Super Soldiers: Why and What For?
AI and Enhanced Warfighters in Asymmetric, Conventional and Future War

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The prevailing image of the super soldier is often cartoon animated. Most depictions, of which Captain America is exceptionally popular, are variations on similar themes of prowess and virility: a "*super soldier,* realizing the Spartan ideal of creating a soldier that can endure more than ever," or a "*Jedi knight*, a super-empowered soldier able to perform solo missions and to transmit data back to headquarters."[1] This view embraces a gladiatorial model of warfare that places the solitary warrior at the center of armed conflict.[2] To improve warfighter performance, military organizations enlist medical science to develop pharmacological, surgical, genetic, and neurological technologies to optimize warfighter performance. *Cyborg Soldier 2050, a Human-Fusion* is the wave of the future. Turning on ocular, neural and auditory implants, the technology is daunting and physiologically transformative.[3] The outcome is decidedly human-altering or trans-human. And although inviting, the tactical and strategic value of super soldiers remains elusive in early 21st century asymmetric and conventional war.

Fashioning super soldiers presents a unique challenge that links the demands of weapons development to the rigid requirements of human enhancement experimentation. Each requires a close accounting of costs, risks, benefits, and feasible alternatives. To evaluate potential weapons of war, policymakers impose financial restraints, while international humanitarian law dictates *proportionality* to ensure "the relevant health factors" do not

[1] Galliott, J. and Lotz, M. (2017). "Introduction," in Super soldiers: The ethical, legal and social implications, eds. J. Galliott and M. Lotz (London: Routledge), 1-8.; Malet, D. (2015). Captain America in international relations: The biotech revolution in military affairs. *Defence Studies* 15:4, 1–21.
[2] Gross 2021 184-190
[3] Emanuel, P. et al. 2019. Cyborg Soldier 2050: Human/Machine Fusion and the Implications for the Future of the DOD. U.S. Army Combat Capabilities Development Command Chemical Biological Center (CCDC CBC).

outweigh "the intended military purpose or expected military advantage of the new weapon."[4] Relevant health factors generally refer to superfluous injury and unnecessary suffering that befall a weapon's target: enemy combatants and civilian bystanders. In principle, however, the health-related consequences of weapons development must also account for the well-being of those chosen to test new weapons. Clinical research makes similar demands when weapons development requires medical experimentation. As the object of controlled medical studies, research subjects must tender informed consent, a particularly fraught process when clinical investigators recruit healthy service personnel for warfighter enhancement.[5] Because healthy, volunteer research subjects face significant risks without enjoying the prospect of any medical benefit, researchers must appeal to collective, society-wide benefits. In non-military research, these benefits turn on contributions to medical science or the welfare of future patients and society.[6] When the research goal is warfighter enhancement to develop super soldiers, the benefits can only translate as some clear military advantage.[7] By bridging the proportionality requirement of weapons development and the consent condition of human experimentation, warfighter enhancement sets a very high bar for satisfying military necessity. Necessity demands that policymakers and weapons designers, no less than experimental subjects, must be

[4] ICRC. 2006. A Guide to the Legal Review of New Weapons, Means and Methods of Warfare: Measures to Implement Article 36 of Additional Protocol I of 1977. International Review of the Red Cross 88 (864) :947 https://www.icrc.org/en/doc/assets/files/other/irrc_864_icrc_geneva.pdf

[5] Pham, M., Goering, S., Sample, M., Huggins, J. E., & Klein, E. (2018). Asilomar survey: researcher perspectives on ethical principles and guidelines for BCI research. *Brain-Computer Interfaces* 5:4, 97-111.; Girling, K., Thorpe, J., and Auger, A. (2017). Identifying Ethical Issues of Human Enhancement Technologies in the Military Defence Research and Development Canada, Scientific Report, DRDC-RDDC-2017-R103 October 2017.

[6] Ireni-Saban, L., & Sherman, M. (2022). Cyborg ethics and regulation: ethical issues of human enhancement. *Science and Public Policy*, *49*(1), 42-53; Morris, M. and Balmer B. (2006). Volunteer human subjects' understandings of their participation in a biomedical research experiment. *Social Science & Medicine* 62 (2006) 998–1008; Wikler, D. (2017). Must research benefit human subjects if it is to be permissible?. *Journal of Medical Ethics*, *43*(2), 114-117.

[7] Military consent forms are deliberately vague in this respects often only assuring research subjects that their participation "will contribute to the medical knowledge and scientific investigation of possible uses for these medications in a military operational setting" (U.S. Army Aeromedical Research Laboratory. 2019. *Consent to Participate in Research*. https://clinicaltrials.gov/ProvidedDocs/32/NCT03893032/ICF_000.pdf.)

satisfied that super soldiers will significantly improve mission success or force protection in a way that no other technology does at a lower cost.

While many observers do not foresee functional super soldiers before 2040-50, they do not question their military necessity.[8] Enhanced soldiers are stronger, smarter, faster, hyper-alert, and more fatigue-resistant and resilient than ordinary warfighters. Pharmaceutical (e.g., Modafinil), mechanical (e.g., exoskeletons), biological (genetic engineering), and neuro-enhancements bolster stamina, endurance, and cognitive processing.[9] Among neuro-enhancements, brain-computer interfaces (BCIs) lie at the heart of cyborg soldiers who meld human and machine capabilities.[10] Implantable brain-computer interfaces and bionic body parts dominate many discussions to offer dynamic human-machine teaming, maximum, high-speed bi-directionality, and brain-to-brain communication.

Four BCI domains stand out in particular: warfighter health, training, mission success, and force protection. Monitoring warfighter health, BCIs can track stress, disease, and injury, regulate and modify cognitive workloads, and expeditiously return soldiers to duty. Coupled with virtual and augmented reality, advanced BCIs will utilize artificial intelligence to improve human and machine learning and training. Interfaced cognitive enhancement contributes to mission success and force protection by boosting data processing, situational awareness, decision-making, targeting, weapons operations, and kill-chain efficiency.[11] The expectation

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[8] Emanuel, P. et al. 2019. *Cyborg Soldier 2050: Human/Machine Fusion and the Implications for the Future of the DOD*. U.S. Army Combat Capabilities Development Command Chemical Biological Center (CCDC CBC).; Reding DF and Eaton J. 2020, Science & Technology Trends 2020-2040, Exploring the S&T Edge, *NATO Science & Technology Organization*; Binnendijk, A., Marler, T., & Bartels, E. M. (2020). *Brain-Computer Interfaces: US Military Applications and Implications, An Initial Assessment*. RAND Corporation. https://www.rand.org/pubs/research_reports/RR2996.html

[9] Goodley, H. 2020 Pharmacological performance enhancement and the military Exploring an ethical and legal framework for 'supersoldiers' Chatham House; Kelley, A. M., Goldie, C., Bernhardt, K., Curry, I., Crowley, J., Mathews, C., ... & Basso, J. (2021). *Enhancing Operational Performance in Healthy Rested Soldiers with Pharmacological Stimulants*. US Army Aeromedical Research Laboratory Oak Ridge Institute for Science and Education.

[10] Miranda, R. A., Casebeer, W. D., Hein, A. M., Judy, J. W., Krotkov, E. P., Laabs, T. L., ... & Ling, G. S. (2015). DARPA-funded efforts in the development of novel brain–computer interface technologies. *Journal of neuroscience methods* 244, 52-67.

[11] Binnendijk, A., Marler, T., & Bartels, E. M. (2020). *Brain-Computer Interfaces: US Military Applications and Implications, An Initial Assessment*. RAND Corporation.

that super soldiers will provide a military organization with critical tactical and strategic advantages is the impetus for research, development, and medical experimentation. Critical advantages, perhaps. But are super soldiers effective and necessary? Do super soldiers function as conceived? Do they realize significant military benefits at lower costs than alternative technologies of equal effect? These questions are important because they reflect the paramount concerns of military research and development.

