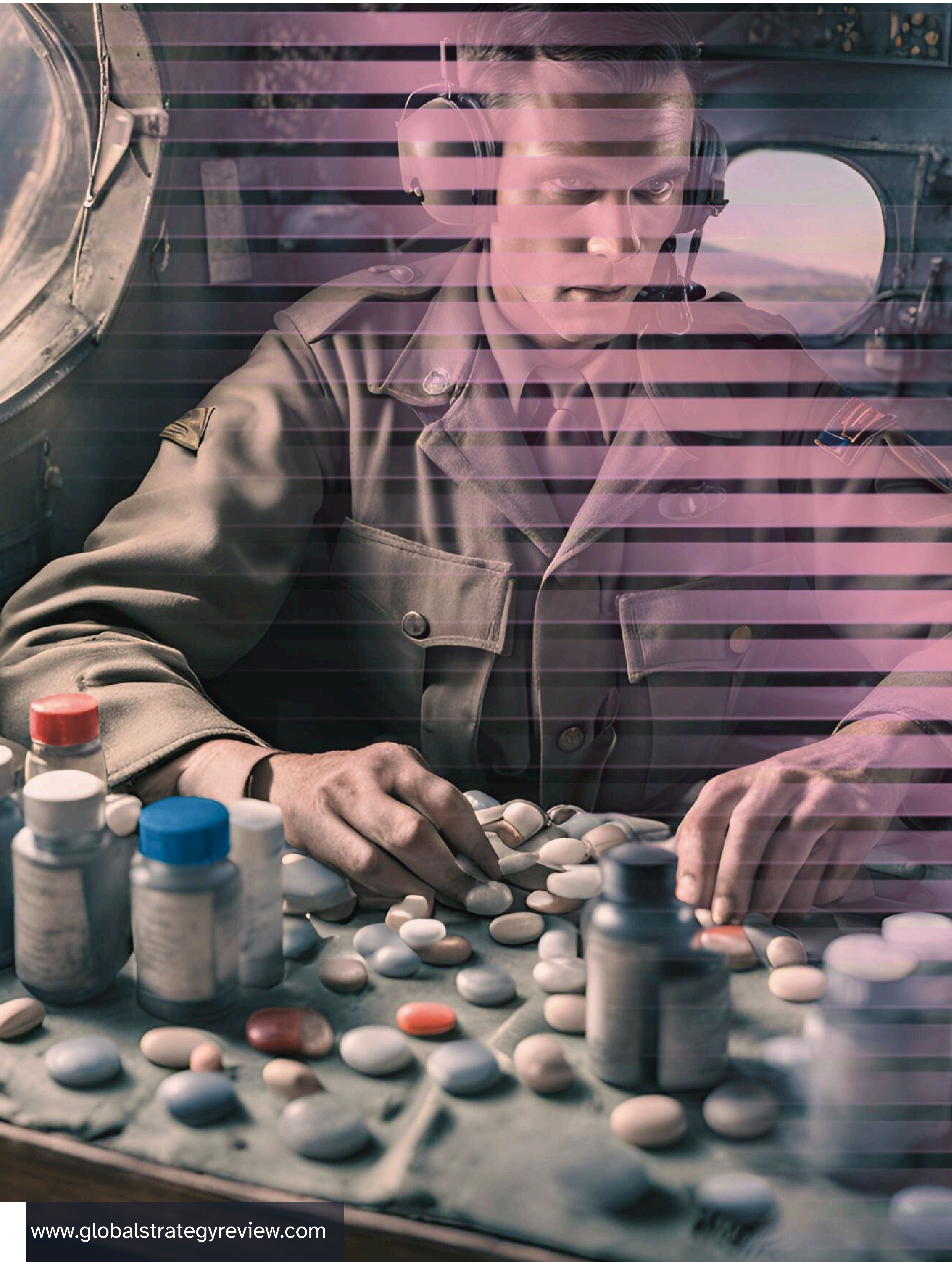
GSR
Charleston, SC

The Weaponizing of Reward Learning and Addiction

Rose Marie Akiki



Organisms evolve to adapt to their environment in order to delay death and promote spread. Reward learning through the nervous system is a biological process that has shaped the behavior and survival strategies of animals, including humans, over millions of years. It allows organisms to associate specific stimuli, actions, or environmental cues with positive or negative outcomes, reinforcing behaviors that enhance survival and reproduction. However, this adaptive (sometimes maladaptive) mechanism also made humans and animals susceptible to substance use disorder, particularly to addictive plants and their derivatives, which play complex roles in ecosystems, human behavior, aggression, power and economy, and overall human societies.

Evolution of Reward Learning

Reward learning stems from the interplay of neural circuits involving dopamine and other neurotransmitters. These systems evolved to promote adaptive behaviors that favor satiety, procreation, and safety. The reward system is highly evolutionarily conserved: insects to higher order primates have a similar core reward processing mechanism. This begs the question of how and why evolution favored such a system and why there is a multispecies susceptibility to substance use disorder. Natural reward processing is without question, evolutionarily necessary: in hunter-gatherer societies, the consumption of calorie-dense foods was reinforced by dopamine surges, ensuring survival during times of scarcity. Similarly, social bonding and cooperation were rewarded with pleasurable feelings, fostering group cohesion and mutual support.

Over time, plants became integral to this reward system. Many plants produce secondary metabolites—chemicals that serve as defense mechanisms against herbivores, fungi, and other threats. These compounds, including caffeine, nicotine, and opioids, interact with the nervous systems of animals, producing effects ranging from stimulation to euphoria. These interactions likely evolved as a form of ecological manipulation: plants producing compounds that affected animal behavior gained an evolutionary advantage by encouraging seed dispersal or deterring overconsumption. In other words, plants' production of secondary addictive metabolites was favoring its own survival through its aversive effects on organisms, and its euphoric effects allowed organisms to spread its seeds in order to get more of the addictive substance. Does this mean that animals co-evolved with plants to develop addiction and favor plant survival?

