





PHARMACOLOGICAL HUMAN PERFORMANCE ENHANCEMENT

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PHARMACOLOGICAL HUMAN PERFORMANCE ENHANCEMENT

AIM

1. The aim of this service paper is to frame the challenges of Human Performance Modifications in western allied militaries. It will examine the chances and risks of developing and using these methods as well as its ethical, legal, social and medical implications. This paper particularly focusses on pharmacological Human Performance Enhancement and makes recommendations for allied interoperability and the development of common doctrines, shared knowledge and best practice for a future joint environment.¹

INTRODUCTION

2. For thousands of years, armed forces have sought to improve the mental and physical capabilities of their soldiers in order to gain advantage against an enemy.² Today, the fast technological development and the ubiquitously available access to knowledge result in the use of human performance techniques not only in elite athletes and militaries all over the globe, but also in civil societies. While personal optimization within biologically predetermined limits seems to be widely accepted in society, enhancement methods that exceed these limits raise serious legal, medical and ethical-social questions that need to be answered before a widespread implementation.³

3. Due to the confusing variety of definitions in the domain of human performance and their contradictory use, this paper uses the terms and definitions proposed by the Multinational Capability Development Campaign that fits most of the purposes and supports interoperability:⁴

- Human Performance Modification (HPM) is the active or passive change of an individual's level of performance, including both Human Performance Degradation and Human Performance Restoration.
- Human Performance Augmentation (HPA) is the application of science and technologies to temporarily or permanently improve human performance. This field can be further divided into Human Performance Optimization and Human Performance Enhancement.

¹ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

² Masci, David., *Human Enhancement: The Scientific and Ethical dimensions of Striving for Perfection. 26 Jul 2016.* Human Enhancement: Scientific and Ethical Dimensions of Genetic Engineering, Brain Chips and Synthetic Blood | Pew Research Center

³ Maslen, H., Faulmueller, N., Savulescu, J., *Pharmacological cognitive enhancement – how neuroscientific research could advance ethical debate*. Frontiers in Systems Neuroscience, Vol. 8, Art. 107, 11 Jun 2014, https://www.frontiersin.org/articles/10.3389/fnsys.2014.00107/full

⁴ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

- Human Performance Optimization (HPO) is the process of applying existing and emerging science and technology to individuals allowing them to <u>reach</u> their biological potential.
- Human Performance Enhancement (HPE) is the process of applying existing and emerging science and technology to individuals allowing them to <u>exceed</u> the biological potential of the individual.
- Human Performance Restoration (HPR) is the return to the baseline when performance has degraded below it. The focus here is on degradation caused by illness, injury, exhaustion, side effects, violence or coercion.
- Human Performance Degradation (HPD) is the decrease in performance below previous levels resulting from four principal sources. It can be explained by factors such as reduced biophysical skills or capacity through [1] fatigue, exhaustion; [2] diseases, injuries; [3] system safety issues, degraded system functionality of prior optimization or enhancement or [4] actions by hostile externally based technologies, platforms or systems.

The **baseline** is the individual level of performance of a human being. It changes over the lifetime as well as over a single day and can be considered as a range rather than a defined line. When the internal state of a person is disturbed by external stimuli, the human body has to find a balance between demand and performance.



Figure 1: Individual life cycle Source: MCDC, *Human Performance Optimization and Enhancement*, 2021

4. Open available resources show that most allied militaries and potential adversaries like Russia and China have some sort of HPA programs.⁵ Most of them relate to the field of optimization, presumably because HPE programs are more secret or classified than HPO programs. These HPA programs are either based on commercially available products or are specifically developed for military purposes. They comprise multiple approaches including telemonitoring, smart textiles, exoskeletons, augmented reality, virtual reality, body heating, power & connectivity, biosensors, neuroenhancement, pharmaceuticals, training applications and "Soldier of the Future" concepts.⁶ Biotechnical methods use "organisms, tissues, cells or molecular components derived from living things, to act on living things; or, act by intervening in the workings of cells or the molecular components of cells, including their genetic material".⁷ This paper will focus on pharmacological HPE in the further course. However, the availability of open sources concerning the military use and development of performance-enhancing substances is limited.