Planning weapons development and procurement, American policymakers currently focus on six domains: long-range precision fire, combat vehicles, vertical lift aircraft, network technologies, air and missile defense, and soldier lethality.[12] Among these, super soldiers would be expected to contribute primarily to soldier lethality. To establish military necessity, weapons developers and clinical researchers must view the entire mix of domains and demonstrate that warfighter enhancement provides an overwhelming tactical or strategic military advantage at costs lower than comparable technologies. Any assessment of military necessity also depends on the context. Two 21st-century conflicts offer the context to probe further: counterinsurgency (COIN) warfare in Iraq and Afghanistan and conventional war in Ukraine. Each highlights the challenges of demonstrating the military necessity for developing cyborgs and bionically enhanced warfighters.

Super Soldiers, Artificial Intelligence and Neuro-Enhancement in Asymmetric and Conventional War

Joining the arsenal of available technology, artificial intelligence (AI) and neuro-enhancement serve diverse tactical and strategic roles as each interacts with human operators in different ways. First, AI might assume an enhancing role that integrates AI directly into

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https://www.rand.org/pubs/research_reports/RR2996.html; Konaev, M. Chahal, H., Fedasiuk, R., Huang, T., Rahkovsky, I. 2020. U.S. Military Investments in Autonomy and AI A Strategic Assessment. *CSET Policy Brief*, 2020; https://cset.georgetown.edu/wp-content/uploads/U.S.-Military-Investments-in-Autonomy-and-AI_Strategic-Assessment-1.pdf; Reding DF and Eaton J. 2020, Science & Technology Trends 2020-2040, Exploring the S&T Edge, *NATO Science & Technology Organization*.

[12] US Army (2019). *2019 Army Modernization Strategy: Investing in the Future*. https://www.army.mil/e2/downloads/rv7/2019_army_modernization_strategy_final.pdf, p. 6.

human decision-making via brain-computer interfaces or take on a collaborative role where external AI systems work alongside and support human decision-making. The former illustrates the super soldier, while the latter comprises normal warfighters working in conjunction with machines. Second, integrated neuro-enhancement systems may utilize non-invasive BCIs or surgically implanted interfaces to facilitate human-machine teaming. Each enhances cognitive performance, but only the latter can fundamentally alter human identity. Finally, whether human-altering or not, neuro-enhancements can enrich two very different sets of skills: hard warfighting skills that optimize lethality and kill-chain efficiency or soft warfighting skills emphasizing interpersonal communication, cultural sensitivity, and language acquisition. Each of these three aspects of neuro-enhancement technology determines the military necessity of super soldiers that later play out in asymmetric and conventional armed conflict.

Two Roles for AI: Integration or Collaboration?

AI-driven warfighting systems may be integrative or collaborative. Integrated systems employ machine systems that interface directly with the human brain to allow warfighters to establish "direct communication with unmanned and autonomous systems, optimize command and control systems and operations…revolutionize tactical warfighter communications, speed the transfer of knowledge throughout the chain of command, and ultimately dispel the "fog" of war."[13] Artificial machine intelligence interfaces with human brains to alter and improve human cognitive performance and enhance "connectivity" between humans and/or between humans and machines.[14] Human-machine integration permits warfighters to transfer data bi-directionally directly from drones, satellites, static field sensors, or wearables to the human brain, and from the brain – its thoughts, analyses, and decisions - to direct computer-based

[13] Emanuel, P. et al. 2019. *Cyborg Soldier 2050: Human/Machine Fusion and the Implications for the Future of the DOD*. U.S. Army Combat Capabilities Development Command Chemical Biological Center (CCDC CBC). Binnendijk, A., Marler, T., & Bartels, E. M. (2020). Brain-Computer Interfaces: US Military Applications and Implications, An Initial Assessment. RAND Corporation:12 https://www.rand.org/pubs/research_reports/RR2996.html

weapons systems (drones, planes, artillery etc.). Integrated technology couples the memory and speed of computers with "tasks that the brain excels at but which currently thwart classical computers, such as extensive heterogeneous data analysis and visual scene.[15]" The result is enriched situational awareness, precision targeting, conservation of resources, fewer casualties, and greater potential for mission success.

Nevertheless, artificial machine intelligence need not necessarily interface with human brains but instead might process big data to supply ordinary (but well-trained) soldiers with the detailed information they need to make better decisions about targeting, troop movements, logistics, and command and control. The US Army 2020-21 *Weapons System Handbook* foresees a pivotal, collaborative role for AI:

> Artificial Intelligence (AI) is expected to strongly enhance performance of all technological components and Army systems. Army Basic Research in this area focuses on integration of AI algorithms and approaches to advancing distributive sensing, target recognition, and cooperative and distributed navigation and mobility. This research will enable optimal and highly coordinated operation of various Army units.[16]

Already, the war in Ukraine reveals significant AI penetration in the battlespace. Drones, satellites, cyber systems, cellular telephones, social media, and open sources generate vast amounts of data – optical and thermal imaging, digital traffic, declassified reports pertaining to Russian weapons and troop positions, and tactical decision-making. Local and external AI tools, machine learning algorithms, and communication networks (e.g., Starlink) analyze and deliver data to enhance apperception, improve targeting outcomes, and facilitate

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[15] Reding DF and Eaton J. 2020, Science & Technology Trends 2020-2040, Exploring the S&T Edge, *NATO Science & Technology Organization*: 97.

[16] US Army. (2021). Weapons Systems Handbook 2020-2021. https://www.army.mil/e2/downloads/rv7/2020-2021_Weapon_Systems_Handbook.pdf: p. 397)

tactical decision-making by officers in the field.[17] More prosaically, AI is well-suited for "dull, dirty and dangerous missions," including surveillance, image analysis, or countermine operations.[18] These scenarios depict human-machine collaboration and teaming to simulate missions, estimate collateral damage, identify enemy vulnerabilities or drive autonomous weapons systems.[19] Humans may be in or out of the loop but are not enhanced in any way. On the other hand, enhancement speaks to human-machine interfacing and integration, and is either human or trans-human.

Two Kinds of Enhancement: Trans-Human and Human

Available and proposed technologies for enhancement, particularly neuro-enhancement, include mechanical devices that interact with the brain and are distinguishable by their degree of physical invasiveness. Wearables are the least invasive and comprise devices and biosensors on the skin's surface to monitor physiological functions, including brain activity. Wearable BCIs are non-invasive caps or helmets that provide scalp-recorded EEG signals.[20] Although non-invasive, EEG-based BCIs carry risks that may affect personality and memory, or cause BCI dependence.[21] Neural implants or implantable BCIs comprise electrodes

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[17] Reeves, S and Lawless R. 2022. Ukraine Symposium – Data-Rich battlefields And The Future LOAC https://lieber.westpoint.edu/data-rich-battlefields-future-loac.

[18] Konaev, M. Chahal, H., Fedasiuk, R., Huang, T., Rahkovsky, I. 2020. U.S. Military Investments in Autonomy and AI A Strategic Assessment. *CSET Policy Brief*, 2020: 15 https://cset.georgetown.edu/wp-content/uploads/U.S.-Military-Investments-in-Autonomy-and-AI_Strategic-Assessment-1.pdf

[19] Australian DoD (Department of Defence) (2020). A Method for Ethical AI in Defence. Defence Science and Technology Group, DSTG-TR-3786.