Humans and other animals inadvertently became addicted to certain plants because of the overlap between plant biochemistry and the brain's reward systems. For example, caffeine and nicotine mimic neurotransmitters, hijacking the brain's reward circuits to create pleasurable sensations, and coca leaves increase dopamine in the nervous system, creating a sense of euphoria. Early humans may have stumbled upon these plants accidentally, but quickly integrated them into their diets, rituals, and medical practices. Psychoactive plants often served as stimulants or analgesics, improving physical endurance, reducing pain, or heightening awareness—traits beneficial for survival. Chewing coca leaves (the ancestor of cocaine) in the Andes helped early populations endure high altitudes and grueling labor. Similarly, caffeine from coffee or tea improved alertness, a trait advantageous for foraging or avoiding predators.

However, these benefits came at a cost. The potent effects of these substances could lead to dependency, reducing an individual's ability to function without them. Yet, the evolutionary trade-off often favored the immediate benefits of heightened performance over long-term risks, cementing a complex relationship between humans, animals, and psychoactive plants.

Modern Drugs: From Utility to Biological Weaponry

While plants provided natural compounds that shaped reward learning, the advent of modern chemistry and pharmacology transformed these substances into concentrated, readily available, and often weaponized forms. Pharmaceuticals, cartels, and governments have exploited the brain's reward system, sometimes with devastating consequences to their own personal economic and military gain.

Pharmaceutical companies often produce drugs designed to alleviate pain, anxiety, and other disorders, but these same drugs can lead to substance use disorder. The opioid crisis in the United States exemplifies this exploitation. Prescription medications like oxycodone and fentanyl, originally marketed by big-pharma as safe 'non-addictive' and long-acting painkillers, have led to widespread addiction and mortality. Over the last two years, there has been a rise of 50% of opioid associated deaths and the core of this issue is the fact that these drugs manipulate the same neural circuits that evolved to reward survival-enhancing behaviors, in a stronger, more sustained way, creating a potent feedback loop of dependency.

