A Faustian bargain?

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Few advances in science and technology have escaped the interests of the military—and indeed many have been fostered by those interests: for many years well over half of the UK's R&D budget was directed towards weaponry, while military research in the former Soviet Union virtually bankrupted civil society. Most weapons developments have engaged physics and chemistry, but the life sciences—not least neuroscience—have also benefited from military investment.

Drugs that affect the brain by enhancing attention, helping keep troops awake, or diminishing the horrors of battle have a long history of military use; their modern successors are Ritalin to increase attention and Modafanil—said to have been used by US pilots on long bombing missions over Iraq—to enhance wakefulness. The massive increase in post-traumatic stress in soldiers returning from Iraq and Afghanistan has resurrected the science-fiction prospect of memory-erasing drugs.

To defeat the enemy, there have long been the acetylcholinesterase inhibitory nerve gases, German and British inventions from the 1940s and 1950s (which were used with lethal effect by Saddam Hussein against the Kurds of Halabja in 1988) and botulinum toxin. Both kill by neuromuscular paralysis and both are prohibited under international treaties.

But the neurosciences promise something different: how about a drug that will incapacitate without killing to bypass the treaties? In the 1950s, under the code name MK-Ultra, the CIA experimented with hallucinogenic agents such as LSD. By the 1960s, the military had hit on a drug that they claimed would disorient and confuse an enemy. Codenamed BZ, it affects muscarinic cholinergic transmission in the CNS. US movies showed troops exposed to it collapsing in laughter, throwing their rifles down and ignoring orders. Unfortunately, army chiefs were too

cautious to employ it. By the 1990s, a whole new generation of 'non-lethal' agents beckoned, euphemistically named calmatives. They were quietly researched in many countries without attracting much attention until 2002 when one such was used with disastrous effect by Russian special forces trying to rescue hostages in a Moscow theatre. At least 130 hostages died when the opioid analogue fentanyl was pumped into the theatre's ventilation system.

The status of these 'non-lethal' agents under international treaties is uncertain, as in practice they do cause death and are at best merely 'less lethal'. However, there are no treaties banning their civilian as opposed to military use. The same is the case for agents that affect the peripheral nervous system such as the classical tear gases—the most ubiquitous of which, CS, is another British development dating from the 1950s. PAVA or pepper spray, a capsaicin-like agent, which produces an intense burning sensation and blistering, is part of the police arsenal in many countries. In August this year a young man in Cumbria died after being hit with PAVA and tasers—a gun that fires a barbed wire into a person's body and administers a strong electroshock.

Neuropharmacology has been but a sub-theme within the military's interest in the neurosciences. From the 1960s onwards, a large proportion of US university-based research programmes in artificial intelligence was supported by grants from the Defense Advance Research Projects Agency (DARPA). DARPA's interest was twofold. Might it be possible to enhance soldiers' capacities by tapping directly into their thoughts? By the millennium, the prospect of direct brain-computer interfaces has become practicable. The increased survival rate of seriously injured soldiers has added to the pressure to develop limb prostheses that can be driven directly via implants into the motor cortex. Similarly, arrays of light-sensitive electrodes implanted into the visual cortex can help the

blind to see. The potential civilian spinoff from such research is obvious.

But as with drugs, the military's ambitions go beyond enhancing its own fighting capacities. For decades, DARPA has been interested in microwave radiation that, beamed at opponents, could disorient and pacify them, or, even better, modify their thoughts. Despite their hopes—and the suspicions of many US citizens that their government was indeed covertly controlling them through radiation—nothing practical resulted. But by the millennium another prospect presented itself, that of intense magnetic fields. In clinical trials such stimulation has been used to treat depression, obsessive-compulsive behaviours and Parkinson disease. Transcranial magnetic stimulation (TMS) requires magnets to be placed directly around a person's head and focused on specific brain regions. But what if it could be used at a distance to control thoughts or change behaviour? No wonder there has been a flurry of TMS-related DARPA contracts. However, the prospect, like that of a memory eraser, is still science fiction.

How should neuroscientists view such developments? Some of course support their goals and welcome the funding. Some reject military involvement in research and have signed a pledge initiated by the neuroscientist Curtis Bell. Still others remain convinced that they can ride both horses—accept the military funding while being confident that nothing they produce will find military use. I'm inclined to remind them of an old limerick:

There was a young lady of Riga
Who went for a ride on a tiger
They returned from the ride
With the lady inside
And a smile on the face of the tiger

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