[20] Defense Advanced Research Projects Agency (DARPA). (2019). Six paths to the nonsurgical future of brain-machine interfaces. DARPA News and Events. https://www.darpa.mil/news-events/2019-05-20.; Karavas, G. K., Larsson, D. T., & Artemiadis, P. (2017, September). A hybrid BMI for control of robotic swarms: Preliminary results. In 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (pp. 5065-5075). IEEE.; Portillo-Lara, R., Tahirbegi, B., Chapman, C.A.R., et al. (2021) "Mind the gap: State-of-the-art technologies and applications for EEG-based brain–computer interfaces." *APL bioengineering* 5:3, 031507.; Abiri, R., Borhani, S., Sellers, E. W., Jiang, Y., & Zhao, X. (2019). A comprehensive review of EEG-based brain–computer interface paradigms. *Journal of neural engineering*, *16*(1), 011001; Toumazou C. and Constandinou T. 2019. iHuman: blurring lines between mind and machine. The Royal Society. https://royalsociety.org/topics-policy/projects/ihuman-perspective/?utm_source=ihuman-perspective&utm_medium=print&utm_campaign=report.

[21] National Academies of Sciences, Engineering, and Medicine (2021). *Human-AI Teaming: State of the Art and Research Needs* (Washington, DC: The National Academies Press): 41, 50 https://doi.org/10.17226/26355 ; Kögel, J., Schmid, J. R., Jox, R. J., & Friedrich, O. (2019). Using brain-computer interfaces: a scoping review of studies employing social research methods. *BMC medical ethics* 20:1, 1-17.; Mehlman, M., Lin, P., & Abney, K. (2013). Enhanced warfighters: risk, ethics, and policy. *Case Legal Studies Research Paper*.; Vlek, R. J., Steines,

or devices embedded into or near neuronal tissues. These include deeply embedded neural brain-computer interfaces (BCI), ocular or auditory implants, and "partially" invasive BCIs resting inside the skull but outside the brain.[22] Implantable BCIs permit wireless bidirectional communication with an external device or other brains and improve speed and signal quality. However, they incur the short-term risks associated with brain surgery (bleeding, brain damage) and longer-term risks of implants (corrosion, infection).[23] Still unsettled and speculative are the psychological and social risks that long-term and permanent cognitive enhancement poses to personal identity and stability, one's sense of self, and social relations in military and civilian life.[24]

For Jedi-knight super soldiers, enhancements utilize invasive, implantable and difficult-to-reverse (or irreversible) cortically coupled AI technology to sense brain states and capture "a user's implicit or explicit computation and then communicate this information to a traditional computer system via a neural interface."Additional enhancements include integrated exoskeletons, bionic body parts (e.g., eyes and ears) and/or orthopedic surgery (e.g., prosthetics) to optimize performance.[25] Building on a cyborg (cyber-organism) platform that integrates bionic (bio-electronic) devices functioning as physiological systems, these

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D., Szibbo, D., et al. (2012). Ethical issues in brain–computer interface research, development, and dissemination. *Journal of neurologic physical therapy* 36:2, 94-99.

[22] De la Torre, G. G., Gonzalez-Torre, S., Muñoz, C., & Garcia, M. A. (2019). Wireless Computer-Supported Cooperative Work: A Pilot Experiment on Art and Brain–Computer Interfaces. Brain Sciences, 9(4), 94.

[23] Nijboer, F., Clausen, J., Allison, B. Z., & Haselager, P. (2013). The asilomar survey: Stakeholders' opinions on ethical issues related to brain-computer interfacing. Neuroethics 6:3, 541-578:553; Naufel, S., Klein, E. (2020). Brain–computer interface (BCI) researcher, perspectives on neural data ownership and privacy. J. Neural Eng. 17, 016039.:2)

[24] National Academies of Sciences, Engineering, and Medicine (2021). *Human-AI Teaming: State of the Art and Research Needs* (Washington, DC: The National Academies Press): 41, 50 https://doi.org/10.17226/26355 ; Kögel, J., Schmid, J. R., Jox, R. J., & Friedrich, O. (2019). Using brain-computer interfaces: a scoping review of studies employing social research methods. *BMC medical ethics*, *20*(1), 1-17; Vlek, R. J., Steines, D., Szibbo, D., et al. (2012). Ethical issues in brain–computer interface research, development, and dissemination. *Journal of neurologic physical therapy* 36:2, 94-99.

[25] Binnendijk, A., Marler, T., & Bartels, E. M. (2020). *Brain-Computer Interfaces: US Military Applications and Implications, An Initial Assessment*. RAND Corporation: 9-10 https://www.rand.org/pubs/research_reports/RR2996.html

technologies alter human physiology. Pushing toward super-human strength, stamina, and cognition, they illustrate *trans-human enhancement*.

On the other hand, non-invasive, reversible wearables or EEG-based brain-computer interfaces are not trans-human and, therefore, are often referred to as "augmentation."[26] They do not physiologically integrate cyber, computer, and biological systems yet may still interface with brains and machines to monitor health, facilitate training, and improve mission success and force protection. Other non-invasive neuro-technologies include targeted neuroplasticity training and transcranial stimulation to optimize training and performance by improving memory and perceptual ability.[27] Pharmaceutical agents, like Modafinil, reduce fatigue while exoskeletons augment physical strength. Often referred to as *human* enhancement or augmentation, these technologies speed learning, strengthen memory, or increase stamina within the bounds that are recognizably human (an admittedly hazy criterion). And like its trans-human cousin, human enhancement can impart two kinds of warfighting skills.

Two roles for enhancement: Hard and soft warfighting skills

Hard warfighting skills embrace those that improve lethality and kill chain efficiency. Kill chains denote the sequence of events whereby an enemy asset is located, targeted, engaged, and destroyed. Intelligence and surveillance provide location, while an array of kinetic, cyber, and electronic weapons target, engage, and destroy an asset. A sophisticated and efficient kill chain apparatus is also a strategic asset that can enhance deterrence and credibility and alter the balance of power among adversaries. Reflecting on the place of the

[26] UK Ministry of Defence. (2021). Human Augmentation – The Dawn of a New Paradigm, A strategic implications project.
[27] Davis, S. E., & Smith, G. A. (2019). Transcranial direct current stimulation use in warfighting: benefits, risks, and future prospects. *Frontiers in Human Neuroscience*, *13*, 114; McClure-Begley, T. nd. Targeted Neuroplasticity Training (TNT) DARPA. https://community.apan.org/wg/tradoc-g2/mad-scientist/m/learning-in-2050/241458/download; Reding DF and Eaton J. 2020, Science & Technology Trends 2020-2040, Exploring the S&T Edge, *NATO Science & Technology Organization*; French, Shannon E., and Jacob A. Sandstrom. "Military Neuro-Interventions. Arthur D. Simons Center for Interagency Cooperation. https://case.edu/inamori/sites/case.edu.inamori/files/2021-01/IAJ-10-3-2019-pg7-19.pdf.

enhanced soldier, the National Research Council emphasized hard warfighting skills in 2009: “A soldier can be trained to set reflexive neurons in a state to pull the trigger without higher neural involvement, decreasing the time between acquiring and engaging the target.[28]” Too narrowly construed, this view evokes images of lone infantrymen holding off superior enemy forces. Nevertheless, a quick trigger finger is a good thing, especially when coupled with exoskeletons that boost strength or helmets that can monitor neuro-states, regulate the flow of information, prioritize tasks, and map terrain. It must be judged, however, with respect to other hard warfighting skills that include small unit tactics, target acquisition, information processing, training and expertise and leadership as well as soft warfighting skills.

