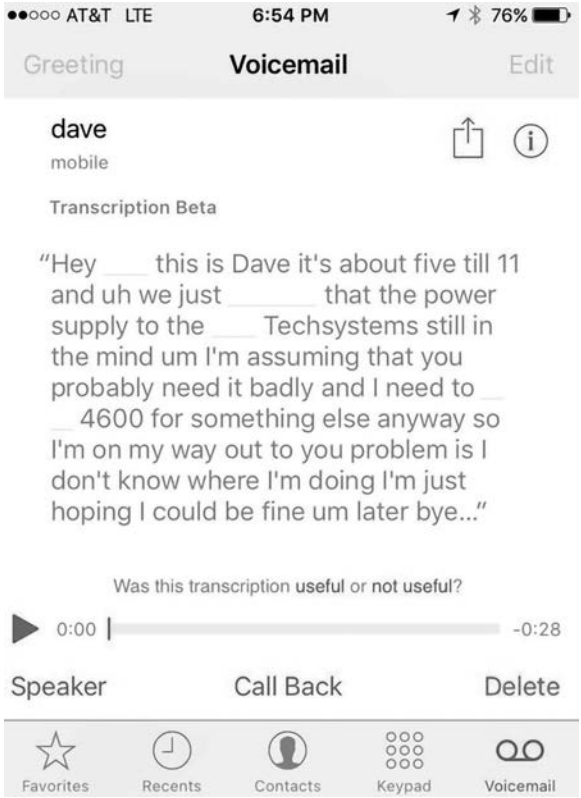
The super soldiers of the future are often imagined as highly trained individuals equipped with technology that improves their ability to sense the world, analyze massive amounts of information, and rapidly eliminate threats. In fact, a superhero's technology has a long history of eventually showing up in civilian and military life. Planes allowed humans to fly. Spacecraft took man to the moon. Videochat software provides world-wide, real-time interaction. Self-driving cars now populate several cities.

However, one salient, pervasive feature of superhero capabilities has yet to arrive: human-like artificial intelligence (AI). The absence is not for a lack of interest in the research community or investment by technology developers. Numerous "smart" technologies populate

1. This research is aligned with the scientific aims of the Human Sciences campaign at the United States Army Research Laboratory (ARL) and the vision for ARL's essential research areas for Human-Agent Teaming, Accelerated Learning for a Ready Force, Machine Learning and Artificial Intelligence, and Discovery. We want to acknowledge the intellectual contribution of the scientific community within the laboratory and its strong influence on the scientific approaches described in this position paper. This research was supported by the U.S. Army Research Laboratory, including work under Cooperative Agreements W911NF-10-2-0022 and W911NF-17-2.

our lives, but it is easier than one might hope to find cases where their vulnerabilities are highlighted. YouTube videos depict robotic vacuums "cleaning up" a paint spill by recolouring the floors all over the house. Cars with sensors for blind spot detection often warn of highway medians or fences that are mistaken for traffic. Voicemail transcriptions can be more confusing than informative (Figure 3.1). An Internet favourite centres on "autocorrect fails" that often make for entertaining reading, but they also demonstrate important barriers between us and human-like technology partners.

Figure 3.1 Example of automated transcription of a voicemail that is more confusing than it is informative



Source: Author's compilation.

In our view, these barriers stem from a disconnect between artificial intelligence and the *intent and goals* of the human user. We posit that the prevalent approach that attempts to make AI behave like humans has limited progress for realizing "smart" technology; instead, our science investigates how to make the human user more understandable or predictable so that the technology can adapt to the human. We liken this approach to the success of the character Data in the Star Trek series: Data was an embodied AI agent who never mastered human emotion, but he was able to understand what task objectives his human colleagues wanted to achieve and then employed his unique strengths and skills to adapt himself and assist.

We propose that measuring and analyzing information regarding an individual's physiology, behaviour and environmental context provides a promising avenue to objectively characterize the intent and goals of a human user. In short, if we can capture the predictive relationship between a particular configuration of our physiology and the resultant behaviour in a given environment, we can insert technology that can assist us to achieve our desired task outcome. To introduce this conceptual research framework, We first discuss how physiological responses are directly linked to behaviour and can be modified by context, and then introduce how we have used brain networks to capture the relationship between physiology and task performance. In the next two sections, we highlight our recent results that confirm the promise of our methods to reveal physiologic signals that reflect changes in human behaviour on multiple time scales, including long-term expertise development and short-term use of autonomous technology. Finally, we conclude with a brief discussion about how our science will enable adaptive technology that provides overmatch and enables super soldiers.

How Does Physiology Capture Human Behaviour?

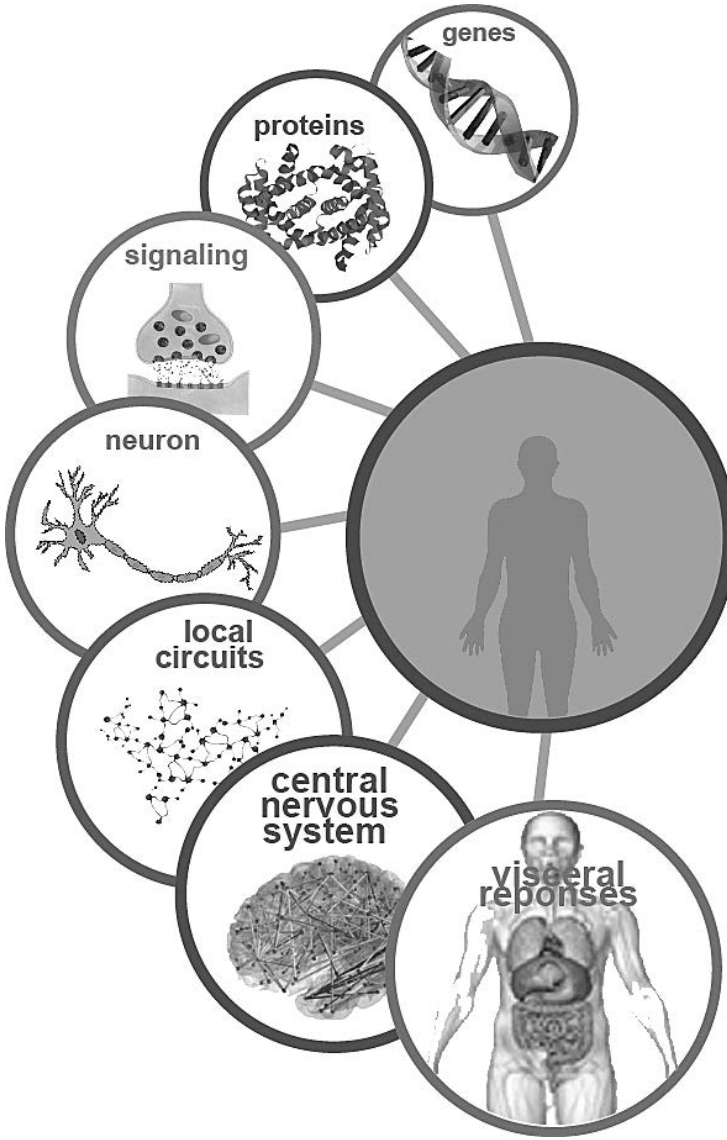
Human behaviour at any given moment is thought to result from the intricate interactions of physiology across many spatial scales within the human body (Figure 3.2). If we hear a loud explosion, we instinctively orient to the direction of the sound, our heart rate increases, and our body tenses. This coordinated response relies on adaptive physiological processes that integrate perceptual processing of sound with the cardiovascular and muscular responses to support immediate movement away from the explosion, yet our decision to stay or run from

the explosion is the result of additional physiological processing in the brain that assesses the incoming information from the senses and determines if danger must be escaped. If escape is deemed necessary, the brain then signals action that requires rapid production of energy from our cells to fuel muscle contractions that are once again intricately timed and synchronized to balance our weight as our limbs move in a sprinting pattern. This adaptive physiological response is well-known as the "fight-or-flight" response. It is often cited as essential for survival. When it occurs, it is so automatic that it feels effortless, yet it is actually a remarkably complicated cascade of physiological processing that requires almost instantaneous coordination across brain and body.

Interestingly, although this fight-or-flight response is foundational to our survival, deployment to a war zone modifies it. Soldiers share stories of routinely "taking fire" where mortars are exploding all around them. They describe how the newly deployed are easy to identify from their response to duck or flinch at the sound of each explosion, while the experienced soldiers only react when the explosion occurs within a narrow distance from their location. As expected and desired, the soldiers learn new responses to accommodate life in the war zone. Importantly, their physiological responses change. The intricate cascade of processing that prepares for rapid escape from danger is modified, and the fight-or-flight response now depends on a rapid assessment of the spatial proximity of the exploding round. The soldier's physiologic response is now dependent on the environmental context and reflects a new perceptual expertise.

In both military and civilian life, we are constantly learning. Our physiological responses are continuously adapting to the demands of the world around us. As we practice marksmanship drills, we are better able to steady the weapon with refined muscular responses while maintaining focused attention through synchronized brain network activity. When we learn the names and faces of new colleagues, our brains adapt their activity patterns and connectivity to represent this information in our internal circuitry. Our physiological responses adapt when we solve a new problem, learn a new navigation route, or master a novel strategy for a complex task. Of course, our physiology also underlies our performance on a moment-by-moment basis. Accurately recognizing our colleague when he or she enters our office can be predicted from patterns of brain activity involved in face processing. Successful target recognition is demarcated by a robust neural response, whether the target is an exit sign on the highway or a threat in a battlefield envi-

Figure 3.2 Human behaviour is a result of the interactions of physiology across many spatial scales



Source: Author's compilation.

ronment. After a night of restlessness and little sleep, we often are more distracted and prone to error, and the resulting physical fatigue often leads to errors in marksmanship. In short, our physiology not only captures our adaptation to life's continued experiences, but our internal systems also dynamically and continuously reconfigure themselves to enable our behaviours each day and night.

Our vision for future technology capitalizes on this relationship between physiological responses and the fluctuations in our performance. If we can capture the predictive relationship between a particular configuration of our physiology and the resultant behaviour in a given environment, we can insert technology that can assist us to achieve our desired task outcome. We conceptualize specific configurations of physiological response as a human state. As such, a human state can reveal what type of interaction with technology will ensure successful performance. Consider an example of shared driving control with an autonomous agent. If a driver is falling asleep at the wheel, and physiology data revealed that in real-time, the autonomy could take over control to navigate the vehicle. Conversely, autonomy may predict low confidence in its own driving performance and want to shift control back to a human driver, but the shift of control should only occur when the human driver's physiology confirms that she or he is attentive to the environment and ready to accept driving control. This driving example is just one way in which knowledge of a human state, and tracking its moment-by-moment adaptations to the task needs of the surrounding environment, would enable us to develop innovative technologies that can truly adapt to soldiers and become teammates on the battlefield. We are executing research at the United States Army Research Laboratory to realize the more generalized Army capability of adaptive technology based on human state assessment.

In support of this vision and future Army capabilities, our science focuses on methods to detect and interpret our physiological responses, but we still must overcome many scientific challenges. Of particular interest in this chapter is the issue of scale, both in space and time. The fundamental science for measuring a soldier's state must address the broad range of spatial scales of physiology within the human body. As shown in Figure 3.2, the physiological scales range from our genes, viewed as the fundamental building blocks of biology, all the way up to the full human organism embodied in a rich environmental context. Recall the example above of a diminished fight-or-flight response in deployed soldiers, where the battlefield context would require us to

expect a different physiological response. Furthermore, this adaptive response changes over time in the same individual, capturing the transition to deployment to a war zone as well as when the same individual has readapted to civilian life. Thus, rich scientific questions exist across both spatial and temporal scales. Here, we focus our discussion on a subset of research within this broad range of physiology: the human brain.

Can Brain Networks Detect Human States?

Our research on the central nervous system largely focuses on brain networks.[2] The human brain consists of approximately 86 billion neurons, with trillions of connections between individual neurons leading to a massively interconnected network.[3] This network is composed of both gray matter (cell bodies) and white matter (axons). The gray matter is typically divided into brain regions composed of large groups of adjacent neurons that have similar properties, and these regions demonstrate specialized information processing and knowledge representation. The white matter provides the structural connections between distant brain regions and is often described as the wiring in the brain.[4] Together, brain networks support cognition and human behaviour by communicating information among brain regions for integrated processing and rely on the structural connections to enable efficient and rapid responses across distant brain areas.[5]

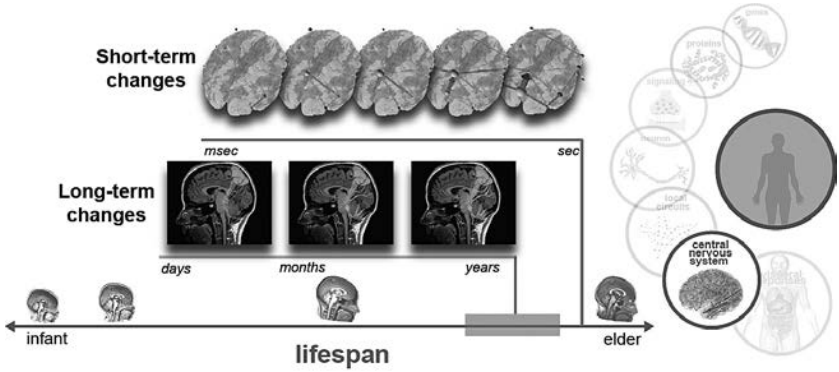
Brain networks capture physiological changes across the lifespan, and these changes can be detected in both functional and structural network connectivity. Functional connectivity refers to the communication of information between brain regions, and these connections are thought to directly support the moment-by-moment fluctuations in

2. J. M. Vettel, P. J. McKee, A. Dagro, M. Vindiola, A. Yu, K. McDowell, and P. J. Franaszczuk, "Scientific Accomplishments for ARL Brain Structure-Function Couplings Research on Large-Scale Brain Networks from FY11-FY13," DSI Final Report, No. ARL-TR-6871, (US Army Research Laboratory 2014).
3. F. A. C. Azevedo, L. R. B. Carvalho, L. T. Grinberg, J. M. Farfel, R. E. L. Ferretti, R. E. P. Leite, … S. Herculano-Houzel, "Equal Numbers of Neuronal and Nonneuronal Cells Make the Human Brain an Isometrically Scaled-up Primate Brain," *The Journal of Comparative Neurology* 513, no. 5 (2009): 532–541.
4. J. M. Vettel, N. Cooper, J. O. Garcia, F. Yeh, and T. Versytnen, *White Matter Tractography and Diffusion Weighted Imaging*, (eLS, John Wiley & Sons, Chichester, 2017).
5. R. E. Passingham, K. E. Stephan, and R. Kotter, "The Anatomical Basis of Functional Localization in the Cortex," *Nature Reviews Neuroscience* 3 no. 8 (2002): 606–616.

performance. An illustration of a time-evolving functional network is shown in Figure 3.3 as an example of short-term physiological changes. This is a top-down view of a 3D brain, and each brain image shows the evolution of the brain activity over several seconds. On each brain, small circular orbs represent regions with specialized information processing. When the region is actively communicating, the size of the orb is larger and lines show what regions are receiving information, with larger lines indicating stronger communication. This dynamic network activity pattern was observed when a person detected a target of interest in their environment. Similarly, structural connectivity also captures physiological changes, but these are often imaged and studied on longer timescales, ranging from days to years. As illustrated in Figure 3.3, long-term changes may reveal increased structural connections between regions. This change is thought to reflect enhanced communication between these regions that likely underlies efficient execution of tasks that require rapid communication of information between these brain areas. Our research examines both functional and structural networks as predictive indicators of human states that account for fluctuations in task performance across timescales.

Importantly, to predict performance fluctuations over time, our research focuses on the network connectivity of specific individuals. This approach is an intentional movement away from the pervasive focus in most neuroscience research that examines the averaged group response. Our vision is to design technology that can adapt to the particular needs of an individual soldier and rapidly account for moment-by-moment changes in his or her needs to maintain successful task execution. The group average is ill-suited for this purpose as illustrated in Figure 3.4. The averaged functional activity for the group is depicted on the large brain in the top left corner (Average Response). In this top down view, brain regions are illustrated as small orbs, and dark lines indicate increased communication between pairs of brain regions while lighter lines indicate decreased communication between regions during task execution. Each of the smaller brains in the image depict the functional connectivity for forty-four unique individuals performing the task; the same set of individuals used to compute the average connectivity response in the top corner. Critically, none of the individual participants perfectly match the group activity. In fact, most have stark differences in what brain regions capture the dominant brain connectivity to support the individual's successful execution of the task. A piece of adaptive technology that relied on the group average would fail for most if

Figure 3.3 Illustration of example brain network changes at varying timescales over the lifespan. Short-term changes are visualized as a time-evolving functional network where brain regions (circular orbs) communicate information to other regions (arrowed lines). Long-term changes are visualized as structural changes between two regions of the brain that may occur across days or years.



Source: Author's compilation.

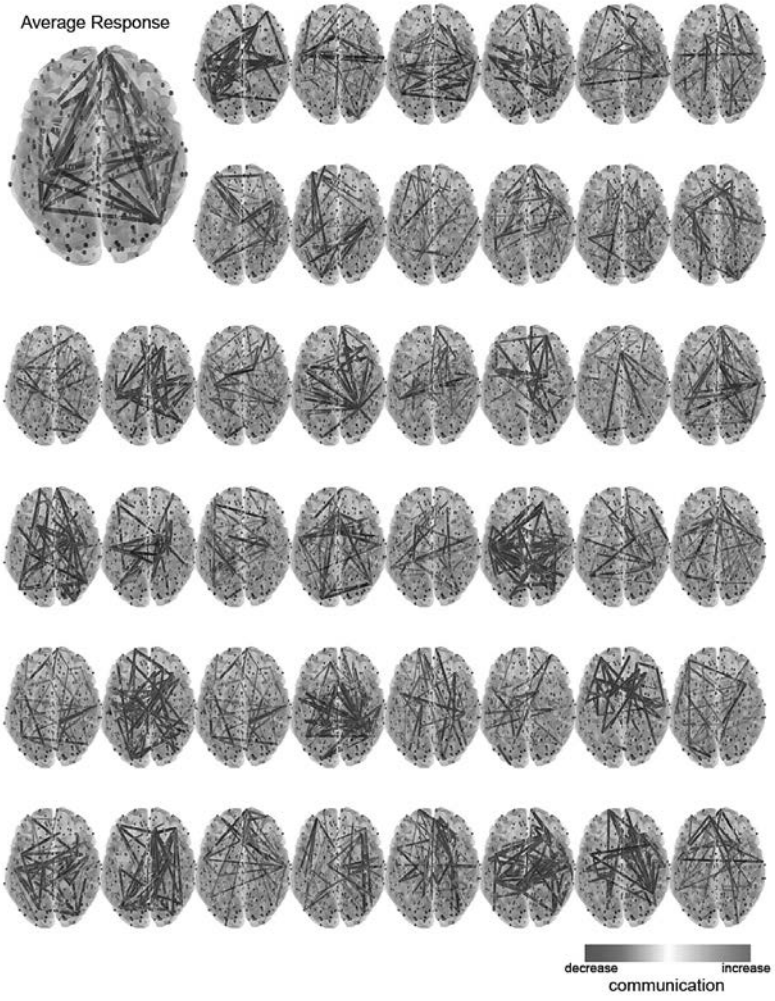
not all individuals. To successfully adapt to the needs of an individual, the technology must monitor the unique brain networks' patterns. Thus, a strong limiting factor for designing adaptive technologies is the need for methods that can capture an individual's unique responses.

The scientific challenge, however, does not end at overcoming the large differences among individuals, since physiologic responses within the same individual also vary across time. One particularly important source of change within a soldier arises from expertise development.

What Brain Changes Occur After Long-term Expertise Development?

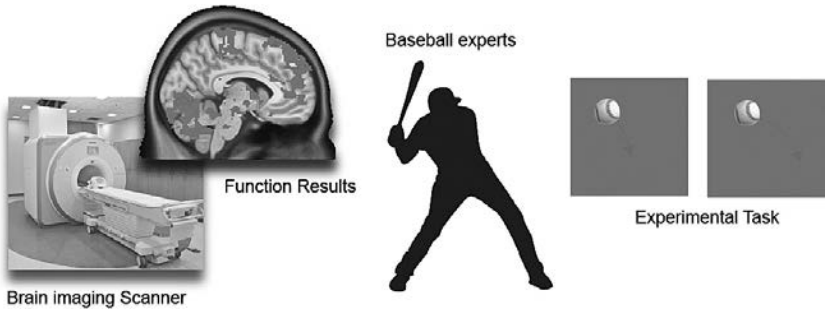
The stark network differences between individuals while successfully executing the same task likely reflects each person's unique blend of task expertise and preferred execution strategies (Figure 3.4). In fact, identifying robust markers of expertise acquisition would be a substantial advantage for improving training programs. This is particularly important for the Army based on the sheer number of hours our soldiers spend training. If physiological changes revealed when a training program was ill-matched to the trainee, the program could be adapted and tailored to the individual soldier and provide a means to decrease time-to-train.

Figure 3.4 Brain regions are connected with a dark line when increased communication occurs during task performance compared to a non-task baseline, and lighter lines indicate decreased communication. The large brain in the top left shows the averaged brain connectivity across all participants, while the smaller brains show connectivity for each of the forty-four participants. Notably, no individual perfectly matches the average.



Source: Author's compilation.

Figure 3.5 Brain imaging data was collection using an MRI scanner that reveals what brain regions show functional activity during task performance. To study long-term expertise developments, baseball experts and non-experts performed a baseball pitch discrimination task (fastball, curveball, or slider).



Source: Author's compilation.

To examine physiological correlates of expertise, we studied a group of collegiate baseball players who had won the series title for three consecutive years. Players must quickly predict a 90 mph pitch trajectory and have the motor control to place a bat on the three-inch diameter ball in less than 400 metres. Although even the best athletes only have a one in three success rate, baseball players have become experts in this specific type of perception-action coupling, especially when compared with non-expert control participants. In our research, we compared experts to non-experts to examine brain network differences.[6] We brought both baseball experts and non-expert controls to the laboratory and asked them to perform a baseball pitch discrimination task (Figure 3.5). They were asked to discriminate whether a trajectory was a fastball, curveball, or slider. We collected both functional connectivity during task execution and structural connectivity during the session to examine physiological changes associated with expertise.