DISCUSSION AND ANALYSIS

5. The attempt to exceed the human cognitive and physical potential by using certain substances is not new and modern neuroscience could demonstrate that the two are closely connected.⁸ The Roman legions and the ancient Greeks already knew about the encouraging effects of alcohol and supplied their troops with wine. The British military used beer, gin and brandy while the Royal Navy preferred rum to stiffen resolve and motivation in order to enhance combat effectiveness. Viking "berserkers" assumedly took agaric mushrooms and bog myrtle to fight in a trance-like state. During the Indian Mutiny of 1857 and the American Civil War (1861-1865) cocaine and opium provided stimulation and pain relief.⁹ Throughout the Second World War, more sophisticated, synthetic drugs were available. Opium was replaced by heroin, which had quicker effects, but also had a significantly higher addictive potential. Steroids were used to help malnourished soldiers to gain weight and methamphetamines like the infamous Pervitin to help suppressing fatigue, hunger and pain. Pervitin was produced by the German chemical enterprise Temmler from 1938 until 1988. Especially during the "Blitzkriege" against Poland and France in 1939/40, it was used by the millions. Nicknamed "Panzerschokolade", "Stuka-Tabletten" or "Hermann-Göring-Pillen," the drug was used to dampen feelings of anxiety and increase the ability to perform and concentrate. In the period from April to June 1940 alone, the Wehrmacht and Luftwaffe purchased more than 35 million tablets of Pervitin. Even Hitler was given methamphetamines, initially in the

 ⁵ NIAG SG.253 (NATO Industrial Advisory Group), *Emerging and Disruptive Technologies (EDT) in the Context of Emerging Powers*. Annex I on Bio and Human Enhancement Technologies (BHET), 2021.
 ⁶ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

 ⁷ NIAG SG.253 (NATO Industrial Advisory Group), *Emerging and Disruptive Technologies (EDT) in the Context of Emerging Powers*. Annex I on Bio and Human Enhancement Technologies (BHET), 2021.
 ⁸ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

⁹ Ibid

form of Pervitin tablets and, from 1942, up to several times a day by injection.¹⁰ Because of an intervention by the then "Reich Health Leader" and physician Leonardo Conti, the drug was no longer freely available from mid-1941, but only on prescription. This noticeably reduced the use of the drug.¹¹ During a speech to colleagues in Berlin in 1940, he commented:

"Anyone who wants to eliminate fatigue with Pervitin can be sure that the collapse of his performance will have to come one day. That the drug may be used once for fatigue for a high-performance aviator who still has two hours to fly is probably correct. However, it must not be used for every state of fatigue, which in reality can only be compensated by sleep. That must be obvious to us as physicians without further ado."¹²

This clearly demonstrates that those in charge were very well aware of the risks and limits of pharmacological enhancement. The substance was also widely used in the American, British and Japanese militaries during World War II, especially high dosed by Japanese Kamikaze pilots¹³. Methamphetamines were also used after 1945 during the Vietnam War and both the Bundeswehr and the Nationale Volksarmee (NVA) stockpiled Pervitin for potential crises until the 1970s. During the Cold War, steroids were applied to build muscle mass and strength, quicker reaction times, greater situational and sensory awareness and to increase resistance to extreme cold and heat.¹⁴

6. Today, in addition to well-known stimulants such as caffeine¹⁵ and amphetamines, "smart drugs" like modafinil and methylphenidate are used for <u>cognitive</u> enhancement. While modafinil is mainly used for the treatment of narcolepsy (pathological day sleepiness) it can induce extended wakefulness in healthy individuals. Methylphenidate was developed and is widely used for the therapy of ADHD (attention deficit hyperactivity disorder). Its effects, namely the increase of concentration focus and alert, are very popular amongst students and managers in stressful situations.¹⁶ Due to known dose-response characteristics there is likely an optimal dose inducing beneficial effects in individuals.¹⁷ The intake of synthetic melatonin can antagonize these stimulating effects by inducing sleep and thereby recovery. Melatonin is a hormone produced in the pituitary

¹⁰ Leonard L. Heston, Renate Heston: *The Medical Casebook of Adolf Hitler: His Illnesses, Doctors, and Drugs.* Stein and Day, New York 1980, ISBN 0-8128-2718-X

¹¹ Chemie.de, Pervitin®, retrieved on 20 Jan 2022. Pervitin (chemie.de)

¹² Kellerhoff, S.F., Schon die Wehrmacht kaempfte mit Crystal Meth. Welt.de Geschichte, 30 May 2015. Zweiter Weltkrieg: Schon die Wehrmacht kämpfte mit Crystal Meth - WELT

¹³ History. A&E Television Networks, 21. August 2018, retrieved on 20 Jan 2022. History of Meth - HISTORY