Soft warfighting skills aim toward cooperation and persuasion rather than competition, destruction and victory. Such “Guardian” traits, as Kaurin terms them, attend to the needs of the weak and vulnerable, resolve issues without the use of force, pay attention to “culture, language and politics,” and display adaptability.[29] Soft skills focus on communication, public affair operations, psychological operations, mediation, and acculturation. Soft skills can “save lives, build and sustain support for operations, reduce enemy resistance, and help ensure the success of the operation.”[30] In this vein, US Marine Corps operations guidelines emphasize such successful counterinsurgency practices as “focusing on the population, its needs and security, embedding quality advisors, and encouraging strong political and military cooperation and information sharing” while rejecting “killing and capturing the enemy rather than security

[28] NRC. (2009). *Opportunities in neuroscience for future army applications*. Committee on Opportunities in Neuroscience for Future Army Applications. Board on Army Science and Technology Division on Engineering and Physical Sciences. National Research Council. Washington, DC: The National Academies Press: p. 78.
[29] Kaurin, P.M. (2014). *The Warrior, Military Ethics and Contemporary Warfare: Achilles Goes Asymmetrical* (London: Routledge).
[30] Hosmer, Stephen T., Maren Leed, David Persselin, Jerry M. Sollinger, Ronald E. Sortor, Jennifer Taw*Bettering the Balance: Large Wars and Small Contingencies*. RAND, 1997.

and engaging the population, conducting large scale operations as the norm, and focusing special operations primarily on raiding."[31]

Whether facilitating hard or soft skills, AI-assisted enhancement will play a growing role. Non-invasive EEG-based or implantable BCIs will allow warfighters to assimilate vast droves of information to improve their ability to locate, target and destroy the enemy through efficient weapons choice and troop deployment. The same AI-assisted technologies also significantly improve education and training for soft skills such as language acquisition and communication skills, particularly when accompanied by targeted neuroplasticity training (TMT) or transcranial stimulation (TS).[32] In this way, many less expensive, less invasive, and less harmful technologies than implantable neuro-technologies typical of super soldier paradigms can enhance a wide range of hard and soft warfighting skills. Deliberately cautious about the risks of surgically invasive enhancement technologies, it is no accident that two of DARPA's most significant AI neuro-enhancement projects emphasize collaborative or non-invasive neural interfaces.[33] The Neural Signal Interfaces and Applications (NSIA) program, for example, is developing non-invasive neuro-technologies "able to interface with the nervous system with high resolution and precision without surgery…" and facilitate standard human-machine interfaces for improved workload balance between man and machine.[34] The Artificial Intelligence and Human-Machine Symbiosis project "develops technologies to enable machines to function not only as tools that facilitate human action but as trusted partners to human

[31] USMC 2011. Marine Corps Operations, MCDP 1-0: 7-7 https://www.usmcu.edu/Portals/218/CEME/courses/MCDP%201-0%20Operations.pdf?ver=2018-09-24-142233-483.
[32] See note 27
[33] Defense Advanced Research Projects Agency (DARPA). (2019). Six paths to the nonsurgical future of brain-machine interfaces. DARPA News and Events. https://www.darpa.mil/news-events/2019-05-20. Here DARPA emphasizes "completely non- invasive interfaces that are entirely external to the body or minutely invasive interface systems that include nanotransducers that can be temporarily and nonsurgically delivered to the brain to improve signal resolution."
[34] DOD 2023. Department of Defense Fiscal Year (FY) 2023 Budget Estimates April 2022 Defense Advanced Research Projects Agency Defense-Wide Justification Book Volume 1 of 5 Research, Development, Test & Evaluation, Defense-Wide: 73 https://www.darpa.mil/attachments/U_RDTE_MJB_DARPA_PB_2023_APR_2022_FINAL.pdf.

operators." Mining human speech and information for diverse media, the system expects to "answer questions, reach conclusions, and propose explanations; and learn, reason, and apply knowledge gained through experience to respond intelligently to new and unforeseen events." Teamed with warfighters, the project will enhance decision-making, intelligence analysis, software and semi-autonomous weapons development.[35] In a similar vein, near-term plans to enhance soldier lethality eschew invasive, implantable neuro-interfaces to focus on next-generation rifles, enhanced night vision, and visual augmentation systems.[36]

In short, the super soldier is a unique application of AI that exploits an implantable brain-computer interface to optimize hard warfighting skills to fashion trans-human warfighters. Meriting further scrutiny, however, alternative, collaborative uses of AI may not include enhancement at all, while those that do may suffice with augmentation via non-invasive, easily-reversible devices to facilitate soft rather than hard warfighting skills while preserving recognizably human agents. Moreover, a plethora of existing and up-and-coming technologies may render the super-soldier concept unnecessary. On the one hand, its driving technology is, perhaps, better met at lower costs by alternative technologies. On the other hand, a closer look at conflicts in Iraq, Afghanistan, and Ukraine permits a detailed assessment of the tactical and strategic role of super soldiers in modern wars.

Super soldiers in Asymmetric and Conventional War: Iraq, Afghanistan, and Ukraine

The hard and soft warfighting skills that AI-assisted neuro-enhancement promises to bolster have tactical and strategic significance. The former highlights an enhanced soldier's role during warfighting and is usually event specific: destroying, degrading, or capturing a military asset, protecting civilians from an attack, facilitating civilian-military cooperation, or gathering

[35] DOD 2023. Department of Defense Fiscal Year (FY) 2023 Budget Estimates April 2022 Defense Advanced Research Projects Agency Defense-Wide Justification Book Volume 1 of 5 Research, Development, Test & Evaluation, Defense-Wide: 84 https://www.darpa.mil/attachments/U_RDTE_MJB_DARPA_PB_2023_APR_2022_FINAL.pdf.
[36] US Army, 2019 Army Modernization Strategy, p. 7; US Army 2021, Weapon Systems Handbook 2020-2021, p. 29., 48.

intelligence. Strategic roles of super soldiers or any military technology aim to project power in the international arena to establish deterrence, enhance alliances and influence the balance of power to prevent or control escalation as it suits a nation's interests. Here, AI capabilities may allow nations to establish dominance, choose among greater and lesser escalatory responses, credibly threaten reprisal and take decisive military actions when needed.

Super Soldiers in Asymmetric War

In a recent RAND study, a panel of experts evaluated various BCI capabilities for use in urban combat. [37] BCI tools include human-machine decision-making, communication and control, performance monitoring, enhanced cognitive and physical performance, and training. Supporting neuro-technologies are both near-term 2030-2040 (non-invasive, EEG-based BCI, TNT or TS) and far-term, 2040-2050 (implantable BCIs, cyborgs). Considering two combat vignettes - clearing a building of insurgents and evacuating casualties following an ambush in urban terrain – the panel emphasized three BCI capabilities: BCI support to human-machine decision making, direct systems control of semi-autonomous systems and drone swarms, and enhanced physical performance through improved auditory and visual capabilities and exoskeletons. Looking further to the future, super soldiers were not far from their minds as they emphasized the revolutionary nature of brain-to-brain communication among service members. In each context, the experts "chose BCI tools over traditional military approaches for tasks across the spectrum of warfighter function." [38]

While studies like these offer insights into the military necessity of BCIs and super soldiers, their focus is excessively narrow. First, the vignettes draw entirely from the American counterinsurgency in Iraq and Afghanistan, specifically the battle for Fallujah. Second, and most important, the vignettes confuse tactics and strategy. It will never be difficult to construct a vignette wherein advanced technology can play a significant tactical role. The larger question

[37] Binnendijk, A., Marler, T., & Bartels, E. M. (2020). *Brain-Computer Interfaces.*
[38] Binnendijk, A., Marler, T., & Bartels, E. M. (2020). *Brain-Computer Interfaces.* p. 20-21.

is whether militarized neuro-technology has a *cost-effective* role given the strategic goals of fighting a counterinsurgency or waging a near-peer conflict. Nations have many competing strategic goals and myriad weapons systems from which to choose. As countries consider different scenarios of future war, they will rank and prioritize the costs and benefits of existing and future technologies, including enhancement. Absent such a comprehensive reckoning in the strategic context of war, the entire debate over enhancement is ungrounded and impossible to settle.

Asymmetric counterinsurgencies, typical of the Iraqi and Afghan conflicts and pitting a large state army against a much smaller insurgency, are one dominant paradigm of contemporary armed conflict. The military goals of COIN and the strategies required to attain them appear in Table 1.