Our analysis first examined the structural connections across the whole brain for both experts and non-experts, and we found that the

6. J. Muraskin, J. Sherwin, G. Lieberman, J. O. Garcia, T. Verstynen, J. M. Vettel, and P. Sajda, "Fusing Multiple Neuroimaging Modalities to Assess Group Differences in Perception-Action Coupling," *Proceedings of the IEEE* 105, no. 1 (2017): 83–100.

structural connections were largely organized in five core subnetworks. As shown in the top row of Figure 3.6, each subnetwork is shown in a different shade, and the regions associated with each subnetwork are illustrated as circular orbs on the 3D brain. When we then compared differences in the structural connections between each of these subnetworks, we found that experts had increased structural connections between subnetwork 1 and subnetwork 2 as illustrated in Figure 3.6, middle row. These two networks include regions that coordinate our physical movements, and these connections likely reflect enhanced circuitry to support efficient motor coordination and execution. This interpretation was further supported when we examined whether these structural differences between experts and non-experts shared any relationship with the differences in their functional network connectivity. In the bottom row of Figure 3.6, we overlay the brain regions that showed increased functional activity for the baseball experts on top of the structural subnetwork. These patches from the functional brain activity indicate regions that were associated with the experts' faster and more accurate performance on the pitch discrimination task. Thus, the brain regions that showed expertise-related structural differences also showed expertise-related functional differences. These results confirm that brain networks show promise for capturing the neural plasticity that supports long-term expertise development.

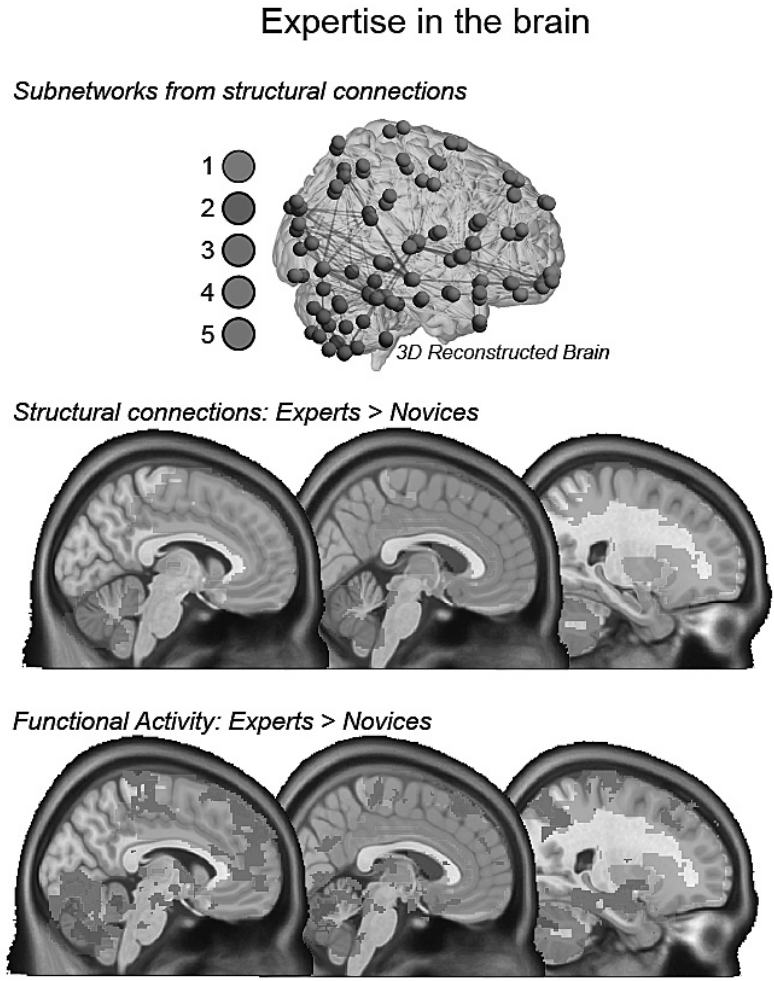
We have also investigated whether brain connectivity can capture training effects on a much shorter timescale, just six weeks.[7] In this study, participants learned a new visuo-motor task, similar to playing a set of piano arpeggios. We found that individuals who learned the task most quickly also had increased structural connections between visual and motor cortices. These results address a critical challenge for our science to realize adaptive technology. While brain network changes after long-term expertise development confirms the importance of studying this scale of physiology, adaptive technology must be able to adapt to human needs on much shorter timescales to provide overmatch and enable future super soldiers.

Do Short-term Physiology Changes Predict Autonomy Use?

One core challenge for adaptive, autonomous technologies to be "smart"

7. A. E. Kahn, M. G. Mattar, J. M. Vettel, N. F. Wymbs, S. T. Grafton, and D. S. Bassett, "Structural Pathways Supporting Swift Acquisition of New Visuomotor Skills," *Cerebral Cortex*, 1–12.

Figure 3.6 Structural connections across the whole-brain are largely organized in five subnetworks shown in the top row. Experts demonstrated increased connectivity between the top subnetwork (1) and dark subnetwork (2) shown in the middle row across three different views of the brain. Importantly, these small brain regions identified from the brain's wiring also showed differences in their functional activity when baseball experts performed a pitch discrimination task.



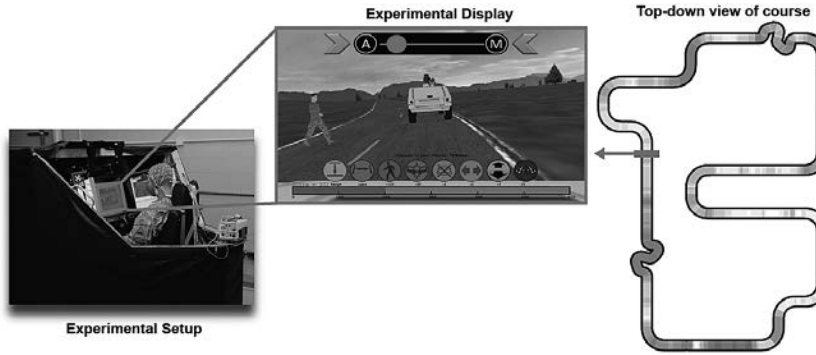
Source: Author's compilation.

teammates is to rapidly adjust to changes in what human agents need and/or want as a situation unfolds. Sometimes human expertise for a task will far outstrip the technology and the autonomy needs to only provide a support role for a task, while other times humans are prone to error, such as decreased ability to focus after a sleepless night or traumatic intel report, and the autonomy must mitigate their sub-par performance.

To examine physiological correlates of autonomy use, we asked a group of individuals to drive around a 5,800 metre course while following the lead vehicle in the convoy (Figure 3.7). The vehicle was equipped with an autonomous driving assistant that could be engaged or disengaged at any time. Collectively, the driver and agent had to maintain a following distance between five and twenty metres of the lead vehicle, remain centred in their lane, and avoid collisions with other vehicles and pedestrians. The route was designed to cause unpredictable challenges for each of these three core driving tasks, differentially taxing the performance capabilities of the human and autonomy team. As participants performed the task, we tracked functional brain activity as well as a variety of complementary measurements from their peripheral nervous system (heart rate, respiration) and the task environment (road curvature, unexpected obstacles). Our analysis examined whether any of these physiological and task factors predicted their decision about how to interact with the autonomous driving assistant.

Our results first confirmed substantial individual variability of when the participants chose to use the autonomous agent. Figure 3.8 shows a series of course maps coloured by the usage of the automated driving assistant. Areas in light gray indicate parts of the course where the automated driving assistant was engaged, while areas in dark gray indicate parts of the course where the driver was manually controlling the vehicle (and the driving assistant was disengaged). Analogous to the variability in the brain networks (Figure 3.4), the sixteen drivers in this study exhibited a great deal of behavioural variability in how they chose to use the autonomous driving assistant as captured by the different shade of gray along their course map. The large map of the course in the upper left is the average autonomy usage across all sixteen drivers. Dark gray and medium gray indicate same usage for all participants while white indicates half of the participants engaged autonomy while the other half drove that section manually. Most of the average course map has light shades of gray, revealing that very few sections of the course had the same autonomy use across participants.

Figure 3.7 Participants sat on a six-degree ride motion platform (left) while maintaining a following distance behind a lead vehicle in a convoy (centre). Participants could trade off driving control to an autonomous agent (denoted as A at the top of the experimental display) at any time around the 5,800 metre course (right).

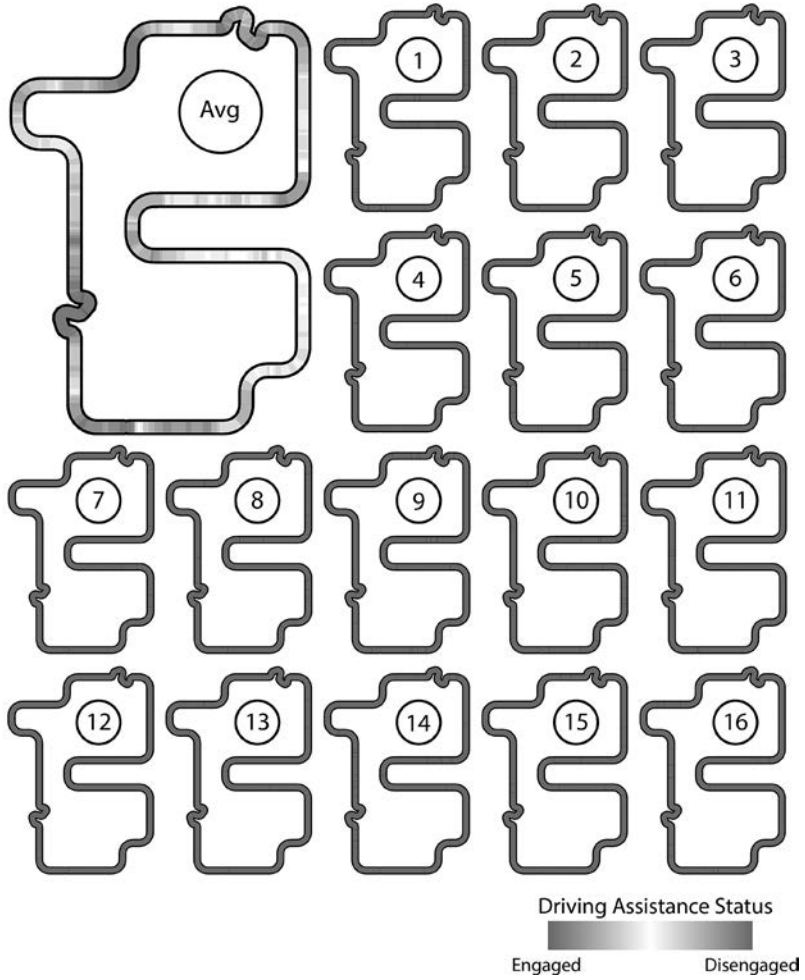


Source: Author's compilation.

These results confirm the importance of tracking an individual's evolving preferences about the level of autonomy assistance. We observed substantial variation in when individuals desired help from the autonomous driving assistant to maintain mission performance during the convoy drive.

Importantly, we were able to predict when participants would choose to engage or disengage the autonomous driving assistant from the physiological and task factors collected. Our machine learning methods were able to achieve an accuracy rate of approximately 80 percent when predicting the decision to disengage the autonomous driving assistant (drive manually) and an accuracy rate of approximately 65 percent when predicting the decision to engage the autonomous driving assistant. This difference in performance accuracy likely arises from different reasons underlying the change in autonomy use. When participants took over control from autonomy, the threat of a collision was imminent. This was a common factor during takeover across participants. In contrast, the decision to hand off control to an autonomous agent is likely derived from a range of factors that are much more specific to an individual, so predicting these events is harder and will require additional research to determine robust metrics. Overall, these results

Figure 3.8 The course map is colored dark gray when the participant chose to manually drive and light gray when they handed off driving control to the autonomous agent. The large map in the top left is the averaged autonomy usage across all participants, where dark gray and medium gray indicate the same autonomy usage for all participant while white indicates an even split. The small maps capture autonomy use for each of the sixteen participants, revealing the substantial variability in when individuals desired help from autonomy.



Source: Author's compilation.

confirm the promise of physiological and task-based measurements to capture dynamic fluctuations about when individuals desire help from autonomy. Continued improvement of these methods may lead to the development of an adaptive driving assistant that could automatically respond to an individual driver's needs at any given moment in time. On a broader scale, our scientific approach provides an opportunity for future technology to mitigate against periods of poor performance, while also capitalizing on times of human excellence, and thus we expect our science will eventually develop adaptive technology to enable overmatch capabilities with our future super soldiers.

What Are the Envisioned Capabilities for the Super Soldier?

While futuristic visions of the battlefield vary in the details, they largely share a common vision where autonomy dominates the battlefield and must be seamlessly integrated in large, distributed teams of human and autonomous agents. At the foundation of our approach, we expect that how a piece of smart technology can assist a human user changes on a moment-by-moment basis based on constantly evolving human needs, and as such, our science focuses on methods to rapidly sense and predict what type of assistance users need for their current task.

We highlighted our recent results that demonstrate the promise of estimating human intent from physiological data, at both short and long timescales, and these objective measurements of intent could be used to change the rules governing how technology dynamically adapts to a soldier's needs. We envision a future where soldiers are issued uniforms containing a full suite of embedded sensors designed to continuously assess them throughout their military career, and efficient analysis of their physiology will enable truly transformative adaptive technologies. It is these adaptive autonomy teammates that will enable super soldiers of the future Army to make the superheros of our modern movies seem weak and equipped with unsophisticated gadgets.

4

Soldier Resilience: Lessons Learned from the Assessment and Selection of High-Risk Military Operational Personnel

James J. Picano

Introduction

In recent years, there has been a great deal of interest in understanding and promoting psychological resilience in military personnel, and research has expanded greatly as a result. Along with this expansion has come increased definitional confusion regarding the resilience construct itself. Definitions of resilience vary depending upon whether resilience is viewed as the *capacity* of individuals to tolerate adversity, the *process* of adapting to adversity, or the *outcome* of efforts to deal with adversity.[1]

Researchers distinguish between the capacity for resilience, such as the personal, social, and community resources that confer the ability to withstand significant adversity, and the demonstration of resilience,

1. Thomas W. Britt, Winny Shen, Robert R. Sinclair, Matthew R. Grossman, and David M. Klieger, "How Much Do We Really Know About Employee Resilience?" *Industrial and Organizational Psychology* 9, no. 2, (2016): 378–404.

which refers to the evidence or demonstration of positive adaptation after encountering significant adversity.[2] Capacity definitions of resilience generally emphasize the potential for an individual to tolerate high levels of stress without significant psychological, physical, or performance decrements, as well as the ability to bounce back quickly after adversity or challenge. Resilience can also be defined in terms of an outcome, that is, an individual's demonstration of positive adaptation in response to significant adversity.[3] Finally, resilience can be defined as "the process of coping with or overcoming exposure to adversity or stress."[4]

Resilience is thought to be broader than an individual personality trait. In a review of 270 publications relevant to resilience in military personnel, twenty factors that promote resilience were identified. Such factors include individual-level factors such as physical fitness, positive coping and affect; family-level factors such as emotional bonds, and closeness; unit-level factors such as teamwork and cohesion; and community-level factors such as connectedness and belongingness.[5]

Resilience is frequently conceptualized in terms of psychological resources.[6] At the most basic level, resource models of resilience propose that those endowed with more psychological resources are more resilient in the face of adversity, in part because they are presumed to be more capable of solving problems inherent in stressful circumstances, and/or more able to withstand the depletion of resources that occurs in stressful conditions.[7] Psychological resources conferring individual resilience can be conceptualized quite broadly and include dispositional resources, such as personality traits, but also other kinds of resilience promoting factors described above such as team cohesion and emotional and social support.

Assessment courses for the selection of high-risk operational personnel (military and others), provide unique opportunities to learn about

2. Ibid.
3. Thomas W. Britt, Robert R. Sinclair, and Anna C. McFadden, "Introduction: The Meaning and Importance of Military Resilience" in *Building Psychological Resilience in Military Personnel: Theory and Practice*, ed. Robert R. Sinclair, and Thomas W. Britt (Washington, DC: American Psychological Association, 2013): 3–17.
4. Lisa S. Meredith, Cathy D. Sherbourne, Sarah J. Gaillot, Lydia Hansell, Hans V. Ritschard, Andrew M. Parker, and Glenda Wrenn, "Promoting Psychological Resilience in the US Military," *Rand Health Quarterly* 1, no. 2 (2011): 1.
5. Meredith, Sherbourne, Gaillot, Hansell, Ritschard, Parker, and Wrenn.
6. Stevan E. Hobfoll, "Conservation of Resources: A New Attempt at Conceptualizing Stress," *American Psychologist* 44, no. 3 (1989): 513–524.
7. Ibid.

the contribution of resilience to successful adaptation in military personnel. High-risk operational personnel engage in physically and psychologically demanding missions involving critical and sensitive national security concerns under conditions of extreme threat with no, or very limited, logistical and tactical support, and dire consequences for failure. Not surprisingly, success in such missions requires highly motivated and physically fit individuals who can tolerate great amounts of stress without impact to performance (i.e., resilience); along with other key psychological competencies such as the ability to quickly adapt to changing conditions, work effectively with others, and exercise sound judgment and decision making under pressure and stress.[8] Examples of high-risk operational personnel include Special Operations Forces (SOF) such as U.S. Navy SEALs, U.S. Army Special Forces (SF), U.S. Air Force Para-rescue Jumpers (PJs), as well as other "paramilitary" personnel such as special operations law enforcement personnel (e.g., SWAT officers). Largely because of the demands of such missions on individuals and the psychological competencies required for successful and sustained performance, high-risk operational personnel are selected for these jobs through the use of specially designed Assessment and Selection (A&S) courses. The content and structure of A&S courses centre around the technical skills and psychological competencies required for effective performance in a particular job. These are typically identified through job analysis with subject matter experts (SMEs).

This chapter focuses on the prominent psychological methods used to assess and select military operational personnel for potential success in high-risk, high stress, non-routine missions. In doing so, some of the more consistent findings predicting successful completion of these rigorous A&S programs are discussed along with conceptual understanding of these results in order to shed light on important factors that may be most salient to individual soldier resilience.

Assessment Programs for the Selection of High-risk Operational Personnel

Assessment and selection (A&S) courses are specifically designed to assess special skills, aptitude and trainability, and performance under

8. James J. Picano, Thomas J. Williams, and Robert R. Roland, "Assessment and Selection of High-risk Operational Personnel," in *Military Psychology: Clinical and Operational Applications*, ed. Carrie H. Kennedy and Eric A. Zilmer (New York: Guilford, 2012), 50–72.

stressful conditions using methods with high fidelity to the operational environment. They are generally structured to test tolerance for hardship, perseverance, sustained performance under stress, and recovery from stress, and as a result are physically and psychologically depleting. Attrition rates are high (upwards of 50 percent) and only the most hardy and persevering generally make it through. Almost by definition,[9] those who complete these rigorous A&S courses can be said to be highly resilient in that they have demonstrated positive adaptation to significant adversity. As such, A&S courses designed for high-risk operational personnel provide an ideal environment to study factors that underlie individual resilience.

The ultimate objective of A&S involves the determination of suitability for high-risk missions as indicated by the assessment of training and job performance potential, risk for personal misconduct and counterproductive work behaviours, in addition to psychological fitness and emotional health risks.[10] Although the structure of individual A&S courses vary somewhat from one another, the design descends from that originally put forth by the Office of Strategic Services during World War II.[11] A&S programs involve multiple methods and procedures including interviews, psychological tests, physical tests, military skills tests, and scenario-based role plays and simulation tasks with high fidelity to the operational environment. They are usually very intense and can be several weeks' duration. Not surprisingly, A&S programs are quite resource and labour intensive.

Typical A&S programs for high-risk operational personnel have three distinct phases: screening, assessment, and evaluation.[12] Screening for attendance at an A&S includes efforts to recruit individuals with the requisite skills and background to be successful in the job, as well as initial evaluation of suitability risks. The review of an individual's technical skills, experience, and aptitude for the job is typically done by experienced operators who serve as technical experts. Other screening activities are conducted by human resources, security, medical, and

9. Britt, Shen, Sinclair, Grossman, and Klieger.
10. James J. Picano and Robert R. Roland, "Assessing Psychological Suitability for High-risk Military Jobs," in *The Oxford Handbook of Military Psychology*, ed. Janice H. Laurence and Michael D. Matthews (New York: Oxford, 2012), 148–158.
11. Donald W. Fiske, Eugenia Hanfmann, Donald W. MacKinnon, James G. Miller, and Henry A. Murray, *Selection of Personnel for Clandestine Operations: Assessment of Men*, (Laguna Hills: Aegean Park Press, 1997).
12. Picano and Roland.

behavioural science personnel. The screening activities often include interviews, questionnaires, physical fitness and medical evaluations, and other screening tests and measures to assess cognitive abilities and personality traits. These procedures generally identify obvious security and behavioural risks, as well as physical and psychological indicators of poor probability of successful completion of A&S. Candidates who successfully complete the screening then participate in an extended assessment of their suitability. This assessment comprises psychological interviews and tests, medical examinations and physical fitness tests, and team and individual simulation tests oriented to assessing training and job performance potential for the job in question.[13] Candidates can be eliminated from further consideration for a number of reasons, but chief among them are failure to meet performance standards, integrity violations or other behavioural security indicators suggesting poor suitability for a high-risk job, injuries or illnesses, and the candidate's voluntary withdrawal from the course (self-elimination). Attrition during this phase can be quite high, accounting for the majority of those eliminated from such courses. Candidates who successfully complete this phase then appear before a review board of leaders from the gaining organization or "unit." The board review comprises another interview, as well as a comprehensive evaluation of a candidate's entire assessment data in order to determine whether the individual should advance to the training required to perform the job.[14]

Predictors of Success in A&S Courses for High-Risk Operational Personnel

If we accept the premise that an individual who has successfully completed the arduous and adverse physical and psychological tests of suitability for assignment to a specialized military organization that conducts high-risk non-routine operational missions has demonstrated resilience,[15] then looking at some of the predictors of success in these courses can tell us something about individual-level factors that may promote this resilience. Among the most consistent predictors are physical and cognitive ability. Personality traits tend to be rather inconsistent predictors of success, with some more recent notable exceptions, which will be highlighted below.