¹⁴ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

¹⁵ Faber N.S., Haeusser J.A., Kerr, N.L., *Sleep Deprivation Impairs and Caffaine Enhances My Performance, but not Always Our Performance: How Acting in a Group Can Change the Effects of Impairment and Enhancement.*, Sage journals, 14 Oct 2015. ¹⁶Ibid

¹⁷ Kapur, A., *Is Methylphenidate Beneficial and Safe in Pharmacological Cognitive Enhancement?* CNS Drugs 34:1045–1062, 13 Aug 2020. https://doi.org/10.1007/s40263-020-00758-w

gland that normally regulates the circadian rhythm of sleep in response to light and darkness.¹⁸ Other research projects examine the therapeutic benefits of drugs such as LSD (Lysergic Acid Diethylamide) and MDMA (Methylenedioxy-methamphetamine) in low or individual doses.¹⁹ In 2018, the U.S. Military published research results concerning the area of physical performance enhancement with a special focus on steroids.²⁰ The research acknowledged that an anonymous survey of U.S. army rangers revealed that one quarter of respondents illegally used steroids or other performance-enhancing drugs (PED). It further concluded that testosterone could improve performance when combined with effective training and even maintain or increase strength (5-20%) during situations where strict training is not always possible such as missions. As the existing literature on steroids is limited due to legal, ethical and methodological constraints, the studies available fail to represent real-world conditions and underestimate both the benefits and costs of steroid uses. In low-dose studies that only used a single steroid no side effects were reported, while interviews with real-world users using multiple high-dosed steroids revealed a high rate of side effects (496 out of 500 respondents experienced at least one side effect). Males suffered from acne, liver tumors, testicular atrophy, decreased sperm production or gynecomastia while women may develope clitoral hypertrophy, breast atrophy or deeper voice. Some side effects did not reverse after the termination of steroid use. Ninety percent of respondents reported increased aggression and mood swings. The article recommends further research on the topic and the addressing of ethical and moral questions if research indicates that the benefits outweigh the disadvantages.

In theory, all substances that are also (usually illegally) employed in sports for doping are suitable for improving physical performance in the armed forces and have already partly been used for military purposes, as the historical overview has shown. The following table summarizes the most important substances used for cognitive and physical performance enhancement and refers to the main effects and side effects:

¹⁸ Karow, T. , Lang-Roth, R., Allgemeine und spezielle Pharmakologie und Toxikologie. Thomas Karow Verlag, 30th Edition. ISBN 978-3-9821223-2-8. 2022.

¹⁹ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

²⁰ Peltier, C, Pettijohn, K., *The Future of Steroids for Performance Enhancement in the U.S. Military, Military Medicine*. 183, 7/8:151, 2018. The Future of Steroids for Performance Enhancement in the U.S. Military - ProQuest

SUBSTANCE	EFFECTS	SIDE EFFECTS
Stimulants: Amphetamines, methamphetamines, cocaine, ecstasy, ephedrine	Suppress fatigue, energy burst, reduce inhibitions, increase aggressiveness,	Severe fatigue states, collapses, nausea, cardiac arrhythmias, circulatory failure, brain disorders, paranoia, psychosis, exhaustion, death, high addictive potential, gradient loss of efficacy
Stimulants: modafinil	Wakefulness, decreased appetite, less addictive potential	Headache, insomnia, restlessness, heavy sweating, anxiety, decreased appetite, insomnia, influences liver and kidney dysfunction, congenital malformations
Stimulants: methylphenidate	Concentration focus, alertness, covers pain and exhaustion, decreased appetite, increases cognitive and physical performance, less additive potential	Decreased appetite and fluid intake, insomnia, gastrointestinal disorders, skin irritations, suicidality, heart palpitations and arrhythmias, nausea,
Hormone: melatonine	Induces Sleep, no addictive potential	Short term application (max. 2-3 months): drowsiness, lack of, concentration, irritability, nervousness, chest, abdominal and extremity pain, headache, dizziness, nausea, skin rashes, itching
Narcotics: opioids, non-opioids	Pain relief	Mood and perceptual changes, in combination with stimulants severe fatigue states, cardiac arrhythmias, respiratory arrest, death, high addictive potential
Anabolics: Beta 2- Agonists, testosterone	Stimulate protein synthesis, muscle growth, increase aggressiveness	Nausea, vomiting, liver damage up to and including liver cancer, increased risk of heart attack, acne, mental disorders, hair loss <u>In adolescents</u> : Growth arrest <u>In women</u> : lower voice, reduction in female sex hormones, masculinization, infertility <u>In men</u> : testicular reduction, increase in female sex hormones, changes in breast tissue up to and including breast cancer
Peptide hormones: recombinant Erythropoietin (EPO) or blood transfusions, Human Growth Hormone (HGH)	Increase of total number of red blood cells (erythrocytes) to increase oxygen binding capacity, muscle growth	Hypertension, thrombosis, abnormal growth of bones and internal organs (acromegaly), heart attack
Genetic or pharmacological myostatine blockade	Deactivation of myostatine by alteration of genetic material or : muscle growth	Rarely known so far, myostatine regulates growth of all cells in the body, assumedly not only muscles grow uncontrollably, risk of rapid cancer growth or uncontrollable deformations and malfunctions of organs, entire genetic material permanently altered