Table 1
Goals and Strategies of Successful Counterinsurgency[39]

Goal	Strategy
Reduce Insurgent Numbers	
Disable Combatants	Targeted killing (drones); ground forces, special operations forces (SOF)
Decrease Recruitment	Population centered COIN
Degrade Insurgent Combat Effectiveness	Jamming and surveillance Cyber, information, and financial warfare
Increase State-army Numbers	Deploy more boots on the ground Force protection and improved survivability: medical care, body, and vehicle armor Decrease fatigue and sleep requirements
Improve State-army Combat Effectiveness	Leadership training Improved weapons: robotics, drones, missiles Military medical enhancement

Body counts are often the best-publicized goal of COIN, but it is not all about killing. While targeted killing reduces insurgent numbers directly, population-centered policies that deliver health care, education, and employment decrease civilians' motivation to join guerrillas and further diminish insurgent forces.[40] Public diplomacy and campaigns to win

[39] Adapted from Gross, M. 2021. *Military Medical Ethics in Contemporary Armed Conflict: Mobilizing Medicine in Pursuit of Just War*. Oxford: Oxford University Press

[40] Kilcullen, D. (2010). Counterinsurgency. Oxford: Oxford University Press.; Paul, C., Clarke, C. P., and Grill, B. (2010). Victory has a thousand fathers: Sources of success in counterinsurgency. Santa Monica, CA: RAND Corporation.; Vizzard, J. W., and Capron, T. A. (2010). Exporting general Petraeus's counterinsurgency

hearts and minds similarly aim to stem recruitment and encourage defection.[41] Degrading insurgents' combat effectiveness addresses the military capabilities of extant guerrilla forces. It depends upon intelligence and surveillance to foil attacks, electronic jamming and cyberattacks to disable weapons, and information systems, and financial warfare and sanctions to block the flow of funds and war materiel. On the government side, higher troop deployments (surges) increase the number of boots on the ground, while better medical management, armor, and other types of force protection improve survivability.

Force protection is particularly significant. In recent wars, improvised explosive devices (IEDs) were the leading cause of death and severe injury.[42] The first line of defense includes human intelligence, surveillance, and electronic jamming equipment to prevent IED attacks and injuries.[43] Further measures combine armored vehicles, body armor and helmets, fire-resistant clothing, front-line medical facilities, and speedy evacuation. Among the most effective responses were "Mine Resistant, Ambush Protected Vehicles" (MRAP) in Iraq and

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doctrine: An assessment of the adequacy of field manual 3-24 and the US government's implementation. Public Administration Review, 70(3), 485–493.

[41] Johnson, N. (2010). Small projects reap large gains in Helmand. *ISAF*. http://www.isaf.nato.int/article/isaf-releases/small-projects-reap-large-gains-in-helmand.html.
Freedman, L. (2006). Strategic communications. The Adelphi Papers 45 (379): 73-93. http://dx.doi.org/10.1080/05679320600661715
ISAF. (2011). Effective civil partnerships: community project yields unlikely find," August 25. http://www.isaf.nato.int/article/coin/effective-civil-partnerships-community-project-yields-unlikely-find.html
Fishstein, P., and Wilder, A. (2012). Winning hearts and minds? Examining the relationship between aid and security in Afghanistan. Medford, MA: Feinstein International Center.
Wilensky, R. J. (2004). Military medicine to win hearts and minds: Aid to civilians in the Vietnam War. Lubbock: Texas Tech University Press.
Wilton Park Conference. (2010). WP1022, Winning hearts and minds in Afghanistan: Assessing the effectiveness of development and operations. Wilton Park Conference, March 11–14, 2010. https://www.wiltonpark.org.uk/wp-content/uploads/wp1022-report.pdf.

[42] Cordesman, A. H., Allison, M. and Lemieux J. (2010). *IED metrics for Afghanistan January 2004–September 2010*. Washington, DC: Center for Strategic and International Studies.
Cordesman, A. H., Loi, C., and Kocharlakota, V. (2010). *IED metrics for Iraq, June 2003–September 2010*. Washington, DC: Center for Strategic and International Studies. Goldberg, M. S. (2010). Death and injury rates of U.S. military personnel in Iraq. *Military Medicine*, 175(4), 220–226; Livingston, I. S., and O'Hanlo, M. (2011). *Afghanistan index: Tracking variables of reconstruction & security in Post-9/11 Afghanistan*. https://www.brookings.edu/wp-content/uploads/2016/07/index20111231.pdf.;

[43] Shachtman, N. (2011). The secret history of Iraq's invisible war. Wired, April 11.; Wilson, C. (2007). Improvised explosive devices (IEDs) in Iraq and Afghanistan: Effects and countermeasures. Congressional Research Report, No. RS22330. https://fas.org/sgp/crs/weapons/RS22330.pdf.

Afghanistan which reduced IED casualties from 22% to 6%.[44] These force protection measures did not include enhancement, nor is it clear that super soldiers, as presently conceived, overcome their vulnerability to these attacks.

As military organizations turn to advanced weapons (including AI-assisted and autonomous weapons systems) and leadership training to optimize troop performance and improve combat effectiveness, enhancement finds a role. At one level, neuroscience can utilize EEG-based BCIs to significantly improve training and learning by offering feedback loops to evaluate data and monitor performance by a human operator. Neuropsychological testing, neuroimaging, and screening for genetic and other biomarkers of successful performance can also optimize recruitment and selection.[45] At the operational level, the National Research Council takes notice of "mission enabling neuroscience technology opportunities" to "contend with an ever-increasing river of information ... avoid information overload and successfully synthesize information that selectively highlights the mission-critical features from multiple sources." Applicable technologies include non-invasive human-computer interfaces, remote physiological monitoring for stress, neural signals to control external systems, and virtual reality training. These training and information processing capabilities eschew the "unrealizable bionic soldier".[46]

Special operations forces (SOF) are an oft-cited target for enhancement. Here, too, however, the most useful technology is not implantable neuro-enhancement nor the archetype super soldiers. Special Operations Forces (SOF) are small cohesive, independent units that

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[44] Friedman, N. (2013). This truck saved my life: Lessons learned from the MRAP vehicle program. Joint Program Office, Mine-Resistant Ambush-Protected Vehicles. Washington, DC: Delta Resources: 62 https://www.dau.edu/cop/pm/dau%20sponsored%20documents/mrap%20history%20final%2030june2014.pdf

[45] Defense Advanced Research Projects Agency (DARPA). (2019). Six paths to the nonsurgical future of brain-machine interfaces. DARPA News and Events. https://www.darpa.mil/news-events/2019-05-20; Flower, R., Dando, M., Hay, A., Iverson, S., Robbins, T., Robinson, J. P., Rose, S., Stirling, A., Tracey, I., and Wessely, S. (2012). *Brain waves module 3: Neuroscience, conflict, and security*. London: The Royal Society; JASON (2010). *The $100 Genome: Implications for the DoD. JSR-10-100.* McLean, VA: JASON, The MITRE Corporation.