13. Ibid.
14. Ibid.
15. Britt, Shen, Sinclair, Grossman, and Klieger.

Physical Ability

A&S programs tend to have high health and physical fitness standards for attendance as these programs tend to be quite physically rigorous. This is not unexpected because A&S programs are designed to mimic the operational environments in which missions are conducted, and these programs use physical pressures such as sleep and food restriction, heavy loads, and demanding physical events (e.g., obstacle courses, ruck marches) to both test fitness and induce stress. These challenges are extremely physically and psychologically depleting so it should come as no surprise that an individual's physical fitness emerges as a strong and consistent predictor of successful completion of these programs for the selection of military Special Operations Forces personnel.[16] High levels of physical fitness have also been found to buffer stress responses in extreme military training.[17] However, physical fitness is modifiable, and in and of itself, might not be a good indicator of individual resilience, especially in military personnel who must maintain high standards of physical fitness. On the other hand, in the population more generally, physical fitness may be a good indicator of overall physical health and perhaps signals *general system integrity*[18] or underlying *biological fitness*.[19]

Military tests of physical fitness, like the U.S. Army Physical Fitness Test (APFT) are age scaled. Thus, depending upon the ages of the candidates recruited, and particularly the homogeneity of the group with respect to age, physical fitness tests may not be as good a predictor of successful completion as age in physically rigorous A&S programs. For

16. Scott A. Beal, *The Roles of Perseverance, Cognitive Ability, and Physical Fitness in US Army Special Forces Assessment and Selection*, (Fort Bragg, NC: Scientific Coordination Office Army Research Institute for the Behavioral Sciences), No. ARI-RR-192, 2010; and Marcus K. Taylor, Amanda Miller, Lisa Mills, Eric Potterat, Geneleah A. Padilla, and Richard Hoffman, *Predictors of Success in Basic Underwater Demolition/SEAL (BUD/S) Training-Part 1: What Do We Know and Where Do We Go From Here?* (San Diego, CA: Naval Health Research Center), No. NHRC-06-27, 2006.
17. Marcus K. Taylor, Amanda E. Markham, Jared P. Reis, Genieleah A. Padilla, Eric G. Potterat, Sean P. A. Drummond, and Lilianne R. Mujica-Parodi. "Physical Fitness Influences Stress Reactions to Extreme Military Training," *Military Medicine* 173, no. 8 (2008): 738–742.
18. Geoffrey Miller, "Mental Traits as Fitness Indicators: Expanding Evolutionary Psychology's Adaptationism," *Annals of the New York Academy of Sciences* 907, no. 1 (2000): 62–74.
19. Jon A. Sefcek, and Aurelio José Figueredo, "A Life-history Model of Human Fitness Indicators," *Biodemography and Social Biology* 56, no. 1 (2010): 42–66.

example, in one of the earliest studies of predictors of success in the U.S. Navy Basic Underwater Demolitions/SEAL (BUD/S) course, the highest rates of success were for 19-to-21-year-olds.[20] Age of officers, who tended to be older than enlisted personnel, was inversely associated with successful completion. More recently, age was inversely associated with successful completion of an A&S course among experienced male US government law enforcement officer applicants for a special operations tactical law enforcement unit.[21]

The importance of physical fitness and age as predictors of success in highly challenging A&S courses suggests that there may be underlying biological resilience mechanisms associated with the capacity to adapt to such adverse conditions. Interest has focused on the neuroendocrine, neuropeptide, and hormonal mediators of the adaptive response to extreme adversity in military personnel. A comprehensive review of this literature is beyond the scope of this work. What follows instead is a presentation of selective findings from some studies involving high-risk operational personnel and extreme training to illustrate some possible biological indictors of resilience.

Testosterone is a frequently studied hormonal marker of resilience in male SOF personnel because the food and sleep deprivation, as well as fatigue in selection, training, and operational environments are known to decrease plasma levels of testosterone.[22] In elite military personnel, plasma testosterone decreased with age, and lower levels of testosterone were associated with higher daily fatigue ratings.[23] Thus, decreases

20. E. K. Gunderson, Richard H. Rahe, and Ransom J. Arthur, "Prediction of Performance in Stressful Underwater Demolition Training," *Journal of Applied Psychology* 56, no. 5 (1972): 430–432.
21. Cara N. Picano, "Predicting Success in Advanced Law Enforcement Personnel," doctoral dissertation, William James College, 2016.
22. Harris R. Lieberman, Emily K. Farina, John Caldwell, Kelly W. Williams, Lauren A. Thompson, Philip J. Niro, Kyle A. Grohmann, and James P. McClung, "Cognitive Function, Stress Hormones, Heart Rate and Nutritional Status During Simulated Captivity in Military Survival Training," *Physiology & Behavior* 165 (2016): 86–97; Jonathan M. Oliver, John P. Abt, Timothy C. Sell, Kim Beals, Dallas E. Wood, and Scott M. Lephart, "Salivary Hormone Response to 12-week Block-periodized Training in Naval Special Warfare Operators," *The Journal of Strength & Conditioning Research* 29, no. 1 (2015): 66–73; and Charles A. Morgan, Sheila Wang, John Mason, Steven M. Southwick, Patrick Fox, Gary Hazlett, Dennis S. Charney, and Gary Greenfield, "Hormone Profiles in Humans Experiencing Military Survival Training," *Biological Psychiatry* 47, no. 10 (2000): 891–901.
23. Marcus K. Taylor, Genieleah A. Padilla, and Lisa M. Hernández, "Anabolic Hormone Profiles in Elite Military Men: Robust Associations with Age, Stress, and Fatigue," *Steroids* (2017): 18–22.

in testosterone levels and consequent effects on physical performance may account, at least in part, for the inverse relationships between age and successful selection in high-risk operational A&S courses. For example, testosterone levels in males are known to peak around 19 years of age and decline steadily between the ages of 23 until about age 40.[24]

Some authors propose that dehydroepiandrosterone (DHEA), a precursor for the synthesis of anabolic steroids, may be an individual resilience factor.[25] Like testosterone, it has also been shown to decrease with age.[26] DHEA levels increase under periods of high stress military training[27] and DHEA is thought to provide a protective effect under stress and enhance resilience.[28] For example, DHEA-s levels were higher among those who performed better in high-stress Survival Evasion Resistance and Escape (SERE) training and military diver combat qualification courses.[29]

Finally, neuropeptide Y (NPY) has also emerged as a pro-resilience biomarker. Like DHEA, it has also been shown to increase under highly stressful training[30] and to correlate with better performance during interrogation in SERE training.[31]

More recently there has been a growing interest in studying resilience as it relates to individual differences in inflammatory responses

24. Thomas W. Kelsey, Lucy Q. Li, Rod T. Mitchell, Ashley Whelan, Richard A. Anderson, and W. Hamish B. Wallace, "A Validated Age-related Normative Model for Male Total Testosterone Shows Increasing Variance but No Decline After Age 40 Years," *PLOS ONE* 9, no. 10 (2014): e109346.
25. Scott J. Russo, James W. Murrough, Ming-Hu Han, Dennis S. Charney, and Eric J. Nestler. "Neurobiology of Resilience." *Nature Neuroscience* 15, no. 11 (2012): 1475–1484.
26. Taylor, Padilla, and Hernández.
27. Lieberman, Farina, Caldwell, Williams, Thompson, Niro, Grohmann, and McClung.
28. Petros Natalia, Jolanta Opacka-Juffry, and Jörg H. Huber, "Psychometric and Neurobiological Assessment of Resilience in a Non-clinical Sample of Adults," *Psychoneuroendocrinology* 38, no. 10 (2013): 2099–2108.
29. Charles A. Morgan, Ann Rasmusson, Robert H. Pietrzak, Vladimir Coric, and Steven M. Southwick, "Relationships Among Plasma Dehydroepiandrosterone and Dehydroepiandrosterone Sulfate, Cortisol, Symptoms of Dissociation, and Objective Performance in Humans Exposed to Underwater Navigation Stress," *Biological Psychiatry* 66, no. 4 (2009): 334–340.
30. Lieberman, Farina, Caldwell, Williams, Thompson, Niro, Grohmann, and McClung.
31. Morgan, Rasmusson, Pietrzak, Coric, and Southwick; and Charles A. Morgan, Ann M. Rasmusson, Sheila Wang, Gary Hoyt, Richard L. Hauger, and Gary Hazlett, "Neuropeptide-Y, Cortisol, and Subjective Distress in Humans Exposed to Acute Stress: Replication and Extension of Previous Report," *Biological Psychiatry* 52, no. 2 (2002): 136–142.

to stress (e.g., Interleukin-6).[32] This line of research has not yet made its way into the literature in predicting success in A&S courses but promises to be an important area for future inquiry.

The study of neurobiological markers of resilience in military personnel undergoing extremely stressful training is exciting and active. While potentially identifying important individual difference correlates in vulnerability to stress, the research has yet to identify consistent bio-markers of individual resilience, nor ways of enhancing these for developing super soldiers.

Cognitive Ability

Cognitive ability, often operationalized as general mental ability (GMA) or simply *g*, has proven to be the most robust predictor of job performance and training success across all types of occupations, with average validities exceeding .50.[33] Not surprisingly, some test of GMA is included in the psychological assessment of individuals attending specialized military A&S courses.[34]

GMA has emerged as one of the strongest predictors of successful completion across a number of different A&S courses for high-risk operational personnel with individuals higher in GMA having higher completion rates than those of lower ability.[35] This may be due in part to the possibility that individuals of higher general mental ability are better at performing the novel problem-solving tasks and situations confronting them in A&S programs.

Sustained military operations—those carried out with limited or no

32. Madeline L. Pfau, and Scott J. Russo, "Peripheral and Central Mechanisms of Stress Resilience," *Neurobiology of Stress* 1 (2015): 66–79.
33. Neal Schmitt, "Personality and Cognitive Ability as Predictors of Effective Performance at Work," *Annual Review of Organizational Psychology and Organizational Behavior* 1, no. 1 (2014): 45–65; and Frank L. Schmidt, and John E. Hunter, "The Validity and Utility of Selection Methods in Personnel Psychology: Practical and Theoretical Implications of 85 Years of Research Findings," *Psychological Bulletin* 124, no. 2 (1998): 262–274.
34. John R. Christian, James J. Picano, Robert R. Roland, and Thomas J. Williams, "Guiding Principles for Selecting High-risk Operational Personnel," in *Enhancing Human Performance in Security Operations: International Law Enforcement Perspectives*, ed. Paul T. Bartone, Bjorn H. Johnsen, Jarle Eid, John M. Violanti, and Jon C. Laberg (Springfield, IL: Charles C. Thomas), 121–142.
35. Beal. Michelle M. Zazanis, Gary A. Hazlett, Robert N. Kilcullen, and Michael G. Sanders, *Prescreening Methods for Special Forces Assessment and Selection* (Alexandria VA: Army Research Institute for the Behavioral Sciences), No. ARI-TR-1094, 1999. Picano.

rest/sleep for greater than a 36 hour period—degrade cognitive functioning and can lead to problems in performance.[36] Moreover, different cognitive operations degrade over different time gradients, with vigilance, reaction time, and working memory affected after only a few hours.[37] In addition, there is individual variation in the decline of information processing under stress as a result of increased motivation and effort.[38] Thus, there appears to be some individual variation in the degree of resilience to the degrading effects on cognitive functioning as a result of the environmental conditions and challenges typical of A&S courses.

One construct that might explain some of this individual variation is *cognitive reserve capacity*. Higher functioning individuals are purported to possess a reserve factor which acts to ameliorate impairments in cognitive functioning as a result of pathology or depletion.[39] Scores on intelligence measures or tests of GMA serve as good proxy measures of cognitive reserve capacity. Thus, candidates in A&S courses for high-risk operational personnel who test higher in GMA can be thought of as having more cognitive reserve capacity. These individuals can be presumed to be more "cognitively resilient" and may have a greater ability to compensate for the depleting effects of stress, fatigue, and food and sleep restriction in A&S courses. Therefore, they may be better able to solve complex problems and perform better than those of lesser ability under these depleting conditions. Differences in cognitive reserve capacity reflected in tests of GMA may partially account for the observed relationship between GMA and success in A&S courses.

Personality

The prevailing model of personality organizes personality traits into five broad domains: emotional stability, which includes resilience and freedom from negative emotionality; extraversion comprising socia-

36. Susan Vrijkotte, Bart Roelands, Romain Meeusen, and Nathalie Pattyn, "Sustained Military Operations and Cognitive Performance," *Aerospace Medicine and Human Performance* 87, no. 8 (2016): 718–727.
37. Ibid.
38. Wayne C. Harris, P. A. Hancock, and Scot C. Harris, "Information Processing Changes Following Extended Stress," *Military Psychology* 17, no. 2 (2005): 115–128.
39. Richard N. Jones, Jennifer Manly, M. Maria Glymour, Dorene M. Rentz, Angela L. Jefferson, and Yaakov Stern, "Conceptual and Measurement Challenges in Research on Cognitive Reserve," *Journal of the International Neuropsychological Society* 17, no. 4 (2011): 593–601.

bility, drive, and positive emotion; openness, including intellectance, broad-mindedness, and aesthetic interests; agreeableness, including compassion and cooperation with others, and friendliness; and conscientiousness including orderliness, dependability, integrity and industriousness. More than twenty-five years ago, an important meta-analysis of studies of personality in the workplace demonstrated that personality played an important predictive role in work and training performance, and employee conduct or counterproductive work behaviours.[40] It is now generally accepted that personality traits are useful in predicting work performance with facets of conscientiousness, and to a lesser extent emotional stability exerting moderate influence across a number of different job performance criteria. Openness to experience has also been found to be important to training success, whereas agreeableness tends to be important to occupations in which teamwork is important to job success.[41]

The contribution of the five personality factors to work-related outcomes has also been studied in military samples. In a meta-analysis of studies of twenty independent military samples who were administered the Self-Description Inventory, a self-report measure of the five factor model of personality, emotional stability and conscientiousness emerged as consistent predictors of work-related outcomes.[42] These same personality domains have been proposed to be important in the selection of personnel for hazardous occupations,[43] and highly select military personnel are normatively higher on these dimensions when compared to the general population.[44] Unfortunately, there is mixed evidence for the predictive effects of these personality traits in selected studies of assessment and selection for high-risk military operational

40. Murray R. Barrick, and Michael K. Mount, "The Big Five Personality Dimensions and Job Performance: A Meta-analysis," *Personnel Psychology* 44, no. 1 (1991): 1–26.
41. Michael K. Mount, Murray R. Barrick, and Greg L. Stewart, "Five-factor Model of Personality and Performance in Jobs Involving Interpersonal Interactions," *Human Performance* 11, no. 2–3 (1998): 145–165; and Sang Eun Woo, Oleksandr S. Chernyshenko, Stephen E. Stark, and Gabriella Conz, "Validity of Six Openness Facets in Predicting Work Behaviors: A Meta-Analysis," *Journal of Personality Assessment* 96, no. 1 (2014): 76–86.
42. Wendy Darr, "Military Personality Research: A Meta-analysis of the Self-Description Inventory," *Military Psychology* 23, no. 3 (2011): 272–296.
43. Joyce Hogan and Michael Lesser, "Selection of Personnel for Hazardous Performance," in *Stress and Human Performance*, ed. James E. Driskell and Eduardo Salas (Hillsdale, NJ: Erlbaum, 1996), 195–222.
44. Picano, Williams, and Roland.

personnel.[45] Part of the difficulty in finding significant predictive effects may lie in the fact that military personnel who vie for these positions are already fairly high in emotional stability and conscientiousness, and this restricted range of scores makes it difficult to find statistically significant differences between those who are selected and those who are not. Nevertheless, within the five factor personality model, it is clear that individual differences in resilience are situated in the personality dimensions of emotional stability and conscientiousness, and these traits must not be overlooked as important indicators of individual soldier resilience.

Other important personality constructs related to individual resilience are emerging as important predictors of successful completion of A&S courses, chief among them are hardiness, grit, and general self-efficacy.[46] Hardiness refers to a set of attitudes or beliefs that provides the existential courage and motivation needed for enhanced performance in stressful circumstances.[47] Hardiness is a personality style marked by *commitment (vs. alienation)* which is the capacity to feel deeply involved or engaged in activities of life; *control (vs. powerlessness)* refers to confidence in one's ability to control events and influence outcomes; and *challenge (vs. threat)* refers to perceiving variety and change as an opportunity to learn and grow.[48]

Hardiness is considered a dispositional or trait-like resilience resource which theoretically predicts successful performance under stress.[49] There is a vast and growing empirical literature that supports this, and hardiness has also been shown to relate to a number of positive outcomes in military personnel under stressful conditions, including deployment.[50] It is reasonable to suggest that individuals who are high in hardiness would be more likely to be successful in the highly stressful and resource depleting conditions of A&S courses for high

45. Ibid.
46. Ibid.
47. Salvatore R. Maddi, "Hardiness: An Operationalization of Existential Courage." *Journal of Humanistic Psychology* 44, no. 3 (2004): 279–298.
48. Ibid.
49. Kevin J. Eschleman, Nathan A. Bowling, and Gene M. Alarcon, "A Meta-analytic Examination of Hardiness," *International Journal of Stress Management*, no. 4 (2010): 277–307.
50. Geoffrey J. Orme, and E. James Kehoe, "Hardiness as a Predictor of Mental Health and Well-being of Australian Army Reservists On and After Stability Operations," *Military Medicine* 179, no. 4 (2014): 404–412.

risk operational personnel. There have been a number of studies that support this contention. Hardiness was found to predict successful completion of Special Forces A&S (SFAS).[51] Studies in other similar rigorous military A&S programs have found hardiness to be a predictor of success in Norwegian border patrol military personnel,[52] and Israeli security forces.[53] More recently, the predictive value of hardiness was demonstrated in an A&S course for US special tactical law enforcement officers.[54]

Another important resilience construct to emerge in recent years is "grit." Grit is conceptualized as a dispositional tendency to pursue long-term goals with sustained interest and effort over a prolonged period of time.[55] Grit is independent of talent, and refers more to consistency of interests and perseverance of effort over time. Grit is thought to be a rather narrow facet of the larger personality domain of conscientiousness.[56]

Grit has also been studied in military personnel and has been found to be associated with retention in West Point cadets.[57] In a recent study, grit proved to be a robust predictor of successful completion of SFAS.[58] Importantly, the predictive effects of grit to completion of SFAS held when the effects of other important predictors such as general mental ability, physical fitness, and age were controlled.

General self-efficacy has also been studied in relation to prediction of successful completion of a rigorous A&S course. General self-efficacy

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51. Paul T. Bartone, Robert R. Roland, James J. Picano, and Thomas J. Williams, "Psychological Hardiness Predicts Success in US Army Special Forces Candidates," *International Journal of Selection and Assessment* 16, no. 1 (2008): 8–81.
52. Bjørn Helge Johnsen, Paul Bartone, Asle M. Sandvik, Rune Gjeldnes, Arne Magnus Morken, Sigurd William Hystad, and Anett V. Stornæs, "Psychological Hardiness Predicts Success in a Norwegian Armed Forces Border Patrol Selection Course," *International Journal of Selection and Assessment* 21, no. 4 (2013): 368–375.
53. Sima Zach, Shula Raviv, and Reuven Inbar, "The Benefits of a Graduated Training Program for Security Officers on Physical Performance in Stressful Situations," *International Journal of Stress Management* 14, no. 4 (2007): 350–369.
54. Picano.
55. Angela L. Duckworth, Christopher Peterson, Michael D. Matthews, and Dennis R. Kelly, "Grit: Perseverance and Passion for Long-term Goals," *Journal of Personality and Social Psychology* 92, no. 6 (2007): 1087–1101.
56. Ibid.
57. Ibid.
58. Lauren Eskreis-Winkler, Elizabeth P. Shulman, Scott A. Beal, and Angela L. Duckworth, "The Grit Effect: Predicting Retention in the Military, the Workplace, School and Marriage," *Frontiers in Psychology* 5 (2014): 1–12.

derives from Bandura's theory of self-efficacy[59] and refers to an enduring confidence in one's ability to meet situational demands and challenges. People high in general self-efficacy see themselves as having the ability to influence their environment and the accomplishment of their goals. In a study of the predictive effects of generalized self-efficacy in A&S of high-risk operational personnel, candidates higher in general self-efficacy were more likely to complete SFAS than those who were lower in generalized self-efficacy.[60]

Taken as a whole, findings from studies involving candidates in A&S courses suggest that highly resilient soldiers are emotionally stable with hardy attitudes including a high degree of motivation and commitment to achieve goals, a strong belief that they can control outcomes, a tendency to construe stressful events as challenges and opportunities for growth, and a confidence that they will be successful in meeting challenges they face. In addition, highly resilient soldiers are conscientious and persistent, with an unusually high capability to sustain interest and effort over long periods of time.

Life History Indicators of Resilience

A&S programs for high-risk operational personnel blend holistic or clinical approaches and traditional assessment centre methods.[61] Psychological interviews used in A&S courses tend to be focused more on broader clinical constructs than on the specific job competencies that are the target of other assessment centre methods such as simulations or situational tasks.[62] These interviews are fairly structured and focus on life history evidence of the candidate's psychological and emotional stability and resilience, training and performance potential, and risks for misconduct or security violations.[63] Such interviews typically yield an overall assessment or rating of an individual's psychological suitability for assignment, and there is good evidence to suggest that these suitability ratings are useful predictors of successful completion in A&S

59. Albert Bandura, *Self-efficacy: The Exercise of Control* (New York: W. H. Freeman, 1997).
60. Kerry A. Gruber, Robert N. Kilcullen, and Seppo E. Iso-Ahola, "Effects of Psychosocial Resources on Elite Soldiers' Completion of a Demanding Military Selection Program," *Military Psychology* 21, no. 4 (2009): 427–444.
61. Picano and Roland.
62. Ibid.
63. Ibid.

courses for high-risk operational personnel.[64] One approach used in an assessment centre for selecting high-risk military operational personnel evaluates five content areas: motivation, occupational fit, trainability, psychosocial stability, and personality competence. Interviewers generate ratings on a four-point scale for each interview area, as well as an overall assessment of suitability.[65] The assessment areas and sample indicators are shown in Table 4.1.

Suitability ratings for these dimensions can be reliably rated from structured interviews with a fairly high degree of agreement. A single factor underlies the five dimensions that is highly correlated with the average of the five domain ratings. The overall suitability rating given to the candidate by the psychologist predicted later selection in a rigorous A&S course over and above cognitive ability, physical fitness, and personality traits.[66]

What do suitability ratings based upon holistic assessments of individuals in A&S courses reflect? According to Office of Strategic Services (OSS) staff, the overall rating its members gave to a candidate was thought to reflect the "total potentialities of the candidate for meeting the challenges of life."[67] This description sounds very much like contemporary capacity definitions of resilience. Thus, suitable ratings that result from holistic assessments of individuals can serve as a good measure of an individual's resilience.