It is to be argued that some pharmaceutical companies have weaponized their knowledge of neurobiology for profit, prioritizing market growth over public health. Aggressive marketing, insufficient regulation, and the underplaying of addiction risks have turned life-saving medicines into societal scourges. This not only makes people dependent on certain drugs but also dependent on the healthcare system that treats them, allowing a continuous vicious cycle of healthcare profit.

Illegal drug cartels have also weaponized addiction, flooding markets with narcotics like cocaine, methamphetamine, and heroin. Similar to pharmaceutical compounds, these substances also hijack the brain's reward system, creating euphoria that reinforces their use. These effects are also heightened by the fact that up to this date, we still do not have efficient cures to substance use disorder, making its rise in prevalence quasi-impossible to control. The social and economic fallout, including broken communities, loss of productivity promoting economic turmoil, and escalating crime, represents a form of biological warfare—an attack on societal stability using addiction as the weapon.

Stimulants in Warfare: From World War II to Today

Stimulants have long played a role in military strategy, altering the landscape of warfare by enhancing aggression, suppressing fear, and increasing endurance. The introduction of these substances into combat has had profound implications for soldier behavior, resilience, decision-making, and the ethics of war.

World War II and the Rise of Amphetamines

During World War II, amphetamines such as Benzedrine were widely distributed to soldiers to combat fatigue and boost alertness. German soldiers used Pervitin (methamphetamine), which became known as the "Nazi wonder drug," to sustain prolonged combat operations. The Nazi militants were often described as extremely fast and efficient: properties that were the consequence of stimulant use. These drugs heightened aggression, reduced inhibitions, and temporarily enhanced physical and cognitive performance, giving troops a tactical edge.

However, the widespread use of stimulants came with significant consequences. Soldiers not only experienced substance use disorder, tolerance, and the need of increased doses, they also often experienced severe withdrawal symptoms, and long-term psychological effects. The phenomenon of hypofrontality—a reduction in activity in the prefrontal cortex—was a notable side effect, impairing decision-making and increasing impulsive, aggressive behaviors. This condition may have contributed to atrocities and reckless actions during wars.

The relationship between stimulant use and behavior in combat settings is complex. Stimulants suppress activity in the prefrontal cortex, the brain region responsible for rational decision-making and impulse control. This suppression, known as hypofrontality, can lead to increased aggression and reduced empathy, traits that may be strategically advantageous in combat, but detrimental in the broader context of war ethics and soldier well-being.

Modern Use of Stimulants in Combat

Stimulant use in the military has continued into the modern era. Pilots, for instance, are sometimes prescribed "go pills" (amphetamines) to stay alert during long missions. These drugs are seen as tools to maintain operational efficiency, particularly in high-stakes environments where fatigue could lead to catastrophic mistakes and war loss.

However, the ethical and psychological ramifications remain contentious. While stimulants enhance focus and endurance, they can also impair judgment and exacerbate aggressive tendencies. Prolonged use can lead to dependency and long-term mental health issues, conjunct depression and anxiety, and physical decline, raising questions about the morality of using pharmacological tools to push soldiers beyond their natural limits.

The Double-Edged Sword of Reward Learning and Stimulant Use

Reward learning and substance use disorder are deeply intertwined with animal and human evolution and history. While these mechanisms evolved to promote survival and adaptation, they have also made humans vulnerable to exploitation—whether by nature and plants themselves, through aversive or euphoric secondary metabolites, or by human institutions, through drugs designed to manipulate behavior.

Stimulants in warfare illustrate the double-edged nature of these substances. While they offer tactical advantages, they come with significant ethical, psychological, and societal costs. As we continue to grapple with the implications of addiction—both natural and manufactured—understanding the evolutionary roots of reward learning may provide insight into addressing these challenges and mitigating their harmful effects. More research in substance use disorder is also needed in order to determine new targets for pharmacological or behavioral treatments that may mitigate this public health and sociological epidemic.