[46] National Research Council 2009: 8, 75-6.

spend long periods in the field to conduct search and rescue, strategic reconnaissance, unconventional warfare, and counterterrorism while often engaging guerrilla forces in close combat. In the US military, their numbers reached 70,000 in 2018.[47] However, as they assume the brunt of counterinsurgency warfare, SOF increasingly turns to population-centered strategies, including internal defense, civil affairs, humanitarian assistance, and information operations. Internal defense trains host-nation forces to provide local security. Civil affairs and humanitarian assistance help local governments build medical, educational, judicial, and other service infrastructures by partnering with local stakeholders, international nongovernmental organizations (NGOs), and military forces.[48]

These strategies decrease the number of insurgents and degrade their effectiveness without fighting. For this purpose, administrative capabilities, language proficiency, cultural understanding, and negotiation skills supersede physical strength and endurance, and assume greater importance as SOF take on civilian-related tasks. The requisite enhancement technologies are not exoskeletons or implantable interfaces but specialized neuro-training techniques. Non-invasive nerve stimulation devices such as earbud electrodes enable targeted neuroplasticity training to accelerate language acquisition, acculturation, and intelligence analysis to facilitate successful population-centered COIN. EEG-based BCIs enable operators to organize information flows to permit fast-moving threat and target identification.[49] In these ways, EEG-based BCIs do not directly enhance the hard warfighter skills some implantable BCIs may offer warfighters but optimize instead human-machine teaming together with the soft skills required to attend to the needs of the local population.

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[47] Feickert, A. (2018). U.S. special operations forces (SOF): Background and issues for Congress. *Congressional Research Service*, Report No. RS21048. https://fas.org/sgp/crs/natsec/RS21048.pdfHennigan, W. J. (2017). The new American way of war. *Time Magazine*, November 30.
[48] FM 3-24. (2006). *Counterinsurgency*. Field Manual 3-24. Washington, DC: Department of the Army. https://legacy.npr.org/documents/2008/may/counterinsurgency_manual.pdf Kilcullen, D. (2006). Twenty-eight articles fundamentals of company-level counterinsurgency. *Marine Corps Gazette*, 90(7), 29–35.
[49] Naufel, S., Klein, E. (2020). Brain–computer interface (BCI) researcher, perspectives on neural data ownership and privacy. J. Neural Eng. 17, 016039.

Degrading insurgent capabilities depends critically on tactics to deplete their financial resources and defeat insurgent propaganda. Decreasing insurgent numbers is a continuous challenge. It is not about body counts as much as diminishing support for guerrillas by offering young men and their families incentives to work and live peacefully rather than join insurgents' ranks. This strategy requires infrastructure investment to provide security, employment, health, and education as well as a horizon for transitioning to local autonomy and control. As nations prosecute an asymmetric war, they often will find soft warfighting skills effected by non-invasive, reversible neuro technologies more valuable than super soldier enhancements spearheaded by implantable interfaces and the proper target of researchers and funding agencies. Ultimately, the killing rate of super soldiering is only a small part of the counterinsurgency (COIN) puzzle, and implantable neuroenhancement is only a small part of improving the killing rate. Conventional war as it unfolds in Ukraine holds similar lessons.

Super Soldiering in Conventional War

If there are growing data to question the strategic value of trans-human enhanced soldiers in asymmetric war, data are only just accumulating about their potential role in other kinds of conflict. Where would enhanced, Jedi-soldiers fit in the Ukraine-Russia war, for example? In contrast to asymmetric war, where state forces emphasize population-centered COIN to reduce insurgency strength and numbers, conventional war looks to military means and lethality to defeat an enemy. To this end, we see numerous roles for various technologies, including high-technology artillery with advanced targeting capabilities and missile defense systems, medium-technology GPS-guided shells for older artillery, and lower-tech air defense systems that have denied the Russians control of the sky.[50] As armies modernize, these systems

[50] Bronk, J, Reynolds N. and Watling J. 2022. The Russian Air War and Ukrainian Requirements for Air Defence. Royal United Services Institute for Defence and Security Studies (RUSI). https://rusi.org/explore-our-research/publications/special-resources/russian-air-war-and-ukrainian-requirements-air-defence.;

become candidates for AI and machine learning that require quickly trained forces. Training may benefit from neuro-technologies such as TNT or EEG-based BCIs as it does in asymmetric war. On the other hand, hard warfighting skills may outweigh the soft skills of civilian-centered COIN in a state-on-state conventional war.

To this end, finding a place for trans-human enhancement requires demonstrating that enhancement is cost-effective and necessary in an irredentist conflict between moderately developed nations.[51] Keeping costs down for the adversaries and their foreign supporters requires a judicious mix of high, medium, and low-tech. At the same time, technology only tells half the story, one where what Tolstoy famously called the "spirit of the army" is decisive. Whatever that "intangible force" is - morale, trust, unit cohesiveness, patriotism – one must ask whether and how human enhancement can contribute to its strength. In Vietnam, US Commander William Westmorland tried to enhance morale (or spirit) by providing 'creature comforts', post exchanges, recreational facilities, rest and recuperation… open channels of complaint and information, participation in civic action programs, the rotation systems and swift evacuation and excellent medical treatment.[52] A 2019 RAND study moves beyond material variables to emphasize how soft warfighting traits significantly contribute to the will to fight. Such traits include fellow-feeling, cohesion, adaptability, and social skills.[53] Each is amenable to enhancement, whether through technological intervention to improve material

Zabrodskyi M. Watling J, Danylyuk OV, Reynolds N. 2022 Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022 RUSI, Royal United Services Institute for Defense and Security Studies; https://www.rand.org/pubs/research_briefs/RB10040.html

[51] Russia and Ukraine rank 52/191 and 77/191 on the 2022 Human Development Index (income, education, life expectancy) respectively. UN Development Reports, 2022 *Human Development Index*, https://hdr.undp.org/data-center/human-development-index#/indicies/HDI. For a discussion of the Human Development Index see: Alkire, S. (2002). Dimensions of human development. *World Development*, 30(2), 181–205.; Sen, A. (2000). A decade of human development. *Journal of Human Development*, 1(1), 17–23; Stanton, E. A. (2007). *The Human Development Index: A history*. Working Papers, Number 127. Medford, MA: Global Development and Environment Institute, Tufts University.

[52] Kellet, A. 1982. Combat Motivation: The Behavior of Men in Battle. Dordrecht, The Netherlands: Kluwer: 247

[53] Connable, B., McNerney, M. J., Marcellino, W., Frank, A., Hargrove, H., Posard, M. N., ... & Cornish, P. (2019). *Will to Fight: Returning to the Human Fundamentals of War*. Research Brief RB-10040, RAND Corporation.

support for troops, pharmaceuticals to enhance solidarity and esprit (e.g. Oxytocin[54]) or neuro interfaces and TNT to facilitate soft skill acquisition. Whether to adopt human or trans-human enhancement turns on their cost, effectiveness, and necessity in present and future conflicts.

Table 2 illustrates the goals and strategies of successful conventional warfare in Ukraine and follows the format of Table 1.

Table 2
Goals and Strategies of Successful Conventional Warfare (Ukraine)

Goal	Strategy
Reduce Enemy (Russian) Numbers	
Disable Combatants	Ground forces, artillery, tanks, drones, anti-tank missiles
Decrease Recruitment	Information warfare to encourage emigration
Degrade Enemy Combat Effectiveness	Electronic warfare, propaganda, cyber warfare, financial warfare and sanctions, lawfare
Increase State-army (Ukraine) Numbers	Conscription, civilian militia, volunteers Increase survivability: medical care, body, and vehicle armor Decrease fatigue and sleep requirements
Protect Civilian Population	Missile and Air Defense Civil Defense, bomb shelters
Improve State-army Combat Effectiveness	Leadership training, combat training Improved weapons: tanks, aircraft, artillery, computers Military medical enhancement

Addressing enemy numbers, Ukrainian forces aim to disable (kill or wound) as many Russian combatants as possible. However, numbers do not tell the entire story considering the technological division of labor and the wide range of military experience among warfighters in a modern army. Russian troops comprise regular army, reservists, conscripts, and mercenaries, each making substantially different military contributions to Russia's military capabilities.[55] Reduction of enemy numbers, however, usually leads the list of avowed military goals. Proven Ukrainian capabilities to reduce Russian troop numbers turn on troops trained and equipped by NATO forces with conventional kinetic weapons, artillery, anti-tank missiles, and armed drones. Alongside troops, volunteer defense forces (VDF) and an active