Conclusion

A&S programs for high-risk operational personnel with their multiple assessment methods focused on identifying the brightest, healthiest, and most adaptive individuals for specialized training and missions provide a unique environment for learning about resilience. Those who complete these courses have demonstrated positive adaptation to adversity (i.e., resilience). Studies show them to be smarter, fitter, hardier, and grittier than their peers, with greater potential to meet the challenges life presents.

From a theoretical perspective, the methods used in A&S courses may tap a broad fitness factor (F-Factor).[68] According to this theory,

64. Ibid.
65. Ibid.
66. Ibid.
67. Fiske, Hanfmann, MacKinnon, Miller, Murray, 217.
68. Miller. Sefcek and Figueredo.

Table 4.1.1 Interview Dimensions, Definitions and Sample Indicators

Interview Dimension	Definition	Sample Interview Content Areas/Life History Indicators
Occupational Fit	Elements of physical fitness, acquired military skills, operational experience	Fitness routines and physical fitness test scores Rugged or challenging hobbies/activities Military/civilian technical skills/licenses "Extreme" or "high-risk" recreational activities/hobbies Competitive athletics Military deployments/combat and field experience Previous military assignments Training schools attended and outcomes
Motivation/Initiative	Motives for seeking assignment (intrinsic vs. extrinsic)	Interest in assignment Career trajectory and fit Alternative career plans Current job satisfaction Understanding of implied job requirements/mission History of successful occupational striving
Trainability	Learning capacity as reflected in academic performance, educational attainment, verbal and communication skills	Oral and written communication-verbal fluency Foreign languages and fluency Previous level of academic achievement (degrees, GPA) Educational progression Academic honours (including in military training) Past successes/failures in military training courses Writing and verbal skills Information processing difficulties (including TBI or other acquired problems) Developmental learning/attention problems Observed mental processing speed and agility
Psychosocial Stability	Lifestyle, family and relationship stability, legal, moral and ethical behaviour	Developmental/early family stability Childhood conduct history (including school suspensions) Legal entanglements (including juvenile offenses) Problematic aggression/physical fights Domestic conflict Substance use/abuse Military judicial/non-judicial punishments Financial management/stability Marital/relationship stability Security risks

… continued

Table 4.1.2 Interview Dimensions, Definitions and Sample Indicators

Interview Dimension	Definition	Sample Interview Content Areas/Life History Indicators
Personality Fit	Aspects of personality competence including emotional stability, stress tolerance, and interpersonal skills	Past/current mental health issues Evidence of successfully coping with life challenges Integrity as reflected in owning up to problems and keeping commitments Impulse control problems Amicability, interview evidence of irritating qualities Evidence of persisting with challenges Team experience and orientation

Source: Author's compilation.

one hypothetical factor likely explains the shared variance indicated by small but robust correlations observed in population studies among measures of physical health, mental health (psychopathology), GMA or *g*, and the general factor of personality (GFP). More narrow measures comprising these broader constructs, such as those used in A&S courses (e.g., intelligence tests, personality tests, and hormonal, medical, and physical fitness tests) serve as fitness indicators of the underlying genetic quality of the individual, or mutation load of the individual.[69] Thus, the processes and procedures of A&S programs are likely tapping into the latent genetic fitness of individuals.

The most important, if not, sobering conclusion from this review of individual resilience indicators from A&S courses for high-risk operational personnel suggests that not all soldiers can become "super soldiers." Super soldiers will likely need to be deliberately recruited and specially selected for resilience.

Psychological resource models of resilience suggest that resilience is a limited resource for all military personnel, and can be depleted by high ops tempo, poor leadership, and disregard for factors that help sustain resilience, such as adequate sleep, exercise, and opportunities for rest and replenishment. Attention to these depleting factors and strategies to mitigate them can optimize resilience in individuals. Final-

69. Sefcek and Figueredo.

ly, evidence exists to suggest the individual resilience may be enhanced to some degree by external factors such as social support and cohesion, as well as directed interventions in resilience training.

5

Moral Autonomy and the Ethics of Soldier Enhancement

C. Anthony Pfaff

Prologue

In the spring of 1940, German General Heinz Guderian had a problem. He had convinced the German General Staff to allow him to lead the invasion of France with pure armored units, taking the tanks out of the infantry units they supported. By doing so, he believed he could overcome the German Army's inferior numbers and equipment by outmaneuvering the French and British forces and encircle them before they had a chance to react. To achieve this objective, the tanks would have to break through the Ardennes forest and get to the French city of Sedan before enemy reinforcements arrived.

At normal rates of march, even for the more mobile tank formations, moving that fast would be impossible unless they could drive and fight for at least three continuous days and nights with no stopping and thus, no rest. To overcome this obstacle, Dr. Otto F. Ranke, director of the Institute for General and Defense Physiology at the *Militärärztliche Akademie* (Military Medical Academy) in Berlin, prescribed the drug Pervitin, a variant of crystal methylamphetamine, to the attacking force. This drug had been used previously in smaller numbers in Poland, reportedly with good effect. As a result of this success, the German Army had ordered the production of 35 million more tablets, enough of which were

available for the invasion of France that in enabled the German panzers to break through the Ardennes in time to beat the reinforcing British and French forces, and thus force France's surrender a few weeks later.[1]

The increased alertness and endurance provided by the Pervitin came with a down side of course. Excessive Pervitin use caused circulatory and cognitive disorders, often impacting operations.[2] In some cases, it caused soldiers to become so jittery they imagined enemies who were not there. One SS unit in the East was easily overrun by Russians because after days of continuous Pervitin use, they fired at the slightest noise and had expended all their ammunition by the time the Russians actually attacked.[3] Even before the invasion of France, Ranke himself, who took Pervitin on a regular basis, had expressed concern about its side effects and insisted that its use be moderated and monitored.[4] The fact that his concerns were rarely adhered to emphasize the moral force "military necessity" can have on overriding more humanitarian concerns, even those directed at one's own people.

History credits France's rapid fall to Guderian's *Blitzkrieg*; however, had the soldiers in those units not been hopped up on crystal meth, that innovation may have failed and World War II would have proceeded very differently.

Introduction

Soldiers—as well as the governments that employ them—have long sought to enhance their ability to destroy the enemy and survive. For the most part, "enhancements" have come in the form of modernization efforts to improve the equipment soldiers use to amplify their destructive capabilities as well as defend themselves against the enemy. Today, however, medical technology is evolving to the point militaries no longer have to settle on simply improving soldiers' equipment, they now stand ready to improve the soldiers themselves.[5] It is this ability

1. Norman Ohler, *Blitzed: Drugs in Nazi Germany*, Shaun Whiteside, trans. (New York: Allen Lane, 2015), 67–88.
2. Ohler, p. 36. See also Andreas Ulrich, "The Nazi Death Machine: Hitler's Drugged Soldiers," *Der Spiegel*, (6 May 2005) at http://www.spiegel.de/international/the-nazi-death-machine-hitler-s-drugged-soldiers-a-354606.html
3. Lukasz Kamienski, *Shooting Up: A Short History of Drugs and War*, (Oxford: Oxford University Press, 2016), Kindle Edition, at Amazon.com, Location number 2902.
4. Ohler, p. 71.
5. David B. Larter, "Performance Enhancing Drugs Considered for Special Operations Soldiers," *Defense News* (16 May 2017) at http://www.defensenews.com/articles/

to improve the soldier that opens up ethical questions not normally associated with other acquisition efforts.

The potential life-saving benefits coupled with the potential life-altering side effects place commanders who would offer such enhancements as well as the soldiers who would receive them in a moral bind. Forcing soldiers to accept enhancements that could have debilitating side effects is the definition of exploitation. Allowing them to volunteer, however, is not much better. Making soldiers choose between death and suffering is a form of coercion; depending on the chances for each, the only rational choice would be "suffering." Thus, simply offering an enhancement in a military context can make the would-be recipient's consent irrelevant. For such compromise to be permissible it must be, in some sense, "fair," that is it must either be permissible to override consent or change the conditions of the offer such that consent is again relevant.

Defining Enhancement

For the purposes of this discussion, enhancement refers to any medical or biological intervention to the body intended to improve a capability or provide one that did not otherwise exist.[6] What this definition excludes are measures that restore diminished capabilities to normal functioning. So, for example, a prosthetic that allows an amputee to walk normally would not count as an enhancement; however, one that allows for greater than human speed or endurance even though there would not be normal functioning without it, would.

In the military context, it is also worth distinguishing between "offensive" and "defensive" measures. Since the best defence is a good offence, in some sense all measures may be considered defensive; however, there is a difference between measures intended to protect soldiers from the effects of enemy weapons and those that increase soldier lethality. The former reduces risk to soldiers, but because they are "defensive" in nature, they do not expose the soldier to additional risk.

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special-operations-command-wants-to-develop-super-soldiers. This article just specifies one particular initiative regarding soldier performance enhancement. As this article will describe, there are several underway seeking to alter body and mind in ways to make soldiers more lethal and resilient.

6. Patrick Lin, Maxwell Mehlman, and Keith Abney, *Enhanced Warfighters: Risk, Ethics, Policy* (Case Western University, Case Research Paper Series in Legal Studies, Working Paper 2013-2, January 2013), 17.

The latter, on the other hand, makes it more likely the soldier will be exposed to the enemy because they would be, by virtue of the enhancement, better able to manage those risks than a non-enhanced soldier.

For example, the pyridostigmine bromide (PB) provided to US soldiers during the first Gulf War to protect against the effects of nerve gas, would count as defensive since its intent was simply to prevent the specific effect of a particular weapon.[7] On the other hand, drugs like Pervitin, which were intended to improve cognitive endurance, would count as offensive since the intended effect was to enhance soldiers' lethality. In this context, it is tempting not to consider defensive measures as enhancements since in many ways their effect is to preserve normal functioning in an otherwise hostile environment. However, since they provide a capability soldiers do not naturally have— in this case the ability to better withstand a nerve gas attack—such measures would count as enhancements under the definition employed here.[8] Perhaps more importantly, taking them still places soldiers and their commanders in the bind described above and thus are worth moral consideration.

Human Enhancement Ethics: Civil Society vs. Military

In a broader discussion on the ethics of human enhancement in civil society, Patrick Lin and Fritz Allhoff argue that the *prima facie* freedom to choose how one lives one's life suggests there should be few restrictions on the kinds of enhancements persons should be allowed to accept.[9] Such freedom does not come without constraint as it not only

7. Ross M. Boyce, "Waiver of Consent: The Use of Pyridostigmine Bromide in the Persian Gulf War," *Journal of Military Ethics* 8, no. 1: 1–18. See also Lin, Mehlman, and Abney, 14–15. Lin et al. argue that vaccines are better thought of as "therapy" and thus not enhancements since they seek to prevent diseased conditions; however, they acknowledge this distinction may not apply in all contexts. Since PB use was not simply to prevent a diseased condition but also to enable soldiers to operate in an otherwise hostile environment, I will consider it as an enhancement for this discussion. See also Lin, Mehlman, and Abney, p. 48 for their discussion on PB use in the Persian Gulf War.
8. Lin, Mehlman, and Abney, 15. Lin, Mehlman, and Abney argue that for the most part vaccinations should not be considered enhancements and, rather, are better thought of as pre-emptive therapy. As they ask, "should it matter if a therapeutic intervention—that is, designed to restore health back to normal—is administered before or after an illness?" While this point suggests that some vaccinations would not count as enhancements, others, such as the PB administered to US troops in the Gulf War would since its purpose is to enable functioning in an environment (one where nerve gas is present) that a human being would not normally be able to function.
9. Patrick Lin and Fritz Allhoff, "The Ethics of Human Enhancement," *Nanoethics* 2

matters how the exercise of one's autonomy can affect others' exercise of their own, the physical effect of enhancements can negatively affect the individual who receives them and thus place a burden on society when those effects are more than the individual can bear. Thus, the deontic permission to seek enhancement is balanced by the more utilitarian concern regarding how pursuing such enhancements would affect the health and safety not only of oneself, but others as well.

In the military context, respecting freedom and autonomy is less concerned with whether one should be allowed to receive an enhancement as much as whether one may be *forced* to receive one. To the extent the enhancement represents the best response to an enemy advantage, military necessity will place a great deal of pressure on commanders to offer them and soldiers to accept. In providing the enhancement, however, one should not only consider the health and safety of the individual who receives it, but also the health and safety of those who do not, as the latter are less capable than their enhanced comrades of handling the rigors of combat and thus surviving.

Furthermore, how society treats its enhanced soldiers is a special concern for human dignity, but not just because of the potentially debilitating and isolating effects enhancements can cause. While these concerns are important, enhancements may also affect how society regards and rewards military service. Society rewards its soldiers precisely because they expose themselves to risks and hardships so that the rest of society does not have to. However, to the extent soldiers employ cogniceutical enhancements that control fear, for example, or physical enhancements to eliminate the source of fear, such as neural implants that allow soldiers to control weapons remotely, such regard and rewards will seem misplaced. If one does not experience fear, it makes no sense to reward one for displays of courage.[10] While enhancing soldier survivability and lethality always makes moral sense, enhancing it to the point of near-invulnerability (or even the perception of invulnerability) will profoundly alter the warrior identity. Soldiers who experience neither risk nor sacrifice are not really soldiers as we conceive of them now and are likely better thought of as technicians than warriors.[11] The concern,

(2008): 256.

10. Aristotle, *Nicomachean Ethics,* Terence Irwin, trans. (Indianapolis, IN: Hackett Publishing Company, 1985), 71–76.

11. Nick Bostrom, "Dignity and Enhancement," in *Human Dignity and Bioethics: Essays Commissioned by the President's Council on Bioethics* (March 2008) at https://bioethicsarchive.georgetown.edu/pcbe/reports/human_dignity/chapter8.html. In this

however, is that before we can address these issues, we first have to address the role moral autonomy plays in determining the permissibility of enhancements as defined here.

Moral Autonomy and Enhancement for Military Purposes

The story of stimulant use in the German Army underscores the central moral concern when it comes to enhancing soldier performance, especially for those in combat. Offering such an enhancement can force the soldier to choose between an increased likelihood of survival but with possible long-term and severe side effects and an increased likelihood of death or serious injury later on. Depending on how much soldiers perceive how receiving an enhancement affects the likelihood of these possible outcomes, they have few good reasons not to accept it: as long as the side effects are not lethal or significantly debilitating, suffering them will always "make sense." Placing someone in such a situation, where they have to choose between the possibilities of death or merely suffering, in effect robs them, to some degree at least, of their autonomy. By constraining their choices to outcomes they would not otherwise choose is very much like Marlon Brando's Godfather making people an "offer they can't refuse."

This loss of autonomy is central to the moral dilemma enhancements create. The German philosopher Immanuel Kant argued that the only

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article, Bostrom argues that one can acquire virtues by means of an enhancement as long as accepting the enhancement is a function of one's authentic self. For example, consider two people, one who was born with a calm temperament and one who was not, but has acquired it through disciplined control of her emotions. In this case, we should think the person who has acquired the disposition through choice rather than birth more authentically possesses the virtue. By extension, then, traits one acquires by virtue of enhancement, as long as the enhancement is one's choice and one chooses it in order to acquire the trait, then that trait is more authentically one's own than traits one has acquired by birth. Thus enhancements may not always have the corrosive effect on human dignity as some suggest. However, to the extent that possessing a trait depends on an ability to control one's response to an emotion, like fear, then one can only display the trait when the relevant emotion is present. So enhancements that eliminate or mask relevant emotions would preclude acquisition of the trait. Bostrom does note that the effects of enhancements on human dignity in general is complex and inconsistent. For example, enhancing one's empathy can undermine one's composure if one becomes overwhelmed by the suffering one perceives. So while it may be conceivable that enhancements can aide one in the acquisition of a virtue like courage, it is not clear that doing so would always entail a positive contribution to one's dignity.

thing that is good without qualification is the "good will" and that it is thus wrong to interfere with its proper exercise.[12] As he famously states, "Act so that you treat humanity, whether in your own person or in the person of another, always as an end and never a means only."[13] Treating persons as ends, and not merely as means, entails respecting their moral autonomy, that is, their ability to make choices and consent to the kind of treatment they receive. As Lin et al. explain, "Morality ordinarily requires the possibility of consent: to be autonomous is, at a minimum, to have the capacity to either give or withhold consent to some action."[14]

Unfortunately, as noted above, the act of providing enhancements in a militarized context seems to preclude genuine consent, thus violating Kant's imperative. Assuming the soldier is fully rational—a condition for the exercise of moral autonomy—what choice does he or she really have but to accept the enhancement? Of course much depends on what the effects actually are. Cost and benefits are, of course, measured against each other and not simply for quantity, but quality as well. Take, for example, efforts by the Defense Advanced Research Projects Agency (DARPA) to allow humans to control robotic systems through a neural interface that connects directly to the brain, even to the point of allowing the human to "feel" what the robot touches.[15] Though currently this research has mostly been applied to aiding amputees control robotic prostheses, this technology could conceivably enable soldiers to control robotic weapon systems remotely, thus limiting their exposure to risk.

The goodness of such an enhancement would seem compelling as it allows the soldier to operate some distance from the combat zone, thus significantly reducing risk. To the extent there are no side effects, there may be no concerns regarding autonomy: what rational person would not choose to reduce the chance of dying or being seriously injured for free? In such cases, offering such an enhancement is not morally

12. Immanuel Kant, *Foundations of the Metaphysics of Morals*, Lewis White Beck, trans. (Indianapolis, IN: Bobbs-Merrill Educational Publishing Company, 1983), 9–13. See also Bostrom, 85.
13. Kant, 47.
14. Lin, Mehlman, and Abney, 61.
15. Defense Advanced Research Projects Agency, "DARPA Helps Paralyzed Man Feel Again Using a Brain-Controlled Robotic Arm," (Defense Advanced Research Projects Agency website, 13 October 2016) at http://www.darpa.mil/news-events/2016-10-13. I owe this example to Jason Wesbrook.

problematic. As noted before, however, most medical and biological interventions come at a cost. Moreover, these costs may not be entirely known at the time of the intervention. So even when a procedure seems fairly safe, the complexity of the interaction between body and enhancement entails soldiers are almost always taking some risk.

Having said that, it is also not difficult to imagine that the side effects are known and potentially severe. Even then, it would still be rational for the soldier to accept the enhancement. German soldiers knew of the future negative effects of Pervitin but took the pills anyway, since doing so increased their chances of surviving in the present. As one German bomber pilot who participated in the Battle of Britain stated, "One wouldn't abstain from Pervitin because of a little health scare. Who cares when you are doomed to come down at any moment anyway?"[16] The point here, however, is not that "informed consent," which features significantly in most accounts of medical ethics, is impossible; rather, it is just that it is irrelevant to the ethics of offering enhancements that increase chances for soldiers' survival even at the expense of significant, long-term side effects.

The question, then, is when, if ever, would it be permissible to override a soldier's autonomy and offer, much less mandate, an enhancement? In too many cases, "military necessity" has sufficed to convince military officials to suspend rights to informed consent to either research or implement enhancements. In fact, the US government has exposed soldiers and civilians to measures such as mustard gas, radiation, as well as psychotropic drugs—too often without informed consent—in its efforts to better protect them from such threats in time of war.[17] More recently, in addition to ordering more than 600,000 soldiers to take PB for off-label use to mitigate the effects of nerve gas exposure, the military also ordered soldiers to take off-label drugs intended to protect against anthrax and mitigate the effect of traumatic brain injury.[18]

In this context it is worth asking the question, informed consent to what? Perhaps a soldier would prefer not to receive a particular enhancement; however, soldiers are subjected to a number of conditions and treatments they would prefer not—in the moment at least— to be subject. Put another way, by joining the military, soldiers consent to risk

16. Ohler, 114.
17. Efthimios Parasidis, "Human Enhancement and Experimental Research in the Military," *Connecticut Law Review* 44, no. 4, (April 2012): 1123. See also Boyce, 4.
18. Parasidis, 1128.

life and limb on behalf of their country and in doing so have not compromised their moral autonomy, despite the fact they would prefer to not lose either life or limb.[19] Moreover, they agree to take part in training that is, itself, also risky. In fact, soldiers may be compelled to receive medical treatment if failure to do so would keep them from their training or other duties, even if there were some risk of side effects from that treatment.[20] It is worth asking then, how is accepting risks associated with restorative medical treatment different from accepting the risk associated with performance enhancement measures. If soldiers consent to risk their lives in the face of an enemy, why then is it not reasonable to subject them to measures that might make them better able to face that enemy?

This rationale is likely compelling for many. It accommodates the utilitarian intuition that not only do such measures benefit soldiers more than it may harm, it also benefits the society they defend by making the military, as a whole, more effective. Moreover, it also seems to accommodate the deontic concern that—at some level at least—respect for persons has been accounted for as soldiers knew—or should have known—that such risks may be called for to defeat an enemy. This latter point could be stronger if it were actually the case that soldiers *explicitly* consented to the possibility of such treatment; however, even then we would not fully address our concerns regarding moral autonomy.

Those concerns begin with the observation that just because soldiers accept some risk, it does not follow they accept any risk. Moreover, in this context, it matters what the source of risk actually is. Assuming just cause, soldiers may be called on to risk their lives and well-being to defeat an enemy that has committed an act of aggression.[21] Here, however, the enemy is the source of risk and not the soldiers' chain of command. Thus the moral burden for that risk falls on the aggressing

19. Ross M. Boyce, "Waiver of Consent: The Use of Pyridostigmine Bromide during the Persian Gulf War," *Journal of Military Ethics* 8, no. 1 (2009): 2.
20. Michael Gross, "Military Medical Ethics: A Review of the Literature and a Call to Arms," *Cambridge Quarterly of Healthcare Ethics* 22 (2013): 92–93.
21. From the point of view of consistency, since aggressors bear the moral burden of a war, their actions, even when they conform to the law of armed conflict, are unjust. This point simply entails that aggressing soldiers do not have the same dilemma regarding enhancements as those defending against aggression. Any measures aggressors take to better defeat their enemy is unjust. From a psychological perspective, of course, most soldiers typically accept the justice of their cause, so regardless of side, would likely experience the enhancement dilemma the same way.

enemy. By ordering soldiers to undergo enhancements, however, the chain of command becomes the source of that particular risk.

Of course, the chain of command is the source of risk regarding possible harms associated with training. However, in this case it is worth noting that in practice there are typically limits on the kinds of training risks commanders should place on soldiers. For example, in the US Army, soldiers must volunteer for training that is especially risky, such as parachute training, before being allowed to take it. If they do not volunteer, they are not subject to any additional risk in training or in combat. If one chooses not to undergo parachute training, one does not have to assume the same risks paratroopers do.