Figure 2: Overview of substances that can enhance cognitive and physical performance Source: Dreher, K.E., *Doping – Mittel und Methoden*, First publication: 2003, last update 16 May 2017. Doping: Geschichte des Dopings - Sport - Gesellschaft - Planet Wissen (planet-wissen.de)

7. As this overview clearly demonstrates, pharmacological HPE might come along with significant, sometimes irreversible side effects. Therefore, it is advisable to consider its application very carefully. Cognitive functions are not located in specific areas of the brain with unique receptors, but pharmaceuticals affect several brain functions at the

same time, which does not necessarily result in an overall enhancement.²¹ The improvement of one area may come along with the deterioration of performance in another. Pharmacological physical performance enhancement does not only foster muscle growth and the increase of strength. The consecutive disruption of hormonal regulatory circuits can induce permanent systemic transformations and severe diseases.²² Since the available data on the subject is very scarce, further research should be conducted before accepting pharmacological HPE for military purposes on a general base.

"Among the questions future research needs to address are what is the optimal dose, how long can one sustain use before health consequences outweigh physical advantages, what can medical supervision do to mitigate side effects, what effects are unique to each sex and what physical benefits can be expected."²³

8. However, the weighing of benefits and costs in the usage of pharmacological and other HPE comprises more than medical considerations. It also raises several ethical, moral and legal questions, which are not sufficiently answered by now. The most pressing is whether the use of enhancing substances would be mandatory, even when further studies will most likely reveal negative health consequences. Are commanders allowed to demand the application of potentially harmful drugs to avoid worse consequences? In dangerous situation that decide over life and death, survival is the more immediate concern than potential side effects. It is imaginable that the use would have such a positive impact on mission success that ignoring the benefits would jeopardize the operation. Do these aspects justify the order? On the other hand, can the application really be optional? Or would peer pressure, competition and inferior physical performance enhancing substances because otherwise the entire group would be endangered?²⁴

9. This specific aspect also contains a potential gender disparity. There is evidence that e.g. the use of testosterone-bases PED will have more negative side effects in women than in men. Is it ethical to expose woman at greater risks, especially if availability and mindset create the necessity to participate for career development? Alternatively, a decision would have to be made as to whether women would be excluded from using those drugs due to side effects and would therefore be non-competitive in certain areas dominated by steroid-enhanced males.²⁵

10. Additionally, the question of moral and legal responsibility emerges as pharmacological HPE can induce aggression and a change of behavior. Does these effects influence decision making and a person's moral agency? Can soldiers still be held

²¹ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

²² MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

²³ Peltier, C, Pettijohn, K., *The Future of Steroids for Performance Enhancement in the U.S. Military, Military Medicine*. 183, 7/8:151, 2018. The Future of Steroids for Performance Enhancement in the U.S. Military - ProQuest

²⁴ Ibid
²⁵ Ibid

⁹

accountable for their actions, if they are not free in their decision to use enhancing substances? The U.S. professor of philosophy at Marquette University, Dr. Jessica Wolfendale, focuses her researchs primarily on the ethics and moral psychology of political violence. She argues, "maintaining the conditions of moral responsibly is essential to the integrity of military personnel and their ability to reflect on and understand the moral consequences of their actions". Furthermore, the laws of war result in ethical commitments and constraints, which require personal accountability for actions in combat.²⁶ Subsequently, the question of the status of medical personnel in armed conflicts arises. Under international law, medical personnel and facilities must be protected as long as they exclusively engage in medical duties. Does military medical personnel, who participates in the biomedical enhancement of soldiers that is harmful to the enemy, lose their status as non-combatants?²⁷