[54] Tennison, M. N., & Moreno, J. D. (2012). Neuroscience, ethics, and national security: the state of the art. *PLoS biology*, *10*(3), e1001289.
[55] Stepanenko, K. Frederick W. Kagan and Brian Babcock-Lumish, Explainer on Russian Conscription, Reserve, and Mobilization March 5, 2022, Institute for the Study of War & The Critical Threats Project 2022. https://search.issuelab.org/resource/explainer-on-russian-conscription-reserve-and-mobilization.html.

citizenry help provide on-site targeting information, civil defense, and other logistical support.[56] At the same time, active propaganda targeted Russian recruitment by encouraging draft evasion, emigration, and public protest, otherwise influencing the behavior of troops, and potentially undermining Russian morale.[57]

Degrading enemy combat effectiveness comes at the behest of the international community and Ukrainian forces. Sanctions, financial warfare, and lawfare (utilizing international law to repudiate claims of self-defense and disincentivize war crimes[58]) indirectly vitiate combat effectiveness by denying funds and technology and impairing troops' motivation. In contrast, cyber warfare, electronic jamming of precision weapons, and a vast array of drone and satellite sensors to provide significant intelligence about troop movements and capabilities severely impair enemy combat effectiveness and improve kill chain efficiency. On the flip side, Ukrainian planners protected assets to improve combat effectiveness by dispersing equipment early in the war.[59] Deceptive maneuvers were pervasive and often

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[56] Jones, SG, Harrington J, Reid, CK, Stohmeyer M. 2022, "Combined Arms Warfare And Unmanned Aircraft Systems: A New Era of Strategic Competition." A Report of the CSIS International Security Project, The Center for Strategic AND International Studies (CSIS): vi; Henkin, Y. 2022 The "Big Three" Revisited: Initial Lessons from 200 Days of War in Ukraine, https://www.usmcu.edu/Outreach/Marine-Corps-University-Press/Expeditions-with-MCUP-digital-journal/The-Big-Three-Revisited/fbclid/IwAR06vYa2Meb1v1zgpb2kcnSFne8BtuPkAhs_aO_KaZZIm6KnqU00Od5HwyU/ ; Volunteer Defence Forces of territorial communities (VDF). 2023. Lviv Regional Military Administration. https://dftg.lviv.ua/en/ . Resolution of The Cabinet of Ministers of Ukraine of December 29, 2021 No. 1449, About approval of the Regulations on voluntary forming of territorial communities. https://cis-legislation.com/document.fwx?rgn=137555.

[57] Romansky, S., Boswinkel, L., & Rademaker, M. (2022). The parallel front. An analysis of the military use of information in the first seven months of the war in Ukraine. The Hague Center for Strategic Studies. https://hcss.nl/report/the-parallel-front-military-use-information-ukraine/ McInnis K., Jones, SG, Harding E. 2022. NAFO and Winning the Information War: Lessons Learned from Ukraine. CSIS. https://www.csis.org/analysis/nafo-and-winning-information-war-lessons-learned-ukraine; RFE/RL. 2023. Ukrainian President Calls On Russians To Surrender, Dodge Military Draft. Sepetember 22, 2022. Radio Free Europe/Radio Liberty. https://www.rferl.org/a/ukraine-zelenskiy-russians-surrender-dodge-draft/32051023.html.

[58] Dill, J. (2017). Abuse of law on the twenty-first-century battlefield: a typology of lawfare. *Soft war: the ethics of unarmed conflict*, 119-133; Dunlap Jr, C. J. (2008). Lawfare today: A perspective. *Yale J. Int'l Aff.*, *3*, 146; Tropin, Z. 2021. Lawfare as part of hybrid wars: The experience of Ukraine in conflict with Russian Federation, Security and Defence Quarterly 2021;33(1):15–29.

[59] Bronk, J, Reynolds N. and Watling J. 2022. The Russian Air War and Ukrainian Requirements for Air Defence. Royal United Services Institute for Defence and Security Studies (RUSI). https://rusi.org/explore-our-research/publications/special-resources/russian-air-war-and-ukrainian-requirements-air-defence.

successful.[60] As the war continued, electronic warfare (EW) allowed Ukrainian forces to defend their electromagnetic space from Russian intrusion while they continued to their capabilities with advance NATO weaponry.

Attending to troop numbers, Ukraine strives to bolster its ranks through conscription, strict emigration controls, foreign volunteers, and civilian militias. These assets can be considerable.[61] As in asymmetric war, protective vehicles, personnel armor, medical evacuation, and care preserve troop strength. There are currently no reliable data regarding survival rates among wounded Ukrainian troops, but the effect of protective interventions may be considerable. In the wars in Iraq and Afghanistan, superior medical evacuation and care among US, NATO, and Coalition troops brought the survival rate to a historical high of approximately 91%. While one might not expect Ukraine to maintain this level, Western aid should allow them to supersede Vietnam-era survivability rates that reached 86.5% of all wounded.[62]

Finally, consider the imperative to protect Ukraine's civilian population, an objective atypical of nations fighting a counterinsurgency. Facing the threat of missile attacks against civilians and civilian infrastructures nations like Israel, for example, respond with anti-missile systems and civil defense. Ukraine, too, met the threat by utilizing its legacy air-defense systems to significant effect while slowly incorporating NATO systems.[63] At the same time,

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[60] Zabrodskyi M. Watling J, Danylyuk OV, Reynolds N. 2022 Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022 RUSI, Royal United Services Institute for Defense and Security Studies.

[61] Collins, L and Spencer J. 2022. How volunteers can help defeat great powers. Military Times 5 July. https://www.militarytimes.com/opinion/commentary/2022/07/05/how-volunteers-can-defeat-great-powers; Thorley, A. (2022). Foreign Fighters, Foreign Volunteers and Mercenaries in the Ukrainian Armed Conflict. International Centre for Counter Terrorism.

[62] Goldberg, M. S. (2016). Casualty rates of US military personnel during the wars in Iraq and Afghanistan. Defence and Peace Economics, 29(1), 44–61

[63] Bronk, J, Reynolds N. and Watling J. 2022. The Russian Air War and Ukrainian Requirements for Air Defence. Royal United Services Institute for Defence and Security Studies (RUSI). https://rusi.org/explore-our-research/publications/special-resources/russian-air-war-and-ukrainian-requirements-air-defence; Zabrodskyi M. Watling J, Danylyuk OV, Reynolds N. 2022 Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022 RUSI, Royal United Services Institute for Defense and Security Studies; https://www.rand.org/pubs/research_briefs/RB10040.html

the Kyiv government also refurbished and opened numerous Cold War-era air raid shelters or repurposed public spaces (e.g., subway stations).[64] And although anti-missile systems usually garner the most attention, civil defense saves many more civilian lives at a far lower cost than missile defense systems.[65]

Where then, at the tactical or strategic level, might enhanced soldiers fit and provide indisputable cost-effective benefits in this kind of war? First, note that many factors affecting enemy/compatriot numbers and effectiveness are not technological but matters of policy. These include, for example, conscription and emigration controls. Others are low-tech. Consider one depiction of successful Ukrainian attempts to defeat precision Russian weapons:

> "The defeat of precision was critical to unit survival. Defeating precision could be achieved by preventing a launcher from accurately determining its position, even with very small displacements, by preventing the enemy determining the precise location of the target or through direct interference with the mechanism for precision strike. The latter did not always require expensive methods. When Russian reconnaissance troops began to mark Ukrainian defensive positions with laser designators, for example, it was found that having laser warning indicators over strongpoints could alert personnel being targeted, who could then pop smoke grenades to disrupt the accuracy of the strike. This would also blind the defenders, making them vulnerable to assault.[66]