It is also worth pointing out that risk in training is also qualitatively different from that associated with the more problematic enhancements. Harms associated with training are rarely certain. While there are always training accidents, each accident is, in principle, preventable. However, with medical treatment in general, and enhancements in particular, there is typically a known percentage of any population who will be negatively affected. An individual may not know if he or she will be one of those who suffer any side effects, but commanders would (or at least should) know that some will.[22] So, for imposing that risk to be moral, there must be some permission in place that allows for overriding (or at least ignoring) the individual soldier's autonomy or one has to establish conditions where soldier consent is relevant again.

In general, the moral rationale for overriding soldier autonomy, especially in the cases of off-label drug use described above, rests on a combination of military necessity, the fact that these measures benefitted the soldier, the inability to obtain informed consent, and lack of any effective alternatives that could either account for informed consent or a measure that would not require it.[23] Simply put: given the lack of morally preferable alternatives, the benefit of saving soldiers' lives exceeded the costs of potential non-lethal side effects. Moreover, "allowing soldiers to refuse these drugs, which the DoD [Department

22. This point was apparently true for the administration of PB in the Gulf War. See One Hundred and Sixth Congress, Joint Hearing before the Subcommittee on Health and Subcommittee on Oversight and Investigations of the Committee on Veterans Affairs House of Representatives, "Possible Health Effects of Pyridostigmine Bromide on Persian Gulf War Veterans," (Washington, DC: U.S. Government Printing Office, 16 November 1999), 5, at https://www.gpo.gov/fdsys/pkg/CHRG-106hhrg62452/pdf/CHRG-106hhrg62452.pdf.
23. Lin, Mehlman, and Abney, 47. See also Parisidis, 1125.

of Defense] considered safe and effective, might cause a greater level of battlefield casualties and further burden protected soldiers."[24] The difficulty here, of course, is what counts as safe and effective now may not be so later on. For example, after the war, studies found that PB use resulted in cognitive difficulties, widespread pain, skin rashes, respiratory and gastrointestinal problems, and other chronic abnormalities.[25] What effect these long-term conditions have on quality and length of the lives of those effected could not have been fully taken into account since at the time they were not known.

It is likely impossible to fully resolve concerns regarding moral autonomy and enhancements that offer a greater chance of survival but at the expense of severe side effects. Having said that, it may be possible to describe instances where violations of other person's rights may be permissible while still treating them as an ends and not, as noted above, merely as a means. Arthur Isaak Applbaum argues that in situations when one's action may harm another, it is "fair" to act if out of the population affected, no one is worse off and at least one person is better off.[26] To illustrate, he relates the famous thought-experiment offered by the twentieth-century British philosopher Bernard Williams, "Jim and the Indians." After a series of anti-government protests in the Amazon, an army captain has arrested twenty indigenous villagers at random. Just as he is about to execute them all to discourage further political protest, a foreigner, Jim, happens to arrive on the scene. The evil captain gives Jim a choice: if he selects and kills one of the villagers himself, the captain will release the other nineteen. If he refuses, however, the captain will kill them all.[27]

The tension here, much like in the case of enhancements, is that the utilitarian "common sense" conclusion is to kill one. Moreover, from a

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24. Boyce, 7.
25. Parisidis, 1126. See also Food and Drug Administration, "Protection of Human Subjects; Informed Consent, Exception from General Requirements," Federal Register, Vol. 64, No. 192 (5 October 1999) at https://www.fda.gov/ScienceResearch/SpecialTopics/RunningClinicalTrials/ucm119107.htm. It is worth noting that that FDA rescinded its permission to forego informed consent when administering PB in 1999, after receiving numerous complaints regarding potential side-effects.
26. Arthur Isaak Applbaum, *Ethics for Adversaries: The Morality of Roles in Public and Professional Life*, (Princeton, NJ: Princeton University Press, 1999), 162–166. Applbaum refers to situations where someone is better off and no one is worse off as "avoiding Pareto-inferior outcomes." Avoiding such outcomes can count as "fair" and warrant overriding consent.
27. Applbaum, 151.

purely rational point of view, it seems that the villagers should want Jim to agree. If the goal of the individual villagers is to survive, their chances go from zero to one in twenty if Jim agrees. Thus, from the point of view of the villager, much like the enhanced soldier, it always makes sense to choose a chance at life—even a morally or physically compromised one—than certain death. Even after Jim chooses whom to shoot, the victim could still reasonably agree that, given the circumstances, that Jim's act is fair, even if being placed in those circumstances is not.[28] Because the circumstances are not fair, however, this rational stance does not count as consent. The villagers (in this story) did not agree to detention or to be subject to the possibility of being killed. However, having been placed in that situation, the only seemingly rational thing to *want* is that Jim shoot one.

Shooting one villager, however, does not mean Jim does the morally correct thing. Jim simply serves as the agent of the evil captain, and while we might understand Jim's reasons, he still has violated the rights of whomever he shoots. The problem here, put simply, is that utility, as well as its corollary, military necessity, take only into account the circumstances one is in and make no room for other moral commitments. Because they make no room for other moral commitments, they rule out no particular kinds of acts.[29] Moreover, such reasoning places one in the position of jettisoning the very moral commitments that typically justify fighting in the first place, namely the universal rights to life and liberty.[30]

Applbaum's point here, however, is that one can make a commitment to fairness that accounts for respect for persons while at the same time allowing circumstances where it may be permissible, even *fair*, to act in a way to which someone does not consent. As he notes, "If a general principle sometimes is to a person's advantage and never is to that person's disadvantage, then actors who are guided by that principle can be understood to act for the sake of that person."[31] In Jim's case, for example, none of the villagers is worse off if he kills one and

28. This point assumes that the selection process itself was "fair" at least from the standpoint of the locals.
29. Michael Walzer, "Political Action: the Problem of Dirty Hands," in *War and Moral Responsibility*, ed. Marshall Cohen, Thomas Nagel, and Thomas Scanlon (Princeton, NJ: Princeton University Press, 1974), 70.
30. Michael Walzer, *Just and Unjust Wars: A Moral Argument with Historical Illustrations*, (New York: Basic Books, 1977), 53–55.
31. Applbaum, 151.

the remaining nineteen are better off. To the extent Jim distributes the risk of being shot equally, each villager would reasonably, if not rationally, choose that Jim shoot one.[32] So rather than understanding his act simply as maximizing the utility of a given population, it is better to understand the choice to shoot the one as acting fairly, since given the circumstances he is placing most at an advantage and no one at a disadvantage.

Regarding enhancements, this point suggests that defensive enhancements are more likely to pass this test than offensive ones. Given that defensive enhancements are a response to a capability the enemy has, then in general no one is worse off and some might be better off for receiving it. This point, of course, assumes that everyone has equal exposure to risk. In the case of PB, for example, given that nerve gas can be delivered by long range missiles and artillery, anyone within range of those systems could be vulnerable, thus everyone would benefit from the drug and no one would be worse off. However, that would only be the case if everyone actually experienced a nerve gas attack. In fact, as things turned out, the Iraqis never did use such weapons. So no one benefitted from its use and some people, given the reported side effects, were worse off.

However, this objection does miss the point regarding the nature of combat. Combat occurs unevenly and, regardless of the intensity of the conflict, some will experience contact with the enemy and some will not. Moreover, even among those who do, the danger that enemy contact represents will always—and uncontrollably—be inconsistent. Thus, soldiers, much like the local Jim chooses at random to shoot, cannot know before they have to choose whether they will be affected or not. This situation is not unlike John Rawls' "veil of ignorance," where persons choose what institutions to live under and what rules to live by without knowing their particular position in that society. Under the "veil" persons would rationally choose institutions and rules that benefitted the most people.[33] This rationality is due, in part, because goods and harms are, conceptually at least, evenly distributed. If one does not

32. Applbaum, 163–164. The account of rationality I employ here assumes survival as the highest goal. That may not always be the case. Applbaum acknowledges the point made by Christine Korsgaard who argued that the "right" choice can depend on other factors besides survival. The villagers, for instance, could be committed pacifists and not want Jim to participate in the evil captain's scheme. In that case, it may not be fair for Jim to decide to shoot the one.

33. John Rawls, *A Theory of Justice* (Cambridge, MA: The Belknap Press, 1971), 136–142.

know one's lot in life, one does not know what sort of arrangements, like an income tax rate, will be to one's advantage or not. In the nerve agent case, then, the reasonable thing to do is treat the likelihood of experiencing an attack as equal and then ask the question who is better off and who is not with the enhancement. The answer will likely be, given that one has the same chance of experiencing a nerve gas attack as anyone else in one's situation and given that in the event of an attack it is better to have taken the PB, then all things being equal, it is rational to require everyone to take the PB.[34] Doing so, as Applbaum notes, is a way of respecting persons since, again all things being equal, in the event of an attack that is what a rational person would have chosen.

This notion of fairness, however, does not seem to work as well with offensive enhancements. Given the logic of military necessity, it just makes sense to commit one's most survivable and lethal systems to battle since they stand the best chance to defeat the enemy. Thus it seems reasonable to expect that those who have offensive enhancements will more likely be committed to direct combat than those who do not. While it is possible that these enhancements will offset some of that risk, statistically speaking, repeated exposure to danger ensures at some point one will be harmed. This point means that by accepting offensive enhancements, soldiers could be worse off than those who do not accept them. Not only are they likely to experience increased risk, they will also have to deal with whatever side effects the enhancements entail.

The point here is not that offensive enhancements may not ever be permitted. Recall that the horns of this dilemma rest on the assumption that soldiers who refuse the enhancement will be committed to battle anyway and experience the same risks as soldiers who did accept it. The way out then is to alleviate the conditions that compromised the soldier's autonomy in the first place. Doing so requires meeting three conditions: (1) soldiers must have the option to consent to the enhancement; (2) their consent must be informed; and (3) if they do not consent, they will not be required to accept as much risk as enhanced soldiers. When it comes to offensive enhancements, enhanced soldiers must be

34. "All things being equal," in this context, means that the other conditions articulated earlier also hold: military necessity, safety of the enhancement, benefit to the soldier, the inability to obtain informed consent, and lack of any effective alternatives. It is worth noting, as cited earlier, that the side effects of PB use exceeded what was expected based on previous use of the drug.

genuine volunteers.

Conclusion

Human enhancement, even apart from war, is morally problematic. In the civil context, where enhancements are typically intended to enhance quality of life, they still raise concerns about autonomy, equality, safety, social stability, and human dignity. The logic of enhancements in civil society, however, suggests little reason to bear much risk or cost in their acquisition. If the purpose of an enhancement is to improve quality of life, then it makes little sense to tolerate much suffering for oneself or society. The logic of military applications, on the other hand, amplify these concerns and turn some on their heads. Because the purpose of military enhancements is to increase lethality and survivability, it does make sense to accept a fair amount of inequality, suffering, social disruption, and isolation. As a result policies regarding the norms of enhancement acquisition are going to look very different in civil and military contexts.

In the civil context, autonomy concerns address what permissions should govern who may get an enhancement. In the military context, however, autonomy concerns are reversed and address rules about who must accept an enhancement. Determining who must entails establishing an account of fairness that permits overriding individual consent in favor of the greater good. In such an account, the character of the enhancement—defensive or offensive—will matter. Regarding defensive enhancements, overriding individual consent may be permissible, all other things being equal, if someone is better off and no one is worse off. Offensive enhancements are a different matter. Because offensive enhancements can place recipients in a position of greater risk, whether from increased exposure to the enemy or as a result of possible side effects, those recipients could be worse off than non-recipients. Moreover, as is the case with enhancements in general, even the offer can be coercive, to the extent it forces the soldier to trade off between death and suffering. The only way to maintain a standard of fairness in this context, then, is not only to require informed consent but also ensure no increased risk if the soldier refuses.

Establishing fairness or restoring the relevancy of consent are, of course, only necessary conditions. As discussed, enhancements also need to be necessary and proportional. They should be necessary in that the enhancement not only conveys an advantage but also avoids

a disadvantage as well. This standard of necessity is somewhat higher than that normally associated with military necessity, which only requires an advantage. However, given the potential harms associated with enhancements, if one can win the war without enhancements, one should. The effects of any enhancements should also be proportional, in that the aggregate harm to autonomy, health and safety, society, and dignity are outweighed by the additional security and resilience the enhancement brings.

Taken together, the real risk of enhancements may be in how their application will affect the soldier and thus the military profession's relationship with the larger society it serves. Changing the nature of the soldier changes the military and changes in the military can have profound impacts on society. The point here is not to avoid enhancements. The rapid pace of technological development, especially in the context of international competition, assures that enhancements will be a part of future military acquisitions. Thus the point is that policies regarding the ethics of enhancements will also constantly evolve and thus policymakers will require constant attention to the moral categories associated with their development and implementation.

6

Virtuous Super Soldiers?

Jesse Kirkpatrick

Introduction

Emerging developments in science and technology have resulted in increasing opportunity to enhance soldiers. Advocates of soldier enhancement argue that enhancing soldiers will increase troop readiness, battle effectiveness, and, in some cases, protect soldiers from the physical and psychological trauma of battle. Others find the prospect of creating so-called super soldiers unsettling, and worry about the potential negative impacts enhancement may have on both society and soldiers in the long term. Much of the debate surrounding soldier enhancement has neglected to investigate the relationship between enhancement and martial virtue. This chapter explores this relationship with the goal of clarifying the compatibility between enhancement and virtue, giving special attention to enhancements designed to promote pro-social virtues.

Soldier Enhancement

Human enhancement can be defined as increasing capabilities "beyond the species-typical level or statistically-normal range of functioning for an individual."[1] This may include enhancing mood, cognitive functions, or physical attributes. Scientific understanding, coupled with

1. Norman Daniels, "Normal Functioning and the Treatment-Enhancement Distinction," *Cambridge Quarterly of Healthcare Ethics* 9 (2000): 309–322.

emerging technologies, increasingly make the possibility of human enhancements that were once considered the stuff of science fiction all the more real. Whether it is wearable technology, such as exo-suits, or pharmacological enhancements, such as performance enhancing amphetamines, scholars have engaged in sharp debate surrounding the ethics of enhancement.[2] These debates include concern over the implications of enhancement on individuals' authenticity,[3] the implications for enhancement on individual autonomy,[4] enhancement and gender norms[5], and the societal implications of distributing the benefits and burdens of enhancement.[6]

Perhaps unsurprisingly, scholars have echoed similar concerns when it comes to enhancing members of the military (which I will generically refer to as "soldiers"). While there is crossover between soldiers and the broad ethical concerns related to civilian enhancement, there exist ethical issues related to enhancement that are specific to warfighters. These include worries over potential exploitation of soldiers, long-term health implications of enhancement, and the potential to widen the

2. See Nick Bostrom and Julian Savulescu, "Human Enhancement Ethics: The State of the Debate," in *Human Enhancement,* ed. Julian Savulescu and Nick Bostrom (Oxford: Oxford University Press, 2009), 1–25; Norman Daniels, "Can Anyone Really be Talking About Ethically Modifying Human Nature?" in *Human Enhancement,* ed. Julian Savulescu and Nick Bostrom (Oxford: Oxford University Press, 2009), 25–43; and Michael Sandel, "The Case Against Perfection: What's Wrong With Designer Children, Bionic Athletes, and Genetic Engineering," in *Human Enhancement,* ed. Julian Savulescu and Nick Bostrom (Oxford: Oxford University Press, 2009), 71–91. Also see Fritz Allhoff, Patrick Lin, James Moor, and John Weckert, *Ethics of Human Enhancement: 25 Questions & Answers* (Washington, DC, National Science Foundation, August 2009); Frances Kamm, "Is There a Problem with Enhancement?" *The American Journal of Bioethics* 5, no. 3 (2005): 5–14; *idem*, "Response to Commentators on 'What's Wrong with Enhancement?'" *The American Journal of Bioethics* 5, no. 3 (2005): W4–W9; and Larry Temkin, "What's Wrong with Enhancements?" *Journal of Medical Ethics*, 39, no. 12 (2013): 729–731.
3. See David Degrazia, "Prozac, Enhancement, and Self-Creation," *Hastings Center Report* 30, no. 2 (2000): 34–40. Also see Neil Levy, "Enhancing Authenticity," *Journal of Applied Philosophy* 28, no. 3 (2011): 308–318.
4. G. Owen Schaefer, Guy Kahane, and Julian Savulescu, "Autonomy and Enhancement," *Neuroethics* 7, no. 2 (2014): 123–136.
5. Robert Sparrow, "Sexism and Human Enhancement," *Journal of Medical Ethics* 39, no. 12 (2013): 732–735. Also see Jeff McMahan, "Genetic Modification of Characteristic Masculine Traits: Enhancement or Deformity?" *Journal of Medical Ethics* 39, no. 12 (2013) 736–740.
6. Felice Marshall, "Would Moral Bioenhancement Lead to an Inegalitarian Society?" *The American Journal of Bioethics* 14, no. 4 (2014): 29–30.

civil-military divide.[7] Many of these concerns are a consequence of the unique hierarchical structure of the military as an institution, and the special role that its members have within society more broadly. From uniform codes to deployments, soldiers' lives are controlled by commanding officers in ways that one would be hard-pressed to find in civilian life. With diminished freedom and autonomy, the acute vulnerability of soldiers makes a comprehensive ethical analysis of each and every proposed enhancement imperative.

In a 2013 report, Patrick Lin et al. explicated a number of recommendations to mitigate ethical issues specific to soldiers. These include the requirement that enhancements meet certain justificatory criteria, such as the prerequisite that they occur only because they are necessary and performed for a legitimate military purpose.[8] In addition, the authors argue that soldier enhancements should ensure that soldiers' dignity is maintained, burdens are minimized, and that the benefits outweigh the risks.[9]

I, too, agree that such broad issues must be given due care when considering the ethical implications of soldier enhancement. Nevertheless, I wish to focus on a single area of concern that has received comparatively little attention: the implications soldier enhancement could have on the warrior ethos and martial virtue.

The Warrior Ethos and Martial Virtue

Cultures throughout history have developed unique ethos specific to their warriors. This "warrior ethos" can be defined as the formal and informal collection of tradition, history, rules, regulations, customs, and norms that have been developed by a society, its military, and its members; when taken together these constitute what it means to be a member of that military.[10] The warrior ethos embodies the understanding of what it is to be a sailor, soldier, airman/woman, and a Marine.

The warrior ethos found in contemporary militaries is often informed

7. For a thorough examination of the ethical implications specific to soldiers see C. Anthony Pfaff, "Moral Autonomy and the Ethics of Soldier Enhancement," chapter 5 in this volume.
8. Patrick Lin, Maxwell J. Mehlman, and Keith Abney. *Enhanced Warfighters: Risk, Ethics, and Policy* (New York: Greenwall Foundation, 2013), 66–76.
9. Ibid.
10. For a discussion of the warrior code, see Shannon E. French, *The Code of the Warrior: Exploring Warrior Values Past and Present* (Lanham, MD: Rowman & Littlefield Publishers, 2003).

by core values. For example, the United States Army's core values are defined as loyalty, duty, respect, selfless service, honour, integrity, and personal courage. Similarly, the Canadian Armed Forces include duty, loyalty, integrity, and courage. Although these core values are generally familiar to most readers, the idea that they are, in some cases, synonymous with, or closely linked to, martial virtue is likely less familiar. There is, of course, some variation between cultures; nevertheless, the majority of militaries across the globe, in part, define the ethical underpinnings of the warrior ethos as comprising martial virtue.[11] Armed services ranging from France to Japan feature the martial virtues as part of their professional military education, and often with significant overlap and agreement on what specific virtues constitute martial ones. We find similar articulations of virtues in militaries across the globe.

We can understand virtues as traits of character that can be acquired and cultivated,[12] which are beneficial for both the individual and for others, require right intent, and are (and can only be) exercised in service of a just end.[13] This description of virtue implies that virtues result from habituation and practice, and that they require an agent's intent, judgment, and knowledge of their exercise and pursuit. In addition, virtues are attributable to an agent's character; they are embodied in the kind of person one is—i.e., an individual in possession of a particular virtue or virtues. This characterization stands in contrast to an individual who merely exercises or acts in a way that *resembles* a virtue. We may say that it takes an act of courage to fly a highjacked airplane into a building, but we would not say that this is an exercise of the virtue courage. Not only does such an act lack a just cause and is committed with bad intent, but it also lacks the proper practice, habituation, and character, which is essential to attaining the virtue courage.[14] Finally,

11. Paul Robinson, "Introduction: Ethics Education in the Military," in *Ethics Education in the Military,* ed. Paul Robinson, Nigel De Lee, and Don Carrick (Aldershot, England: Ashgate, 2008).
12. The focus on the agent and her character denotes that virtues entail a disposition, a way of being. A connection between virtue and character dates to antiquity. See Aristotle, *The Nicomachean Ethics* (Indianapolis, IN: Hackett Publishing Company, 2014), 1107a.
13. The features of what constitute a virtue are, of course, a matter of great debate. For a useful discussion on the question of whether a virtue must serve a just cause, see George Kateb, "Courage as a Virtue," *Social Research: An International Quarterly* 71, no. 1: 39–72.
14. For a fuller discussion of the distinction between an act and a virtuous act, see Jesse Kirkpatrick. "Drones and the Martial Virtue Courage," *Journal of Military Ethics* 14, no. 3–4 (October 2015): 202–219.

because virtues develop within a practice, they require practical reasoning and prudence concerning their proper exercise. For example, the virtue courage will look very different when considering the context; the courage required of a mother will be different from the courage of a sexual assault survivor, or a paramedic, or a soldier.

Given that virtues are traits of character that can be acquired and cultivated, and they vary according to the practice in which one is engaged, martial virtues are the qualities and traits of character that are specific to the practice and profession of arms. In sum, possession of certain virtues is what is required to be a just and ethical soldier; these virtues, in turn, form the ethical core of the warrior ethos. It is no wonder why militaries, and societies, find the kind of character development intrinsic in virtuous ethics appealing: virtues are thought to help guide behaviour in complex environments and situations, and to help cultivate a particular character that embodies the spirit, ethos, and conduct that is desired in the role and practice of being a warrior. It is what separates the warrior, who uses legitimate, ethical force, from a mere criminal or mercenary.