11. Social and civil society aspects should also be considered. How is the accountability of soldiers to be assessed who have undergone permanent changes? Who is responsible for their behavior and deeds when they are not on duty but in their private social environment? Will families, friends and society accept biomedical enhanced soldiers in their midst and still consider them as "normal human beings"? Does society understand and accept that biomedical enhancement in the military is a correct means to take advantage of the enemy, while using the same substances in sports is forbidden by law? Will HPO and HPE become a general development within societies including all potential implications?²⁸

12. Another important aspect is the area of future joint operations. Is interoperability and cooperation between different allied nations still possible when there are different views and legal approaches to HPE? Can performance-enhanced soldiers and those non-enhanced fight together in multinational operations, or will peer pressure, mission requirements and competition arise here as well? Is it possible that this imbalance alone could lead to dangerous situations? Are allied militaries willing to share knowledge derived from clandestine programs? How will HPE affect future combat scenarios on a general base? All those considerations need to be addressed between collaborating militaries before using enhancing substances or methods on the national level.²⁹

 ²⁶ Wolfendale, J., *Performance-Enhancing Technologies and Moral Responsibilities in the Military*. American Journal of Bioethics, Vol 8 Issues 2, p 28-38, Feb 2008. DOI: 10.1080/15265160802014969.
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 ²⁷ Liivoja, R., *Biomedical enhancement of warfighters and the legal protection of military medical personnel in armed conflict*. Medical Law Review, Vol. 26, No. 3, pp. 421-448, 24 Oct 2017. Biomedical Enhancement of Warfighters and the Legal Protection of Military ...: EBSCOhost (oclc.org)
 ²⁸Ricci, G., *Pharmacological Human Enhancement: an Overview of the Looming Bioethical and Regulatory Challenges*. Frontiers in Psychiatry, Review, Vol. 11, Art. 53, 17 Feb 2020. Pharmacological Human Enhancement: An Overview of the Looming Bioethical and Regulatory Challenges – DOAJ
 ²⁹ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

CONCLUSION

13. Pharmacological HPE offers opportunities and risks at the same time. Further research is required to determine whether the benefits outweigh the negative effects.

14. These effects do not only refer to medical side effects. The use of performanceenhancing substances and methods in the military raises a variety of ethical, moral, legal and social questions that need to be addressed before HPE is implemented.

15. In future joint operations interoperability is key. In order to ensure further military cooperation under the conditions of HPE it is advisable to share knowledge between allied partners and to establish common standards. Otherwise, severe consequences could emerge for collaborating units.

16. Future military challenges include high-level scientific research to prevent potential enemies from getting ahead and to protect the own troops as good as possible. Even if a decision will be made not to use HPE in the military at the national or allied level based on upcoming research results, research has to continue to obtain the ability to counter potential adversaries with less ethical and legal constraints. HPE will change future warfare³⁰.

RECOMMENDATIONS

17. Commonly accepted definitions should be adopted to support understanding, comparison and interoperability on a national and international level.³¹

18. A meta-analysis of existing HPE programs versus conventional training and HPO programs should be conducted on a national and international level. The sharing of reviews and evaluations to assess usability and best practice amongst partner nations and the development of common doctrines and guidelines including conflict scenarios would support the comprehensive approach³².

19. Further research is crucial to confidently assess the overall benefits and costs of using PED from which decisions can be derived on the strategic, operational and tactical level.

³⁰ MCDC Multinational Capability Development Campaign, *Human Performance Optimization and Enhancement*, Final 22 March 2021

³¹ Ibid

³² Ibid

20. A whole-of-society approach is recommended to enable the development of legal and ethical frameworks that could provide guidance beyond the military sphere for the use of HPE, pharmacological or else.^{33 34}

³³ Ibid

³⁴ Ricci, G., *Pharmacological Human Enhancement: an Overview of the Looming Bioethical and Regulatory Challenges*. Frontiers in Psychiatry, Review, Vol. 11, Art. 53, 17 Feb 2020. Pharmacological Human Enhancement: An Overview of the Looming Bioethical and Regulatory Challenges – DOAJ

FIGURES

- Figure 1:Figure 1: Individual life cycle
Source: MCDC (Multinational Capability Development Campaign),
Human Performance Optimization and Enhancement. Final 22 Mar 2021
- Figure 2: Overview of substances that can enhance cognitive and physical performance. Source: Dreher, K.E., *Doping – Mittel und Methoden*, First publication: 2003, last update 16 May 2017. https://www.planet-wissen.de/gesellschaft/sport/doping_gefaehrliche_mittel/pwiegeschichtede sdopings100.html

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