Nevertheless, "correct employment of exquisite capabilities can magnify the impact of cheap and crude equipment."[67] One question is, which "exquisite capabilities" offer the biggest bang for the buck? Super soldiers can sometimes narrow the kill chain, a role often given over

[64] Zhidkova, T. B., Selikhova Y., Kazachenko V. (2022). Urban-aspects aspects of organization of energy-efficient underground space for protection. *Theory and practice of design. Architecture and construction*, (25), 140-148. DOI: 10.18372/2415-8151.25.16790.
[65] Armstrong, M. J. (2018). The Effectiveness of Rocket Attacks and Defenses in Israel. Journal of Global Security Studies, 3(2), 113-132.
[66] Zabrodskyi M. Watling J, Danylyuk OV, Reynolds N. 2022 Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022 RUSI, Royal United Services Institute for Defense and Security Studies: 68.
[67] Zabrodskyi et al 2022:65.

to special forces. Unlike their role in asymmetric war, SOF are not typically engaged in civilian missions in conventional wars. Neuro-enhancing these soldiers with AI might, for example, improve their performance in sabotage operations, although, by some accounts, saboteurs were often local collaborators.[68] Additional roles for warfighter enhancement mirror those in asymmetric war and focus on information processing, targeting and weapons training, particularly as Ukraine receives advanced battle tanks from NATO. These do not necessarily entail trans-human enhancement but the judicious application of those technologies described in the context of asymmetric war: AI assistance, targeted neuroplasticity training (TNT), and virtual and augmented reality.

Without a clear and overwhelming tactical or operational role in asymmetric and mid-level peer conflict, a central strategic role for super soldiers remains to be firmly established. Can super soldiers rearrange the balance of power among nations or significantly affect the competition for influence in the international system? Might super soldiers establish sufficient technological superiority to seriously challenge an adversary's force structure to prevent or end conflict, as some speculate?[69] Assessing these strategic claims requires a precise evaluation of past performance, a temperate expectation of future results, and sensitivity to the demands of military necessity rather than the allure of high technology. Warfighter enhancement and super soldiers can benefit from similarly sober assessments. And while the forgoing analysis is partial and subject to changes as events play out, it nonetheless offers a comprehensive template for evaluating the military necessity of super soldiers.

Conclusion

Warfighter enhancement is a constant challenge for military organizations. Ordinarily, weapons, equipment, training, and leadership strive to optimize performance. Cognitive

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[68] Euronews 2020. Ukraine hints blasts at Russian base in Crimea were an act of sabotage. https://www.euronews.com/2022/08/09/ukraine-war-huge-explosions-rock-russian-military-base-in-crimea
[69] Reding DF and Eaton J. 2020, Science & Technology Trends 2020-2040, Exploring the S&T Edge, *NATO Science & Technology Organization*:101.

enhancement is not new. Caffeine and alcohol could magnify mental acuity or, conversely, dull the senses to push fears aside. Moving forward, artificial intelligence and computing capabilities encapsulated in brain-computer interfaces are the critical components of super soldiers. They offer warfighters the technological superiority to overwhelm adversaries on the battlefield by strengthening their capacity to process vast amounts of data, perfect targeting decisions, broaden acuity to grasp the bigger picture, and operate smart weapons while reducing military and civilian casualties. Unlike any other weapon, enhancements - neural interfaces, drugs, exoskeletons, or engineered genes - require human experimentation. Human experimentation requires convincing evidence of effectiveness and military necessity to enlist research subjects. Any new weapon or technology must demonstrate its necessity, but those requiring clinical research double the demand.

There are many operational challenges surrounding super soldiers in battle, pivoting on the locus of responsibility, operator liability, the self-identity of enhanced soldiers, their role within traditional military hierarchies, and integrating super soldiers into civilian life after discharge. Prior questions about military necessity, however, are no less compelling. Looking at the role of super soldiers in asymmetric and conventional war demonstrates that some technologies meet the necessity condition, while others do not. This overview draws the following conclusions:

1. The tactical and strategic needs of asymmetric and conventional warfare demand an array of tools and policies to decrease enemy and increase compatriot numbers (Items 1, 2 Tables 1,2) and degrade enemy while improving compatriot military capabilities (Items 3,4 Tables 1,2) and protect civilians (Item 5, Table 2). These tools include weapons systems, defensive/protective equipment or infrastructures, public diplomacy and propaganda, financial warfare, and domestic policy. In this array of military goals and the tools to achieve them, human-machine *teaming* plays a growing role.

2. Human-machine teaming, however, may take one of two forms: collaboration or integration. In the final analysis, human-machine *collaboration* accompanied by large-scale, external AI-driven computer systems offer more expansive military benefits across multiple domains than human-machine integration via neural interfaces to enhance warfighters directly. As a result, enhancement occupies a relatively small space in human-machine teaming for military purposes.
3. In its small space, human-machine enhancement is either human or trans-human. Human enhancement, characterized by non-invasive neuro augmentation, offers greater military benefits and lower risks than trans-human warfighter enhancement utilizing implantable BCIs.
4. Within the realm of human enhancement, moreover, soft warfighting skills often have greater tactical and strategic utility than the hard warfighting skills typically associated with super soldiers.

Moving through steps 1-4, the place of super soldiering diminishes as it gradually loses its claim on necessity, supplanted at the margins by the soft warfighting skills optimized by human rather than trans-human enhancement.

What then of future wars? Few, if any, observers in 1999 foresaw two decades of futile, multi-trillion-dollar asymmetric war in Iraq and Afghanistan or a conventional regional war between two middle-weight adversaries that would cost upwards of 250,000 casualties in its first year alone. Future wars may replay the past or engage advanced armies requiring new weapons and technologies to augment their legacy systems. Robotics, AI, and semi-autonomous weaponry will drive some, but not all, forms of future warfare. Here, cognitively and physically enhanced soldiers endowed with mental fortitude and the capacity to establish human-to-human and human-to-machine collaboration may provide tactical value on urban, conventional set-piece, nuclear, or cyber battlefields.[70] Whether their contribution is necessary, however, must consider that presently these capabilities remain nested in a) overarching strategic goals nations pursue by hard and soft power of which battlefield operations are only one part and b) in alternative technologies that are overwhelmingly collaborative (unmanned systems, robotics, and AI) rather than integrative and, among the latter, augmented rather than trans-human. And while the picture may surely change moving forward, the conditions armies must fulfill to ascertain military necessity remain the same as those guiding early 21st -century asymmetric and conventional war.

The debate over super soldiers also speaks to a larger conversation about Western warfighting doctrine and its emphasis on technological superiority and low causality war. Here, some observers wonder if the West emphasizes high technology at the expense of primary warfighting resources and whether "fascination with technology and the results it can produce may deter hard thinking about larger strategic goals and how they can be achieved."[71] Precisely by overlooking the larger strategic goals of asymmetric and conventional warfare and the pivotal role played by social policy, morale, soft warfighting skills, and alternate weapon arrays, the super soldier debate gives weight to this warning. Ultimately, a judicious evaluation of military necessity must demonstrate how despite astonishing technological advancements, neuro-enhanced super soldiers will surpass the superior utility of many conventional warfighting capabilities, and outshine the promise of artificially intelligent systems that operate alongside rather than inside human beings. This conversation has yet to engage warfighter enhancement fully. Super soldiers require a much more severe reckoning than currently

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[70] Billing, D. C., Fordy, G. R., Friedl, K. E., & Hasselstrøm, H. (2021). The implications of emerging technology on military human performance research priorities. *Journal of Science and Medicine in Sport*, *24*(10), 947-953; Binnendijk, A., Marler, T., & Bartels, E. M. (2020).

[71] Carvin, S. (2022). How not to war. *International Affairs*, *98*(5), 1695-1716.: 1709.

provided, one that accounts for the tactical and strategic requirements of present and future warfighting before they justify trans-human weapons development.