Martial Virtue and Emerging Technologies

The core concept of martial virtue has endured, and virtues specific to the military remain. But as military technology has evolved, it has continuously shaped and informed the definition of particular martial virtues. For example, take the martial virtue courage, which changed as new technologies were introduced. In reaction to the introduction of gunpowder in battle, a prominent European nobleman declared in the 1500s, "so many brave and valiant men" to be killed by "cowards and shirkers who would not dare to look in the face the men they bring down from a distance with their wretched bullets."[15] Speaking of the warrior ethos more generally, writing in 1814, the scholar Benjamin Constant lamented:

> The new way of fighting, the changes in weapons, artillery, have deprived military life of what made it most attractive. There is no longer any struggle against danger…Courage itself must be tinged with resignation or indifference. We no longer enjoy…the development of our physical and moral faculties that made hand-to-hand

15. Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York: Penguin, 2006), 22.

> fighting so attractive to the heroes of antiquity or to the knights of the Middle Ages. War has lost its charm.[16]

With the introduction of repeat action weaponry, a French general commented after the Battle of Verdun in 1916 that, "three men and a machine gun can stop a battalion of heroes."[17] What was once the peak of courage, to stand firm in the phalanx or the firing line, became, with the introduction of the machine gun, recklessness or even lunacy. Such interplay between martial virtue and emerging technologies is a recurrent theme throughout the history of warfare.[18]

Like the invention of gunpowder, military aviation, and long-range missiles, all of which radically altered warfare, we now face a similar technological inflection point. Fuelled by the desire to gain military advantage in the twenty-first century, governments worldwide are leading major research and development efforts in priority areas, including soldier enhancement. And, as they have in the past, these technological developments are raising concern over how they may transform existing warrior ethos and martial virtues. Take, for example, philosophers writing in the *Australian Army Journal*, who conclude, "there is a real risk that enhanced personnel will challenge the army's core values to such an extent that they will contest what it means to be an Australian soldier. In so doing, they may challenge, undermine or redefine core army values."[19] Such concerns are not unfounded; soldier enhancement, and emerging technologies more generally, has the capacity to disrupt existing conceptualizations of warrior ethos. In addition, particular enhancements that increase soldier lethality will likely add to general concern surrounding the possibility that enhancement will make super soldiers super killers, an idea that some individuals find unsettling.[20]

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16. Benjamin Constant, "The Sprit of Conquest" in *Political Writings*, Biancamaria Fontana trans. (New York: Cambridge University Press, 1988), 55.
17. Margaret MacMillan, *The War That Ended Peace: The Road to 1914* (New York: Random House, 2013), 326.
18. See Jesse Kirkpatrick, *Drones, Robots, and Super Soldiers: Emerging Technologies and Military Virtue* (Cambridge, MA: Harvard University Press, under contract).
19. Matthew Beard, Jai Galliott, and Sandra Lynch, "Soldier Enhancement: Ethical Risks and Opportunities" *Australian Army Journal* 13, no. 1 (2016).
20. See Eric Tegler, "Russia and China's 'Enhanced Human Operations' Terrify the Pentagon," *Popular Mechanics*, 15 December 2015, at http://www.popularmechanics.com/military/research/a18574/enhanced-human-operations/

Pro-Social Soldier Enhancement

While such concerns may be valid, I want to instead focus on a particular type of enhancement that may contribute to positive ethical outcomes even in the face of potentially challenging and redefining martial virtue.[21] What I mean are enhancements designed to augment pro-social traits and behaviour. Pro-social behaviour is behaviour that is considered positive, helpful, and of benefit to other individuals and to society more broadly. Such behaviour is familiar to us. Whether it is helping someone carry his baby stroller up the stairs or giving up one's seat on the bus, we know it when we see it. Some pro-social traits of character include altruism, self-sacrifice, empathy, composure, and calmness. Acquiring or augmenting these traits can be defined as what some philosophers call moral enhancement—enhancements designed to make humans morally better.[22]

As may be obvious, some of these qualities will be desirable for militaries to enhance. Early research in mice suggests the drug Ketamine, an anesthetic typically used in animals, *may* attenuate fear and stress when used prophylactically.[23] While it may be currently a big jump from mice to humans, potential therapeutic applications of Ketamine are certainly on people's minds. This is evidenced by such academic articles as, "From Mice to Men: Can Ketamine Enhance Resilience to Stress?"[24] We can imagine how such enhanced resilience could not only

21. Space does not permit me to address the relationship between pro-social traits of character and martial virtues. I do believe, however, that pro-social character traits are compatible with, and could enhance, such time-tested virtues as loyalty, duty, and honour.
22. See Joan Specker, Farah Focquaert, Kasper Raus, Sigrid Sterckx, and Maartje Schermer, "The Ethical Desirability of Moral Bioenhancement: A Review of Reasons," *BMC Medical Ethics* 15, no. 67 (2014); Ingmar Persson and Julian Savulescu, *Unfit for the Future: The Need for Moral Enhancement* (Oxford: Oxford University Press, 2012).
23. Josephine C. McGowan, Christina T. LaGamma, Sean C. Lim, Melina Tsitsiklis, Yuval Neria, Rebecca A. Brachman, and Christine A. Denny, "Prophylactic Ketamine Attenuates Learned Fear," *Neuropsychopharmacology*, (2017); Rebecca A. Brachman, Josephine C. McGowan, Jennifer N. Perusini, Sean C. Lim, Thu Ha Pham, Charlene Faye, Alain M. Gardier, Indira Mendez-David, Denis J. David, Rene Hen, and Christine A. Denny, "Prophylactic Against Stress-Induced Depressive-like Behavior," *Biological Psychiatry* 79, no. 9 (May 2016m): 776–786; Linda Li and Phillip E. Vlisides, "Ketamine: 50 Years of Modulating the Mind," *Frontiers in Human Neuroscience* 10 (2016): 612; and Rebecca B. Price. "From Mice to Men: Can Ketamine Enhance Resilience to Stress?" *Biological Psychiatry* 79, no. 9 (2016): e57–e59.
24. Rebecca B. Price. "From Mice to Men: Can Ketamine Enhance Resilience to Stress?" *Biological Psychiatry* 79, no. 9 (2016): e57–e59.

increase combat effectiveness during kinetic engagements, but how it could also benefit soldiers engaged in hearts and minds counterinsurgency campaigns, where positive relations with local populations are crucial for success.

Enhancing pro-social traits through fear reduction and stress resilience would not only be strategically and prudentially beneficial in such environments, it could also result in positive ethical outcomes. (I do not mean to suggest that prudential and ethical benefits are mutually exclusive; they are not, although they can be.) We could imagine a reduction in civilian casualties that result from soldiers' stress, fear, or anger, or, perhaps, more humane engagement with civilian populations and better treatment of prisoners of war. All of these are examples of positive ethical outcomes from pro-social enhancement.[25]

Another possible candidate for pro-social enhancement is use of the hormone Oxytocin. As Dubljevic and Racine note, "early evidence indicated that this neuropeptide plays a critical role in social cognition, bonding, and affiliative behaviors," which makes it potentially suitable as a neuro-enhancer for soldiers.[26] Not unlike stress and fear attenuating enhancements, enhancing such pro-social behaviours as affiliative bonding could result in more effective engagement with civilian populations. There is also the possibility that pro-social enhancements could lead to deeper and stronger bonds between soldiers. This may result in such benefits as greater unit cohesion, trust, and loyalty. Enhancing social cognition and affiliative behaviours could also contribute to reducing rates of sexual assault, which remains a persistent issue across all of the U.S. Armed Forces.[27]

If our desire is for philosophical consideration to contribute to smart and informed defence policy, then it is necessary to tie our ethical evaluations of potential enhancement to what is technologically achiev-

25. It is, of course, possible that facilitating too much calmness and restraint in soldiers could have adverse impacts on their ability to effectively carry out the mission.
26. Velijko Dubljevic and Eric Racine, "Moral Enhancement Meets Normative and Empirical Reality: Assessing the Practical Feasibility of Moral Enhancement Neurotechnologies," *Bioethics* 31, no. 5 (2017). See also Heather E. Ross and Larry J. Young, "Oxytocin and the Neural Mechanisms Regulating Social Cognition and Afflictive Behavior," *Frontiers in Neuroendocrinology* 30, no. 4 (October 2009): 543–547.
27. For an overview of sexual assault in the U.S. Armed Forces see "United States Department of Defense," *Annual Report on Sexual Assault in the Military: Fiscal Year 2016* (Washington, DC: prepared by the United States Department of Defense Sexual Assault Prevention and Response Office, [SAPRO], 2017).

able. To divorce our considerations from scientific understanding of enhancement runs the risk of engaging in idle speculation that is untethered from reality. Consequently, these two candidates for soldier enhancement are mere examples; they are to be taken as illustrative and not definitive. I readily admit that there may be alternative forms of enhancement that are more likely to appear on the horizon and are more suitable for enhancing pro-social behaviour.

The Compatibility of Enhancement and Virtue

Pharmacological interventions are representative of one avenue by which soldiers' pro-social behaviours could be enhanced; there may be preferred alternatives. Nevertheless, using Ketamine and Oxytocin as heuristic examples of potential pathways to enhancing pro-social traits in soldiers allows us to explore the possibility that enhancements may be incompatible with virtue.[28] This concern turns on the belief that virtues result from habituation and practice. Furthermore, virtues must be attributable to an agent's character, not simply her singular actions. And because virtue and character require training, practice, and habituation, how the given virtue is attained matters. Consequently, if enhancements are used as proxies for habituation, practice, and learning, they could cheapen the acquisition of traits of character that would otherwise be acquired through hard and dedicated work. This could, in turn, lead to an erosion of virtue in soldiers who might cultivate the desired traits of character in the absence of enhancement.

The problem with this concern is that it is predicated on a false premise—the belief that enhancements are mutually exclusive of an agent's character. It denies the possibility that enhanced individuals could continue to engage in habituation and practice of the enhanced trait(s) in ways that complement and are in keeping with the agent's character. We could imagine a virtuous soldier who, through hard work, habit, and practice, has cultivated loyalty; she is loyal to her comrades, her compatriots, and to those she has sworn an oath to serve. In addition, she critically reflects on the possibility that loyalty may come into conflict with other virtues. Let us call her Soldier A. Further imagine that Soldier A is given a pill that enhances her loyalty (but not to the extent that she is blindly obedient). She is now more loyal, fulfilling her duties more fully, all the while continuing to knowingly and purposefully cul-

28. This issue is raised in Lin, Mehlman, and Abney, *Enhanced Warfighter*, 77–80.

tivate this trait of character.

Would we be inclined to wholly dismiss the possession of this soldier's virtue because of the enhancement of her pro-social behaviour? Or perhaps we would concede that she possesses virtue through her loyalty, but that the possession of the virtue has a threshold; it ends at the point in which her cultivated loyalty meets the loyalty achieved through the given enhancement. It is not clear to me that, in the presence of continued practice, habit, and willful cultivation of her character, one would be correct in dismissing this soldier as not in possession of virtue. Nor is it clear that, even if we so desired, we could locate the point at which her virtue meets her enhancement. It seems a failed enterprise to engage in efforts to determine where her virtuous pro-social behaviour ends and her non-virtuous enhancement-induced pro-social behaviour begins.

In contrast, we can imagine a soldier who does little to develop virtuous traits of character. Let us call him Soldier B. He is not disloyal, but he makes little to no attempt to cultivate loyalty. We may say that this soldier engages in loyal actions; he goes through the motions, but his loyalty is not attributable to his character, to his virtue. Now imagine that Soldier B received the same enhancement as Soldier A, and he is now as dutiful and loyal as Soldier A. He exhibits similar affilliative traits: he bonds with his comrades, and he is loyal to the civilians under his protection. Here, I think correctly, we ought to be reluctant to conclude that Soldier B is virtuous. This is because his loyalty is not creditable to his character, to his pursuit of a virtuous life, or to hard work and cultivation of the given virtue.

While the difference between Soldier A and Soldier B may appear to turn on an abstruse philosophical distinction—a cultivated and enhanced virtue versus merely enhanced behaviour—the distinction could have important implications for inter-soldier relations, particularly between the enhanced and un-enhanced. Take the additional case of Soldier C and Soldier D. Imagine that Soldier C cultivates fortitude and courage by spending a great deal of her time building strength and endurance and exposing herself to her fears. Soldier D, in contrast, is weaker, slower, and less courageous because of natural limitations. Despite his best attempts, the same level of effort, and the same training regiment as Soldier C, he can never achieve the traits of character that Soldier C has come to possess. But imagine that Soldier D has taken an enhancement pill, and he can now perform just as well as Soldier C. This may elicit the intuition that Soldier D's enhancement is a shortcut

to acquiring an admirable trait of character, and that it tarnishes the acquisition of the trait. But it seems that, unlike Soldier B, who made no attempt at cultivating virtue, Soldier D *has* cultivated courage and fortitude; it is simply the fact that, through no fault of his own, he lacks the capacity to natural possess it as fully as others. It seems that Soldier D's virtue is creditable to his character. He has made every effort to be the most courageous and resilient soldier he is capable of, and has now achieved parity with his peer.

Even if the distinction between these two cases is correct, and Soldier D should be viewed as a virtuous soldier, it does not follow that unenhanced soldiers will draw the same conclusion. In fact, it is quite possible that those soldiers who achieve virtue through hard, dedicated effort may grow to resent soldiers like Soldier D. Possibly they view them as cheats who have taken an easy path or as less worthy of their newly enhanced trait. Such resentment may be especially applicable to those soldiers who use enhancement procedures or techniques not to achieve enhancement (i.e., increasing capabilities "beyond the species-typical level or statistically-normal range of functioning for an individual"[29]) but to merely achieve optimization (i.e., achieving skills or qualities that are within the highest range of expert functioning and *are* attainable through natural endowment and hard work). Because optimization suggests that traits of character and the level of performance are attainable through hard work, we can imagine some soldiers believing that their comrades who achieve optimization through enhancement techniques are simply seeking a shortcut. This stands in contrast to enhancement, which may, by definition, be the only way to achieve particular traits or performance levels.

The fact that enhancement may be the only path to becoming a "super soldier" may make some soldiers more tolerant of those who undergo enhancement. But it also seems likely that we will encounter cases where unenhanced soldiers do not *resent* enhanced soldiers, but are *envious.* And this is because the capability endowed by the enhancement could never be acquired through even the most hard and dedicated effort. This problem could become exacerbated as elite soldiers benefit from enhancement, and the non-elite are left with their natural capacities.

So on the one hand we have resentment, and the other envy. These

29. Norman Daniels, "Normal Functioning and the Treatment Enhancement Distinction," *Cambridge Quarterly of Healthcare Ethics* 9 (2000): 309–322.

are the two poison pills of interpersonal relationships, and they possess real potential to destructively undo the bonds militaries work so hard to achieve between soldiers. While not analogous, militaries might consider past integration and cohesion strategies, such as the desegregation of its armed forces by the US, or its integration of gay and lesbian soldiers. It may be worth considering having mixed units, where the enhanced work side-by-side with those who have not had enhancements. This may increase fidelity between the two groups. Unfortunately, I do not have a satisfactory answer for how to address this potential divide. Such an answer will turn, in part, on empirical findings.

Conclusion

In closing, I would like to note that, unlike other forms of soldier enhancement, which enhance abilities directly linked to, or perceived to be directly linked to, increased lethality (e.g., drug-induced resistance to pain), pro-social traits are, generally speaking, considered to be related to individual and social well-being. The distinction between enhancements that directly increase lethality and those that do not is, admittedly, imperfect. Enhancing pro-social behaviour could, in theory, contribute to increased lethality if it increased unit cohesion. Nevertheless, it is likely that enhancing pro-social traits of character may be viewed as standing in contrast to enhancements linked to lethality.

However, even if some individuals find compelling the distinction between pro-social enhancements and enhancements that increase lethality, there will inevitably be members of the public who remain unmoved. This distinction will do little to persuade those who oppose human enhancement in general, and in any form. Consequently, we may witness opposition to soldier enhancement that does not take the goal of the enhancement (i.e., pro-social behaviour) as the source of objection, but instead how the goal is achieved; namely, through enhancement technologies.

A rough analogue to this opposition can be found in the debate surrounding genetically modified organisms (GMO). Most of us can agree that increasing crop yields, food nutrition, and disease resistance are good ends to achieve. Despite this agreement, we have seen considerable objection not over these goals, but the means used to achieving them, i.e., genetic modification. Despite widespread scientific agreement that GMO foods are safe for human consumption, many continue to remain opposed to the production and consumption of GMO

foods.[30] Some of this opposition results from the normative judgment that, even if safe, GMOs are unnatural, disgusting, and that they should be banned.[31] Like those absolutists opposed to human enhancement, GMO absolutists remain opposed to GMOs irrespective of the risks and benefits.

In contrast, there are those individuals whose opposition to GMOs arises from ignorance or misinterpretation of relevant scientific findings. This suggests that individuals opposed to GMOs as a result of such conditions may be open to persuasion if provided proper information. Similarly, we can imagine that knowledge of the fact that certain soldier enhancements will target pro-social virtues may assuage concerns that emanate not from enhancements per se, but from specific soldier enhancements designed to increase lethality.

Public engagement and effective science communication has been critical to dispelling myths and increasing acceptance of GMOs. There is good reason to think that similar strategies could play an important role should we, as a society, decide to engage in soldier enhancement. This will be particularly critical in enhancements that lead to enhancing key virtues associated with pro-social behaviour. These virtues are often overlooked, and, quite possibly, do not fit into the existing characterization of the warrior ethos, but perhaps they should.

30. On the safety of GMO foods see *National Academies of Sciences, Engineering, and Medicine. Genetically Engineered Crops: Experiences and Prospects* (Washington, DC: The National Academies Press, 2016). https://doi.org/10.17226/23395. For public opinion on GMO food see Cary Funk and Brian Kennedy, "The New Food Fights: U.S. Public Divides Over Food Science," *Pew Research Center* (December 2016).

31. Sydney E. Scott, Yoel Inbar, and Paul Rozin, "Evidence for Absolute Moral Opposition to Genetically Modified Food in the United States," *Perspectives on Psychological Science* 11, no. 3 (2016): 315–324.

7

Ethical Implications in Generating or Selecting for Super Soldiers

Col. James Ness and Steve Kornguth[1]

Introduction

Technologies developed over the last two decades have led to the possibility of modifying the human phenotype in order to produce individuals with extraordinary physical, cognitive, and behavioural capabilities that can be employed in the athletic and military arena. The technologies include pharmacological, physiological, and neural modifications that are invasive in nature or fundamentally alter the human organism in a manner that cannot be predicted to return to a steady state similar to that prior to the modification. As an example, the pharmacological enhancements may be used to sustain continuous operations for six to seven days (methamphetamine as an enhancer of time on task [GO pill],[2] testosterone as an increase aggression supplement). The physical interfacing of computers with the human brain may be employed to give a soldier or

1. The views expressed herein are those of the authors and do not reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.
2. W. D. Killgore, T. L. Rupp, N. L. Grugle, R. M. Reichardt, E. L. Lipizzi, and T. J. Balkin, "Effects of Dextroamphetamine, Caffeine and Modafinil on Psychomotor Vigilance Test Performance After 44 h of Continuous Wakefulness," *Journal of Sleep Research* 17, no. 3 (September 2008): 309–21.

athlete an ability to have rapid cognitive assessment of a changing environment or to enable an operator to multi-task with a benefit of enhanced parallel and serial circuit interfacing. The technologies attributed to the Singularity (state of a human who has her/his brain highly connected to a computer) have been promoted as a method to develop super soldiers.[3] Alternative behavioural modifications may be employed to increase high risk-taking actions or avoidance of fear in order to yield a soldier with aggressive traits suited to intense combat environments (deep brain stimulation of amygdala or related structures).

This chapter will differentiate enhancements that are reversible and meant to maintain/sustain human performance transiently at a high level from those enhancements that are intended to create a new phenotype of the individual soldier/athlete. The latter are likely to result in irreversible alterations in the structure/function and behaviour of the operator. In our view, this distinction is a critical component of ethical considerations that military leadership must take into account as decisions are made regarding the development and sustainment of the super soldier.

The question we address is posed in this manner because any emerging answer has to be evaluated from a cost/benefit ratio. The "cost" of the modification of the soldier is measured as a function of retention of individual identity, and ability to reintegrate into civil life with family after separation from the service. The cost also includes changes negatively affecting the ultimate physical and psychological wellness of the surviving soldier. The benefit of the modification has to be evaluated with regard to alternative options in the training paradigm and alternative strategies for selection of operators for specific tasks rather than attempting to change the phenotype of the soldier.

Finally we will address the metaphors that may be used to justify invasive technologies to create super soldiers. A frequent metaphor is that the brain can be viewed as a muscle. In this metaphor, it is imagined that in the same manner as a muscle can return to an initial state after relaxation from an intense workout, the brain can also return to its original state after brain stimulation or modification is relaxed. The fundamental difference between brain and muscle is that the brain is a learning network where the circuitry (i.e., wiring pattern and data

3. Ray Kurzweil, *The Singularity Is Near: When Humans Transcend Biology* (New York: Viking, 2005); and Rolfe Winkler, "Elon Musk Launches Neuralink to Connect Brains With Computers," *Wall Street Journal* (27 March 2017).

fusion) is modified as a result of experience. The resultant rewiring and enhanced effects of circuit function creates a system that cannot return to the unlearned state. Therefore the analogy is fundamentally flawed and such a misperception can lead to long-term unintended negative consequences for the long-term survivor of brain and pharmacological modification.

Primary Thesis Regarding the Ethical Demands Placed Upon the Services When Developing a Super Soldier

The primary responsibility of the military services to our fighting force is to do or cause no long-term avoidable harm as a result of intentional decisions by the command structure or by decisions based on ignorance of likely risk to the soldier. There are two corollaries to this thesis: (1) there is a need to preserve the physical, cognitive, and behavioural capability and wellness of the soldier from accession through separation from military service and for the lifespan that is anticipated to be approximately seventy-nine years for persons born after 2000;[4] (2) because the soldier does not have full agency of her/his actions while in the military, the full context of informed consent is not attainable by the soldier. The responsibility for future disabilities arising from experimental trials that attempt to generate a new super soldier phenotype reside with the command structure and the institutional military services.

Differentiating Soldier Enhancement Opportunities That Pose Minimal Ethical Challenges From Those That Require Extensive Exploration From an Ethical Perspective

There are many technologies currently available that enhance soldier performance, and the employment of these technologies to enable soldiers to meet mission requirements pose minimal to no ethical dilemmas. These include exo-skeletal supports, boots, camouflage, and nutritional amendments that do not alter transmitter or hormonal receptor levels in the central nervous system. In addition there are numerous pharmacological supplements that can permit a service person to re-

4. U.S. Department of Health and Human Services, "How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General" (Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2010).

main vigilant for extended periods of time on task (forty-five hours) and then return to normal baseline sleep cycles. These additives have minimal to no long-term undesirable irreversible effects on behaviour or cognition. There are also training and dietary protocols that enhance muscle development and permit extended time on task performance with minimal to no adverse long term effects.[5]

Ethical Use of Pharmacological Enhancement for Mission Completion

In the 1990s, Danish pilots who had missions requiring long flights were supplied with caffeine to sustain vigilance and cognitive ability. The Danish government determined that it was appropriate to administer caffeine to achieve the mission goals but that administration of amphetamines was to be precluded.[6] The U.S. Air Force has approved the use of dextroamphetamines for single piloted planes having missions exceeding eight hours and for dual piloted planes having missions exceeding twelve hours (Official Air Force approved Aircrew Medications Effective, 19 May 2011). The dextroamphetamines or GO pills are formulated to sustain cognitive ability and to reverse fatigue. Ambien has been utilized to permit sleep on mission completion.

Modafinil has been employed to retain vigilance and reduce the effects of fatigue in helicopter pilots and emergency medical teams.[7] While the administration of these pharmacological agents has adverse effects on the individual, in most cases withdrawal from the agent is usually accompanied by minimal long-term deficits. As a result, these compounds have been used in many aspects of society to attain increased performance and time on task.

These compounds have been employed by pilots and ground forces to markedly increase performance.[8] The Danish government and others have precluded the use of amphetamines because of cardiovascular complications, persistent psychiatric adverse outcomes and prolonged

5. JohnEric W. Smith, Megan Holmes, and Matthew J. McAllister, "Nutritional Considerations for Performance in Young Athletes," *Journal of Sports Medicine* (Hindawi Publishing Corporation, 2015): 734649.
6. Jan N. Nielsen, "Danish Perspective: Commentary on "Recommendations for the Ethical Use of Pharmacological Fatigue Countermeasures in the U.S. Military," *Aviation Space and Environmental Medicine* 78, no. 5 (May 2007): B134–B135.
7. Colin Sugden, Rajesh Aggarwal, Charlotte Housden, Barbara J. Sahakian, and Ara Darzi, "Pharmacological Enhancement of Performance in Doctors," *British Medical Journal* 340 (18 May 2010): c2542.
8. Killgore, Rupp, Grugle, Reichardt, Lipizzi, and Balkin, 309–21.

changes in personality of the individuals using the enhancement.[9] The U.S. Air Force has permitted the use of amphetamines for very extended mission operations (eight or more hours continuous operations). The long-term irreversible effects of methamphetamine on soldier cognition and behaviour will be described in the section describing adverse outcomes of performance enhancing pharmaceuticals.

Physiological Enhancements with Minimal Long-term Consequences

Physiological enhancements that permit a soldier to carry heavy loads or to fall from a height of ten feet (three metres) or higher with minimal damage on impact are examples of modifications that pose minimal long term risk to an operator. The rucksack with supports that permit the soldier to carry loads of 120 pounds (54 kilograms) over distance has been used for many years with no long-term negative effects. The FORTIS exoskeleton devices in development by Lockheed Martin in conjunction with the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) are anticipated to permit a service member to exit a helicopter and rapidly egress the landing zone. These devices absorb the force following impact with the ground and markedly reduce bone fractures or breaks. These devices are placed on the soldier prior to engaging in an operation and the removal of the device from the person is readily accomplished with no adverse residual effects. In a similar manner the enclosure of an operator in MOPP 4 gear for protection from chemical agents can be readily removed once the proximity to threat agents is removed. In these cases, physiological protection is applied when needed and removed when the environment changes.

Potential Soldier Modifications that Produce Long-term Effects and Therefore Create Significant Ethical Challenges

Pharmacological enhancements that have been, and are being, used in society and the military that can affect long-term adverse functional, behavioural, and cognitive changes in the operator include the use of amphetamines and methamphetamines.[10] During the Second World

9. Nielsen, "Danish Perspective: Commentary on "Recommendations for the Ethical Use of Pharmacological Fatigue Countermeasures in the U.S. Military."
10. Ray J. Defalque and Amos J. Wright, "Methamphetamine for Hitler's Germany: 1937 to 1945," *Bulletin of Anesthesia History* 29, no. 2 (April 2011): 21–4, 32.

War, the use of amphetamines led to long-term dependence of the German soldiers on the drug, and resulted in adverse psychiatric function and behaviour after the cessation of hostilities.

Testosterone administration and elevated levels of the hormone are correlated with increased aggression and hostility in subjects.[11] These effects persist and when the testosterone administered is reduced there is a residual long-term period of depression with increased anxiety.

Because the changes in behaviour and cognition following amphetamine and testosterone administration persist, and because these drugs and hormonal agents affect transmitter as well as receptor expression, the likelihood that the operator will return to a steady state behaviour exhibited prior to drug administration is reduced. An example of the effect of receptor up-regulation following drug-induced inhibition of receptors is the development of irreversible choreoform dyskinesias (i.e., tardive dyskineasia) in patients following administration of cholinergic active agents.[12]

Acceptable Use of Long Term Invasive Technologies to Treat Critically Ill Patients

Long-term intracranial deep-brain stimulation has been used successfully to treat patients with Parkinson's syndrome to improve behaviour and motor function. The implantation of electrodes into the basal ganglia of patients with Parkinson's syndrome has been found to alleviate the tremor, rigidity and bradykinesia that markedly impair function of the individual.[13]

Brain machine interfaces (BMI) have now been reported to have major positive outcomes when used to treat patients during rehabilitation of patients following strokes.[14] In these cases, the quality of life of the patient is markedly enhanced. The patient is provided a capability to resume a degree of independence and freedom of movement.

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11. Menelaos L. Batrinos, "Testosterone and Aggressive Behavior in Man," *International Journal of Endocrinology Metabolism* 10, no. 3 (Summer 2012): 563–8.
12. H. L. Klawans and Randi Rubovits, "Effect of Cholinergic and Anticholinergic Agents on Tardive Dyskinesia," *Journal of Neurology, Neurosurgery, and Psychiatry* 37, no. 8 (August 1974): 941–7.
13. Michael S. Okun, "Deep-Brain Stimulation for Parkinson's Disease," *New England Journal of Medicine* 367, no. 16 (October 2012): 1529–38.
14. Surjo R. Soekadar, Niels Birbaumer, Marc W. Slutzky, and Leonardo G. Cohen, "Brain-machine Interfaces in Neurorehabilitation of Stroke," *Neurobiology of Disease* 83 (November 2015): 172–9.

The benefit of the invasive technologies into the brain of such patients has given rise to the notion that the performance of healthy individuals may be enhanced using deep-brain stimulation (DBS) or BMI. The distinguishing feature of the clinical trials involving patients with advanced Parkinson's syndrome or stroke is that these individuals have clinical conditions that preclude standing independently, moving with intention, handling a drinking cup, or verbal/written communication. The potential risks associated with DBS or BMI are balanced by the ability of the patient to lead a semi-independent life. The balance can be described as the cost/benefit ratio of treatment where the cost is the probability of adverse outcomes from the procedures (e.g., infection from the invasive probe into the brain, gliosis or scarring of the fibre tracts following insertion of stimulating devices, micro-bleeds in the region of the probe insertions) and the benefit is the retention or gain of critical function. From the clinical studies to date on the Parkinson's patients, the frequency of infections (8.7 percent to over 15 percent), gliosis and bleeds approximates 30 percent of the subject populations. For the markedly impaired this may be an acceptable cost/benefit ratio.[15]

Two futurists have enthusiastically proposed modifying soldiers and other high intensity operators with DBS or BMI to enhance performance, time on task, and cognitive awareness. Kurzweil[16] proposes that humans with their brain directly coupled to computers will function with the combined interfacing between global data sets available on the web and with the internal capabilities of the brain.[17] Elon Musk has established a company to develop a lace elastomeric device that will be implanted in the brain with numerous stimulatory elements that are postulated to stimulate enhanced neural function.[18] The company is Neuralink and the concept is to merge the human brain with artificial intelligence.

The fundamental ethical difference between the DBS for Parkinson's or BMI for stroke patients with that proposed by Kurzweil and Musk is that the former understands that the risk for adverse outcomes in the patient is real but the potential benefits with regard to patient retention of independence and agency outweigh the risk. In the latter the sol-

15. Silie Bjerknes, Inger M. Skogseid, Terje Sæhle, Espen Dietrichs, and Mathias Toft, "Surgical Site Infections After Deep Brain Stimulation Surgery: Frequency, Characteristics and Management in a 10-Year Period," *PLOS ONE* 9, no. 8 (2014): e105288.
16. Kurzweil, *The Singularity Is Near: When Humans Transcend Biology*.
17. Ibid.
18. Winkler, "Elon Musk Launches Neuralink to Connect Brains With Computers."

dier is recruited as a healthy, physically fit, and cognitively well formed 18-year-old and by manipulation will be altered phenotypically to a state that cannot be reversed. It cannot be reversed because the brain is an evolving network structure that learns and is modified by every experience (whether by intent or life condition). There is no known way to unlearn or return to original steady state at this point in time. For these reasons the end goal of the treatments for disease states (Parkinson's syndrome and stroke) are fundamentally different from an ethical and social perspective. In the case of the healthy soldier, the "cost" almost certainly outweighs the potential "benefit."

Finally the reality is that a soldier cannot assert his or her agency of decision making over the command structure. In this sense, as in the situation with prisoners or minors, the soldier cannot provide informed consent to the modification that is being considered for deployment in the field.

To further illustrate the ethical conundrum that is under discussion, it may be helpful to consider whether our defence community would accept the amputation of legs above the knee if the soldier with an adaptive prosthetic device could traverse the ground more rapidly or leap from a helicopter at a height above ten feet with greater agility and survival than an unmodified soldier. This illustration raises the point of enhanced mission completion in the modified state. The amputee would be in a non-reversible condition much the same as the brain modified soldier. We anticipate that Army leadership would reject such a modification. If so, the difference between the modification involving limb amputation and brain modification is that the former is highly visible while the latter is not visible. Yet prolonged loss of cognitive ability and behaviour management is likely more severe for the operator since it involves an "invisible" loss of self-identity while the loss of limb is readily seen. The amputation is also likely to be associated with persistent pain from the phantom limb phenomenon. Nonetheless, the limb amputee can retain function in society and even compete at a very high level as society understands and makes accommodations for such physical challenges (e.g., Aimee Mullins).

Approaches to Utilize the Inherent Variability of Human Performance Skills to Create a Super Soldier

We believe that the U.S. Army must consider alternative strategies to develop a force that can compete effectively with an adversary who has

phenotypically changed populations to extend time on task and cognitive capability. It is clear from measures of cognitive ability, sustained performance, and physical performance that there is a wide range of capabilities across the healthy population. Some individuals are very fast runners in sprints while others are better suited for long endurance races. Some individuals have a high cognitive functional capability to sustain decision making for long times on task (over forty hours) while others exhibit shorter periods of attention and focus.[19] High levels of cognitive function associated with extended times on task have been correlated with fractional anisotropy as discussed below. Additionally some individuals are more resistant to chemical toxins than are other individuals.[20] In all of these cases the individuals are healthy, of similar age and developmental stage. The distribution of capability can be described as Gaussian where the highest performing cohort on a particular function is toward the right end of the curve and the lowest performing cohort is to the left of the peak. Individuals will differ with regard to the tasks for which they excel and those for which they have lowered performance skills. Some of the traits are modifiable by training and experience while others are affected by genetic or epigenetic factors.

As an example of physiological traits that are predetermined is the capability to perform as a sprinter versus a long distance runner. A prime example is the sprinter Colin Jackson, who was studied by researchers at Ball State.[21] High performance sprinters have a high proportion of Type II fast twitch muscle fibres (white fibres) whereas marathoners have a high proportion of Type I slow twitch muscle (red muscle). The

19. Steve Kornguth, Rebecca Steinberg, David M. Schnyer, and Logan T. Trujillo, "Integrating the Human into the Total System: Degradation of Performance under Stress," *Naval Engineers Journal* 125, no. 4 (December 2013): 85–90; and Kimberly G. Noble, Mayuresh Korgaonkar, Stuart M. Grieve, and Adam M. Brickman, "Higher Education is an Age-independent Predictor of White Matter Integrity and Cognitive Control in Late Adolescence," *Developmental Science* 16, no. 5 (September 2013): 653–64.
20. Kyriaki Pliarchopoulou, Gerasimos Voutsinas, George Papaxoinis, Katherine Florou, Maria Skondra, Konstantina Kostaki, Paraskevi Roussou, Konstantinos Syrigos, and Dimitrios Pectasides, "Correlation of CYP1A1, GSTP1 and GSTM1 Gene Polymorphisms and Lung Cancer Risk Among Smokers," *Oncology Letters* 3, no. 6 (March 2012): 1301–1306.
21. Juleen R. Zierath and John A. Hawley, "Skeletal Muscle Fiber Type: Influence on Contractile and Metabolic Properties," *PLOS Biology* 2, no. 10 (October 2004) e348; and S. Trappe, Luden, Minchev, Raue, Jemiolo, and T. A. Trappe, "Skeletal Muscle Signature of a Champion Sprint Runner."

muscle phenotype of the soldier can be determined and the soldiers with selected muscle types that have exhibited rapid acceleration capability can be trained as super soldiers for such operations. Soldiers intended for long-term sustained operations can also be selected based upon physiological traits and capabilities.

Our laboratory and others have shown that the ability to sustain time on task can be assessed by examination of the extent of projection of myelinated fibres in the brain prior to deployment.[22] The more extensive projections of fibre bundles from anterior to posterior and right to left and reverse, the longer the ability to perform at a high level of function up to forty hours. The measures are achieved non-invasively using magnetic resonance imaging by a method called diffusion tensor imaging and with a metric called fractional anisotropy.[23] By assessing fractional anisotropy measures of the soldier, it is possible to determine probability of capability of the individual to sustain function over an extended period of time. While diffusion tensor imaging provides a reliable measure of potential for long operations, the technology is not portable and can also be costly from a time and budgetary perspective. An assessment of fatigue that is low cost and readily transportable is available using electroencephalography (EEG) and event-related potentials (ERP).[24]

Finally there are measureable biological traits that can provide estimates of susceptibility or resistance to chemical toxicants in the environment. There are two primary detoxifying enzyme systems in the body: cytochrome P450 (CYP) and glutathione S transferase (GST). Absence of one of the twenty or so isoforms of CYP and/or GST can render a person more susceptible to toxicants than the population with all these isoforms.[25] The toxicants include cigarette smoke and polyaro-

22. Kornguth, Steinberg, Schnyer, and Trujillo, "Integrating the Human into the Total System: Degradation of Performance under Stress"; and Kimberly G. Noble, Mayuresh Korgaonkar, Stuart M. Grieve, and Adam M. Brickman, "Higher Education is an Age-independent Predictor of White Matter Integrity and Cognitive Control in Late Adolescence," *Developmental Science* 16, no. 5 (September 2013): 653–64.
23. Ibid.
24. Kornguth, Steinberg, Schnyer, and Trujillo, "Integrating the Human into the Total System: Degradation of Performance under Stress"; and Logan T. Trujillo, Steve Kornguth, and David M. Schnyer, "An ERP Examination of the Different Effects of Sleep Deprivation on Exogenously Cued and Endogenously Cued Attention," *Sleep* 32, no. 10 (October 2009): 1285–97.
25. U.S. Department of Health and Human Services, "How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report

matic hydrocarbons. The assessment of the CYP and GST isoforms that are expressed genetically during selection of soldiers for operations involving exposure to potential toxicants in the environment may prove beneficial to retaining wellness following separation from the services.

The super soldier could be identified for specific tasks in 2017 by simple selection approaches in place of brain modifications or physiological modifications. The Army would then be on a stronger footing for meeting an adversary with modified soldiers and would not be confronted with the ethical quandaries posed above.

Discussion

The concept of super soldier implies the expression of an ability tailored to achieve a desired outcome in a specific context. This can be accomplished in one of three ways: maintaining a currently expressed ability, facilitating the expression of an existing ability, or inducing the expression of an ability novel to the bio-behavioural complex of the soldier. Soldiers are accepted into military service by selecting for bio-behavioural function within normal limits. Training is then employed to maintain soldier health, well-being, and fitness, establishing the basis for unit readiness. At a minimum, to maintain readiness the baseline pre-deployment function must be sustained in the context of very abnormal environments faced in deployment. To meet mission requirements, desired abilities can be maintained, facilitated, or induced from the soldiers' readiness posture. Maintaining, facilitating, or inducing desired abilities can have negative health and well-being effects, which in the short-term achieve mission requirements, but in the mid-term may impact readiness and in the long-term may have significant consequences to a service member's health and well-being. These benefits and costs are what a commander wrestles with in making operational and tactical decisions.

In general, the facilitation or maintenance of a functional ability is likely reversible, since the ability is within the repertoire of the soldier's phenotype. This said, as discussed, at some point quantity of sustainment of a desired function yields an irreversible qualitative change as described with the use of amphetamines. The induction of a new ability, if biologically invasive, is very likely irreversible since the ability

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of the Surgeon General"; and Pliarchopoulou, Voutsinas, Papaxoinis, Florou, Skondra, Kostaki, Roussou, Syrigos, and Pectasides, "Correlation of CYP1A1, GSTP1 and GSTM1 Gene Polymorphisms and Lung Cancer Risk Among Smokers."

does not, by definition, exist within the repertoire of the soldier's phenotype. The induction of a phenotypic expression through biologically invasive methods, although shown to be medically achievable, is done so in an abnormally functioning person within a typical environment. In contrast, induction of a new phenotype in a soldier changes an otherwise normally functioning system to achieve a mission objective in an atypical environment. Herein lies the very possibility of creating a hopeful monster rather than a super soldier.[26]

The imperative is that a decision to maintain, facilitate, or induce a desired ability requires a deliberately applied due diligence. This is an imperative because the soldier may be changed in an irreversible manner uniquely tailored to achieve a specific objective in an atypical context. Upon return from deployment, the affected soldier risks permanent abnormal functioning in a normal environment. This situation is seen in cases of PTSD or other deployment-related injury but these are not a result of a purposefully applied manipulation to the soldier by decision makers to induce a change. These are the risks assumed by the soldier volunteering for service, which obligate a nation to the long-term care of its service members.

Deliberate manipulations of the soldier may present a strategic necessity but that decision must be made in a deliberate manner. To ensure an ethical decision in the case of the use of purposeful manipulation, a deliberate process of due diligence must be applied. The first step in the decision process is self-awareness. Why is the concept of super soldier being considered? Do we believe wars are won through technical superiority? Do we see soldiers as expendable or composed of interchangeable parts? Is there an underlying fear or other irrational motivation driving the decision?

The self-awareness promotes a healthy skepticism in evaluating one's motivations in decisions of such magnitude. Certainly to turn a blind eye to the possibility that a warped mind may catalyze a faction to profoundly immoral and malevolent acts is naïve. However, to succumb to tenaciously held presuppositions in one's logic, is to think as one is inclined.[27] This risks overlooking viable alternatives, becoming tactically and operationally predictable, and can lead to becoming the very warped mind one fears. The ethical issue is thus plain: how to sup-

26. David Castle, "Hopes against Hopeful Monsters," *American Journal of Bioethics* 3, no. 3 (Summer 2003): 28–30.

27. Charles S. Pierce, "The Fixation of Belief," *Popular Science Monthly* 12 (1877): 1–15.

port decisions to be made in preparations for future conflicts, without destroying from within, the very lives one is charged with defending.

As discussed, applying an ethic is to give the decision maker a guide for one to discern right from wrong, good from bad, virtuous from non-virtuous. In this way the ethic is designed as decision support in the due diligence applied to any decision. Decisions to be made in future conflicts begin in military human sciences. The objective of military human science is to explore the art of the possible in augmenting human performance while articulating near and long-term health consequences to the soldier. The later is important because the first principle of the ethic is, "service members are not expendable items nor are they made of interchangeable parts."

Military human sciences are responsible for researching the art of the possible to meet challenges of future conflicts, which includes concepts such as super soldier. In designing a program of research on the concept of the super soldier, investigating possibilities such as inducing the expression of a phenotype should be complemented with lines of effort researching countermeasures and alternatives. Countermeasures and alternatives are quintessential to the bio-ethic because they force a new set of presuppositions, which provide a new perspective rendering alternatives to decision makers for strategies and tactics to be employed. The diversity of options provides viable alternatives to the decision makers such that they are not left with a binary choice of either to treat soldiers as expendable or lose the war. If the binary choice is all that is afforded the decision maker, then military human science has failed its mission, failed the soldier and bears responsibility.

As discussed, an alternative to inducing a phenotype would be to select within the population of soldiers those who present with desired phenotypes. The genetics yielding these phenotypes can be readily sequenced and thus discoverable in the individual soldier. Facilitating an expressible trait would yield the desired outcome while remaining within the first principle of the proposed bio-ethic. This said, health and diversity of phenotypic expression comes with an ontological history. This issue, although beyond the scope of the paper, implies a national program promoting and supporting education, diet, exercise, sleep, and a strong social/emotional base. These are the underpinnings of a well-formed, diverse societal phenotypic complex from which to build the national defence team.

In developing programs of research in exploring the concept of the super soldier, metaphors, descriptions, and explanations must retain a

reasonable isomorphism between the discoverable phenomenon and biological and behavioural reality. The metaphor of the brain as a muscle is an example of an inappropriate metaphor. Brain as an integrator is truer to the brain's biological function. Maintaining a reasonable isomorphism will lead to informed questions and ameliorate the dalliance of specious presupposition. It will force an empiricism necessary for dispassionate observations, which is the strength of science in the method of strong inference.[28]

In summary, this chapter argues for due diligence on the part of military human science and commanders when considering the concept of super soldier. To assist with the due diligence process the following proposed bio-ethic derived from discussion at NATO Symposium HFM-181 is recommended concerning decisions involving super soldiers:[29]

1. Has an honest self-awareness been engaged as to why the solution is being considered?
2. Are the metaphors consistent with reality? Is there a reasonable isomorphism between the conceptualizations and biological and behavioural reality?
3. Is the soldier being treated as expendable or composed of interchangeable parts?
4. Has due diligence been applied in that all other alternatives have been exhausted?
5. Is the use truly informed and voluntary?
6. Is the use safe for the individual and the operational environment?
7. Is the use consistent with protecting the immediate and long-term health and well-being of the soldier?

We certainly recognize that these decisions are never cavalier. We also recognize that even though the immediate operational and tactical decision is on the commander, the military human sciences are responsible for options and to clearly articulate risks. The service member is obliged to follow a lawful order and thus the commander and military human sciences must ensure these decisions are above reasoned reproach.

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28. John R. Platt, "Strong Inference: Certain Systematic Methods of Scientific Thinking May Produce Much More Rapid Progress Than Others," *Science* 146, no. 3642 (October 1964): 347–53.
29. James Ness and Steve Kornguth, "Technical Evaluation," paper presented at the HFM-181 Symposium Human Performance Enhancement for NATO Military Operations (Science, Technology, and Ethics), October 2009.

8

Metrics: Training the Mind of the Super Soldier

Jason Dozois

Introduction

When I accepted an invitation to deliver a keynote address at the Kingston Conference on International Security (KCIS)—which, incidentally, I had never heard of—I didn't know what to expect. To say it was culture shock is an understatement, but it did make me realize one thing: you don't know what you don't know. A clichéd expression, but often true. When you're entrenched in your own culture, with your own people, you begin to take things for granted and to have certain expectations. We all do it. For instance, while at KCIS, I wasn't expecting to hear any French—in Kingston, Ontario, of all places! But the evening before the conference, I was told by an American colonel that all officers in the Canadian Armed Forces are required to give part of their speeches in French. Now, part of me found this terribly impractical—even though I speak French fluently, everyone there spoke English—but another part of me was very impressed with the consistency with which this policy is applied. It makes Canadian officers stand out in a unique way, which I'm sure is the point. And this was but one of many things I learned at KCIS.

Being an outsider at this conference was somewhat of treat for me. As the "video game guy," I was asked a lot of questions, intelligent

ones, about technology and how exciting and creative games must be. I asked my own questions and learned a lot, leaving the conference with not only a deeper understanding of myself and of my own industry, but also with an idea, one that is in line with the mission of this year's conference: developing the super soldier. It's a simple idea, something I had never stopped to consider, something I would have continued to take for granted had I not had the experience of talking to attendees at the conference: metrics. We measure everything in video games. As we create software simulations, we are constantly changing, evolving, and iterating. We are basically doing two things: teaching the players and learning from the players. The combination of all the data we use to help guide our development, we call metrics, and it is my belief that the power of metrics can be leverages to train the mind of the super soldier.

When thinking about using video games to help train military personnel, most people think about action shooter games, where the player roams around with weapons and shoots people. A smaller number of people think of real-time strategy (RTS) games, simulations of large battles, contemporary or historic, where the player is the high commander making decisions on a massive scale. I am referring to something else entirely, to simulations that focus on small operations in dangerous locations that are filled with both hostile forces and civilians, and where the objectives and battle lines are not always as clear as we would like them to be. Today, these complex situations are a reality, perhaps the norm. Important decisions are now often made at a low level. I believe the creation and use of software simulations where soft skills, human interaction, and the use of force—when necessary—are taught and tested should be an area of great interest to the military community. How can we train and improve decision making in soldiers? The same way we attain wisdom: through failure. Software simulations allow soldiers to fail without consequence all the while gathering metrics on performance to help teach the soldiers and the developers.

Learning from Failure (Teaching Players)

Players learn through failure. Traditional game design is done in loops (repeated actions) which are performed to learn a new skill. Like a story, this learning is broken down into three main sections: introduction, testing, and mastery. When you introduce a new skill that you want a player to learn, you isolate it, making sure the player focuses on it, and you force an input from the player. This is a "free" success, in a

safe environment where nothing can go wrong. As you move on to the testing phase, you gradually remove the focus and ease, since there are always multiple skills that a player can use at any given moment, and you measure if and when they use that new skill. When you enter the mastery phase, you now add more stress to test for reaction time and performance of players under more difficult conditions to see how far they've come. This can be done at a micro level (learning the skill itself) and a macro level (learning which skills to use in a given situation). This is the general approach to teaching skills to players, and I believe the same applies to learning any new skill. When learning to play the piano, first you learn scales (introduction), then you move on to simple melodies and exercises (testing), and finally you learn a real piece of music and perform it at a recital (mastery). Training behaviour can be done in this same way, first with skills, then with skill sets, then ultimately with the decision-making ability to choose the right skill in the right situation.

Changing the Plan Based on Metrics (Learning from Players)

But games are a two-way street. We create the software simulation and expect a result. In most cases people learn the skills we want them to, but sometimes they don't. That doesn't mean the skill is beyond their capacity, it usually means our approach is wrong. Metrics give us a large data set to look at and see how we can improve the simulations and even create new metrics to help us better measure player performance and increase overall enjoyment of the game. In game development, our main goal is to immerse and entertain the players and metrics help us do that, but used as a teaching tool there is virtually no limit to how effective metrics can be. I worked on a game called *Deus Ex: Mankind Divided*. One of the unique aspects of the game was choice and consequence. We had several game situations that had multiple solutions (multiple skills could be used) and we tested the content rigorously to see not only how well the players performed, but also which choices they were making. We wanted to make sure each choice was appealing, in different ways, so that players could express their own play style and feel like they were in control. It is always surprising to see what people do with a game you make. The collective intelligence of an audience is vastly superior to that of any one person and you will start to see trends, very obvious ones, if something is not clear or not right in your simulation. We made several revisions to our content to

make sure all the choices we supported were equally presented and understood so we would get cleaner understanding from the metrics. By continuously testing our content, we both teach players and learn from players, a positive feedback loop, and we improve both the speed and effectiveness of the players (as they learn new skills) and the developers (as we improve our content). It's an ongoing process.

Using Software Simulations to Create Culture

So, we've seen how metrics can be used to help create better software simulations and how the analysis of metrics (1) helps us teach players more efficiently and (2) teaches us, the game developers, how the players learn. So how is this all useful in an applied way? In one word: culture. One topic that came up a lot in different ways at this year's conference was culture. For me, culture is a set of beliefs and behaviours shared by a group of people. I made a few comments after my keynote speech warning of the loss of culture. I believe that culture is what draws people to difficult and elite jobs like military service. People who choose to serve their county and put themselves in harm's way are a cut above the rest and they need to be taught the culture of the group they are joining. From the minute soldiers enlist, they are taught the culture of the military. They train together, work together, follow chain of command. They are taught what to do, how to do it and when, all with the aim of instilling a set of values, a culture.

While I was at the conference, I was stunned to see so much disagreement on this word, culture. I have only my own experience creating interactive software to draw upon, but I think technology—the internet, social media, and games—is one of the main drivers of culture today. We used to have a shared culture in North America, mostly through the unifying power of television. When I was a kid, three networks would show you the world and tell you what was going on in it. They would entertain and teach you. If you wanted to watch cartoons, they aired on Saturday mornings. Sometimes very early on Saturday mornings. And that was it. No other time during the week could you see a cartoon. Now there are multiple channels on television, or online, and on demand. Nobody has to wait anymore. The culture of media has changed, and changed drastically in my lifetime. From music to television to films, and more recently in video games, the culture of media has evolved and become more interactive. That interactivity has accelerated its effect on culture, fracturing it into the micro-cultures we now

live with. While some can look at this fracturing as a negative thing, the takeaway is that culture-creating power can be harnessed to create your own culture as others have done.

While at the conference, I was concerned by what I was hearing because the world is changing so quickly that people seemed to be unsure of what they want their culture to be while also wanting to ride the wave of this new technology which can help create it. That's a dangerous place to be. I modified the end of my keynote speech after the first day of the conference because I felt so strongly about this point. This is what I wrote in my navy-blue moleskin notebook and read to those assembled:

> People keep trying to find ways to be diverse but I'm not sure it's clear to everyone what that means. Adaptability, flexibility, and inclusiveness are great, but if you fragment a group's identity too much, instead of a beautiful mosaic you could end up with rubble. People want to be a part of something, something great. As an organization, if you don't provide a culture, one that you are proud of, people will find their own—don't surrender your control over the narrative. Believe me, your enemies aren't. I've heard a lot of accommodation and what not to do or be and very little "this is who we are—this is what we do." I recommend the latter. People want to know what you do and why.[1]

The internet and online communities have helped create micro-cultures all across the planet. You can find and connect with people who share common interests from stamps, to sewing, to politics. Shared experiences, even virtual ones, create strong connections between people. Technology can be used to learn together and grow stronger as a team. You can see this all over the gaming world with clans (groups of players who are part of a team). These culture-creating technologies can and should be leveraged by military organizations to create and evolve their own cultures. An organization's culture should be ingrained into its people, helping to ensure that established guiding principles become second nature and that people are more likely to use preferred solutions to complex problems in the field.

Conclusion

In his book, *The Three Uses of the Knife*, playwright David Mamet talks

1. Jason Dozois, "KCIS 2017: Keynote Address," (June 2017).

about the three-act structure reducing each act to one word: thesis (Act One), antithesis (Act Two), and synthesis (Act Three).[2] When I read it I was struck by the simplicity of it, but it's entirely true. While constructing a narrative, writers are proposing a view of the world. In Act One, they present the problem. In Act Two, they show the hero failing to solve this problem, making the situation worse until Act Three, when the stakes are the highest and the hero must synthesize and reconcile all he has gone through and learned and make a final attempt, which will either succeed or not. This synthesis is the view of the author. From the beginning of civilization, humans have gathered around the campfire to tell stories. Some people say you are what you eat, but I think you are the stories you hear. Stories teach us right and wrong, what is socially acceptable, how we need to act to be one with the "tribe." Stories have tremendous power. That power is amplified by technology.

E tenebris lux is the motto of the Intelligence Branch of the Canadian Armed Forces. It means "Out of darkness, light." That's a culture in one sentence. Mottos are important; like national anthems, they're stories about who we are as a group. Likewise, software simulations help creates a culture by scaling the three key phases I spoke about earlier: introduction, testing, and mastery, which will themselves scale from skills, to skill sets, to decision making and ultimately to culture.

Well developed, implemented, and tested software simulations will help the super soldier learn the culture of tomorrow's military not only in mind and body, but hopefully in spirit as well.

2. David Mamet, *The Three Uses of the Knife: On the Nature and Purpose of Drama* (New York: Vintage Books, 2013).

9

People First, Mission Always: Super Soldiers and the Future of Human Performance Enhancement

Ryan Anderson

Introduction

As Lieutenant-General Christine Whitecross—Canada's most senior female military officer and serving Commandant of the NATO Defense College—remarked at the 2017 Kingston Conference on International Security (KCIS), the military mantra of "mission first, people always" must finally change to reflect a "people first, mission always" attitude. While the difference between the two may seem trivial, prioritizing the individual in the decision-making process carries multidimensional significance. In addition to the positive effects this mindset could have on military leadership and culture,[1] putting people first would mark a fundamental shift in how the military and policymakers handle the future of human performance enhancement.

Seen as an effort to achieve more effective and sustainable outcomes in combat operations, human augmentation and performance enhancement has become of great interest to several militaries around the

1. Charles D. Allen, "Ethics and Army Leadership: Climate Matters," *Parameters* 45, no. 1 (Spring 2015): 69–83.

world, including Canada's.[2] Unfortunately, the "people first, mission always" ethos, which implies a strong focus on human considerations, has been repeatedly overlooked in both government dialogue and scholarly literature. Alternatively, attention has been mostly focused on the physical, cognitive, and technological side of enhancement, and the development of "super soldiers"; stereotypical to most science fiction movies or videogames about futuristic warfare.[3]

Geared from head to toe in the latest technological innovations, such as non-invasive exoskeletons or wearable computing, and dosed with groundbreaking pharmaceutical drugs to increase pain tolerances, recovery times, or physical abilities in austere environments, super soldiers have commonly been perceived as an essential puzzle piece towards increasing operational success. However, this approach not only exaggerates the usefulness of these enhancements by portraying technology as the only solution, but more importantly, it neglects to consider its cultural, social, ethical, and policy implications in both combat environments and at home.

Why Technology and Drugs Are Not Enough

As Stéfanie von Hlatky and H. Christian Breede have put it, "enhancement is more than just about technology—it is about how technology is integrated to enhance combat effectiveness without the soldier losing [his or her] underlying humanity."[4] By thinking about and developing super soldiers as "super killers" with the intention of overcoming physical burdens to increase kinetic capability, policymakers are ignoring the fact that operational success is not merely a result of cutting-edge

2. David Pugliese, "Canadian Troops to Test Bionic Knee Brace to Boost Strength, Endurance," *National Post* (11 July 2016) at http://nationalpost.com/news/canada/canadian-troops-to-test-bionic-knee-brace-to-boost-strength-endurance/wcm/133b065a-c45d-4070-8f9e-8848ffd18a14.; "Soldier System 2030," (National Defence and the Canadian Armed Forces, 12 March 2015) at http://www.forces.gc.ca/en/business-defence-acquisition-guide-2015/land-systems-332.page; and Lockheed Martin, "U.S. Navy To Test And Evaluate Lockheed Martin Industrial Exoskeletons" (News release, 18 August 2015) at http://www.lockheedmartin.com/us/news/press-releases/2014/august/mfc-081814-US-Navy-To-Test-And-Evaluate.html
3. Sarah Knapton, "British Military Interested in 'Iron Man' Flying Suit," *The Telegraph* (28 April 2017) at http://www.telegraph.co.uk/science/2017/04/28/british-military-interested-iron-man-flying-suit/
4. Stéfanie von Hlatky and H. Christian Breede, "Putting the Human Back in Human Performance Enhancement," *Vanguard* (May 2017): 20.

weaponry, technology, or even military strategy. Achieving effective and sustainable outcomes is just as much, if not more, about individual service members and the diverse array of responsibilities they are assigned. With this in mind, it is critical that the discussion, and application, surrounding human performance enhancement puts individuals—both soldiers *and* civilians—first. In other words, new technology and physical enhancements cannot be the only factors or qualities that super soldiers are composed of. Individuals must also receive the proper education, and social and cultural skills that these enhancements are incapable of acquiring, or worse, are interfering with.

Social, cultural, and ethical considerations have undoubtedly been salient factors in determining the outcomes of military operations over the past decade. Both Canadian and American missions during this period have often been led by objectives and mandates that traditional forms of kinetic engagement cannot solely accomplish. In lieu of the conventional ways of war that require only bombs, bullets, and boots on the ground to succeed in, the scope of military intervention today has maintained a steady shift that instead requires specific human elements and local interaction to effectively orchestrate, such as advising and training operations, nation building, cultural engagement, and humanitarian aid.[5]

Moreover, lack of cultural interoperability during military operations has become an issue worthy of attention that highlights the significance of developing multifaceted super soldiers. While the lack of cultural, religious, social, and ethnic awareness has shown to create difficult barriers between intervening forces and local populations,[6] these differences also create barriers between intervening forces themselves.[7] One would be hard-pressed to identify any contemporary conflict that has been entered unilaterally by a Western force, as the overwhelming majority of recent military operations have been undertaken by international co-

5. Brig.-Gen. (Ret.) Pete Palmer, "Getting to a Good Enough Cognitive Shoe Size—an Operator's Perspective." Paper presented at the International Conference on Applied Human Factors and Ergonomics, Las Vegas, NV, July 2015.
6. Robert A. Rubinstein, Diana M. Keller, and Michael E. Scherger, "Culture and Interoperability in Integrated Missions," *International Peacekeeping* 15, no. 4 (August 2008): 540–55.
7. William Hardy, "Cultural Interoperability: Applying Social Categorization to Better Understand and Mitigate Cultural Friction in Multinational Operations," United States Army (Human Dimension Capabilities Development Task Force, January 2016): 1–41.

alitions or alliances (i.e., NATO, ISAF, ICRtoP etc.). With this in mind, the cultural or social differences between multinational commands and multinational forces yields similar types of barriers and levels of uncertainty. Though in different contexts, the consequences remain the same; cultural and social barriers ultimately hinder the effectiveness and sustainability of mission outcomes. As such, in order to reduce the level of cultural interoperability between multinational commands, forces, and local populations, the importance of putting people first and focusing greater attention on the human aspects of performance enhancement cannot be understated.

Nevertheless, this approach should *not* be misconstrued as an argument against technological innovation or the strengthening of service members' capabilities that serve to better prepare, protect, and defend them during duty. Doing so would be both detrimental to the safety and well-being of our soldiers, and counterproductive to the development of super soldiers moving forward. Instead, the military and policymakers should begin to take a more holistic and balanced approach that emphasizes non-kinetic enhancement and education while also identifying the cultural, social, ethical, and policy implications of the more traditional forms of human performance enhancement.

Challenges and Implications

While the use of technology, drugs, or physical augmentation to enhance soldiers' performance may increase their overall lethality or protection, these enhancements spark various questions and challenges that are oftentimes left unanswered. A large number of these concerns are ethical in nature; however, several questions related to the application of performance enhancement exist as well. This section will serve to briefly lay out some of these concerns.

In the ethical realm, there are three primary challenges that need to be recognized. First, it must be clear that everyone who receives a type of performance enhancement—be it physical, cognitive, invasive or non-invasive—must consent to such enhancement and the potential risks they entail. Although the lines and boundaries of ethical concerns are somewhat unclear as short- and long-term effects are distinct to each form of enhancement (some of which have yet to be tested), militaries and policymakers must do their due diligence and receive consent first before employing such enhancements. In addition, strict guidelines must be established to determine who does and does not

receive human performance enhancements. If none exists, there is the possibility for "enhancement strife" to emerge within militaries between those who have been given performance augmentations and those who have not.

Second, it is highly unlikely that the enhancements soldiers receive will ever be experienced by the populations they serve—at least in the same capacity. However, these soldiers have to eventually transition back to society once they have participated in conflict in "enhanced" environments. With the gap that already exists between the military and society,[8] there is potential for this gap to be exacerbated. As such, the proper tools, resources, and preventative frameworks must be made available to both soldiers and society in order to account for any difficulties that may arise during this transition.

Lastly, militaries and policymakers must recognize the potential implications performance enhancement has on future warfighting, operational mandates, and soldiers' mental psyche. As soldiers become accustomed to fighting with operationally driven enhancements that increase lethality while simultaneously reducing the level of risk involved, is it possible that these soldiers may become desensitized to the consequences of using such force? If so, to what extent would this willingness to use low-risk, lethal enhancements affect the scope of future combat operations and mandates? These are just a few of the ethical questions and challenges ahead that militaries and policymakers need to consider and work through when assessing the future of human performance enhancement.

However, ethical questions are not the only concerns that exist. Particularly, with regards to the application of performance enhancement, there are two critical challenges that need analysis. First, there is a commonly told story that, following the United States-led intervention in Iraq, local Iraqis became convinced the Oakley sunglasses American troops wore were capable of x-ray vision.[9] Despite being a small and harmless piece of equipment that was only meant to protect soldiers' eyes, Iraqi men spread rumours that young American soldiers could see through women's clothing while wearing them. Consequently, this

8. Helen Brunger, Jonathan Serrato, and Jane Ogden, "'No Man's Land': The Transition to Civilian Life," *Journal of Aggression, Conflict and Peace Research* 5, no. 2 (April 2013): 86–100.
9. Steve C. Baker, "Toward a Theory of Low Intensity Propaganda," in *Strategic Influence: Public Diplomacy, Counterpropaganda, and Political Warfare*, ed. Michael J. Waller (Washington, DC: Institute of World Politics Press, 2009), 292.

propaganda contributed to the negative perception of American troops by local Iraqi populations, thus creating another barrier between the two sides.

This is not to say that the military should be self-conscious when it comes to its appearance, but rather the armed forces should always be mindful of how local populations—especially those that are not as technologically advanced—perceive foreign forces or super soldiers while outfitted in the latest technological attire, such as exoskeletons or "smart helmets."[10] Bearing in mind that human intelligence (HUMINT) gathered from local populations has been instrumental in the success of past operations,[11] this challenge should not be overlooked.

Finally, this discussion prompts a fundamental question that all governments and militaries must ask when developing their forces: how useful or desirable is this new technology or capability? A critical evaluation, at least in the Canadian context, may be helpful as the answer does not seem as clear as it should be. While in 2017 the government of Justin Trudeau pledged to increase defence spending by 73 percent over the next decade, an increase in funding does not warrant the acquisition of undesirable capabilities and technology. To this end, further research must be conducted to assess the impact human performance enhancement would have on the operations the Canadian Armed Forces are involved in, including peacekeeping and advise-and-assist missions.

Conclusion

This policy brief has made the case for thinking more holistically about the future of human performance enhancement, as the current posture falls short in two major ways. First, this posture overstates the effectiveness of physical and cognitive enhancements by portraying technology as the best and only way to achieve more desirable outcomes in military operations. Continuing down this path not only misrepresents the factors that lead to effective and sustainable outcomes in today's way of war, but it also significantly overlooks the cultural, social, ethical,

10. Karen Gregorczyk, "Augmentation Technologies for Enhancing Physical Performance," (Presentation, U.S. Army NATICK Soldier Research, Development and Engineering Center, Kingston Conference on International Security, Kingston, ON, 13 June 2017).
11. "INTelligence: Human Intelligence." (Central Intelligence Agency, 30 April 2013) at https://www.cia.gov/news-information/featured-story-archive/2010-featured-story-archive/intelligence-human-intelligence.html

and policy implications that human performance enhancement entails. In turn, a "people first, mission always" mindset that focuses on cultural education and other forms of non-kinetic enhancement must be applied to the development of future super soldiers.

Second, policymakers have to consider the various ethical and practical challenges that exist regarding the application of physical and cognitive performance enhancement. If left ignored, there is a chance that the well-being of service members and the outcomes of military operations will be put at risk. Nonetheless, several questions still remain as this topic continues to evolve while technology and militaries grow over time. However, whether or not super soldiers are integrated into operational environments next year, or next decade, it must be the individual underneath the technology and uniform that shapes the future of human performance enhancement, not the other way around.

Envoi

The chapters in this volume capture the central themes of each of the panels at KCIS 2017, while providing deeper context and a richer exploration of the data and analysis. If the papers in this volume have sparked an interest, consider viewing the remainder of the presentations—they are available on the Kingston Conference on International Security website at http://www.queensu.ca/kcis/home.

While you are there, have a look at the agenda for the 2018 Kingston Conference on International Security. We look forward to national security stakeholders and critical thinkers joining us at that conference entitled, "The Return of Deterrence: Credibility and Capability in a New Era." We will look at the return of deterrence in global politics, examining how to balance capabilities and political commitments in a way that maintains a credible defence posture in the contemporary era. This conference will take place 11–13 June 2018 in Kingston. Look for our conference report, panel videos, and compilation of papers following this important event.