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Knowledge can be dangerous. As neuroscience delves more deeply into our organ of thought and its complex soup of neurotransmitters - could it also be exploited for malign purposes? Is the brain the next target of terrorism? Pharmaceutically enhanced soldiers, chemical torture, incapacitants, neurological weaponry... The possibilities are frightening and progress rapid. Two leading researchers into biological weapons present their concerns, and argue scientists need to take action now. But are we at risk of paranoia?

## Transcript

**Natasha Mitchell:** And Natasha Mitchell joining you for All in the Mind - thanks for your ears here on ABC Radio National. And everyone gets a word on this week's Federal Budget, even All in the Mind, 30 million dollars of the grand lottery goes to a new neuroscience research precinct in NSW – we'll watch that one with interest. That's now two neuroscience hubs, one for Melbourne; another for Sydney.

But as neuroscience continues to attract the attention it does and to progress at the rate it is, is there a risk it'll be exploited for malign purposes? Some people think so. Could your brain, for example, be the next target for bioterrorism – hang onto your seat.

### Montage of archival news reports:

An Australian executive is one of hundreds of people still recovering after inhaling poisonous gas in the Tokyo subway this week...

As we begin to understand the exquisite and molecular mechanisms that regulate this remarkable structure called the human body, the ability to understand those circuits means simultaneously the capacity to scramble them. George Post, 2002.

Pharmaceutical companies are only just beginning to mine the spectrum of psychological elements that flesh is heir to. *The Economist*, 2003.

A world in which these capabilities are widely employed for hostile purposes would be a world in which the very nature of conflict radically changed...

**Malcolm Dando:** The problem with the kind of weapon we're talking about now, the chemical and biological weapon is that you cannot contain it in the way that we've been able to slow proliferation of nuclear weapons down, by restraints on the nuke fissile material

**Mark Wheelis:** What we have to do is develop a much more complex, much more comprehensive, much more diverse control regime and that control regime really has to rest on an international consensus that these are weapons that no-one in the world wants developed.

**Natasha Mitchell:** My guests this week are Dr Mark Wheelis, a microbiologist and senior lecturer at the University of California, Davis. He's active with the Center of Arms Control and Non-proliferation in the USA. And Malcolm Dando, also a biologist, Malcolm is now professor of international security in the Department of Peace Studies at the University of Bradford in the UK. Together they've co-edited a recent book, *Deadly Cultures: Biological Weapons since 1945* and they've penned a paper

with the unsettling heading *Neurobiology: A Case Study of the imminent militarisation of biology*. A compelling reason to get them on.

Mark Wheelis and Malcolm Dando, many thanks for joining me on the program this week.

**Mark Wheelis:** Thank you Natasha.

**Malcolm Dando:** Thank you.

**Natasha Mitchell:** You both suggest that biology will very much become the next military technology. Malcolm, why is that so?

**Malcolm Dando:** Well the first thing to say is that we don't have an example of a major scientific and technological revolution which hasn't been applied in a major way to hostile purposes as well as to benign purposes. So unless we do something radically different it's very likely that this huge revolution that's going on in the life sciences will get applied in a major way to hostile purposes.

**Natasha Mitchell:** What makes you suspect that the tools and knowledge of neuroscience and our really emerging understanding of the sophistication of brain chemistry are particularly vulnerable to abuse?

**Malcolm Dando:** Well if you look at the kind of reports which are being produced for example by the national academies in the United States, it begins just after the turn of the century with reports stressing that we have to be careful that the traditional biological agents, the pathogens, can be modified by genetic engineering. But then when it's looked at more systematically the argument is then expanded to say it's just not about genetic modification of pathogens, there are many other ways in which hostile purposes could be achieved.

For instance if you were to interfere with the immune system you wouldn't have to worry too much about what pathogen you were using because the person would be open to any kind of attack from any pathogen that was around. So it's across the whole range of biology that we have to be careful and we have to look very carefully at the possibilities of misuse. And in that context you can see how rapidly change has taken place in our understanding of the nervous system. We know attempts have been made in the last 50-odd years to do precisely that, to use the current neuroscience in order to achieve hostile ends.

**Natasha Mitchell:** Mark Wheelis, let's then walk back a moment into history, because certainly the nervous system has been a target in the past – obviously mustard gas comes to mind in the early days – but perhaps give us a couple of other examples to trigger our memories.

**Mark Wheelis:** Well I wouldn't say that mustard gas was specifically targeting the nervous system but certainly after the second world war there were conscious attempts on the part of several countries, we know about the UK and the United States in particular, in developing not only more lethal chemical agents such as the nerve agents, but also in developing non-lethal agents for different kinds of tactical purposes. So the United States went as far as to stockpile at least an ostensibly non-lethal chemical agent called BZ – although the stockpile didn't last very long and the United States ultimately destroyed its BZ stockpiles.

**Natasha Mitchell:** And what was BZ?

**Mark Wheelis:** It's a chemical that specifically interacts with the nervous system in particular ways by binding to particular classes of neuro-receptor.

**Malcolm Dando:** You know that the lethal chemical agents, things like sarin and soman and VX interfered with the operation of the acetylcholine neurotransmitter by blocking the enzyme that cleared it from the synapse and therefore flooding the body with acetylcholine with disastrous effects. Well BZ interfered with the same synapses but in a different way and therefore led to confusion, all kinds of aberrations in central nervous system operations.

**Mark Wheelis:** As far as I know that was the only psycho-active chemical that was stockpiled for non-lethal purposes. So there was a continuous effort from the 1950s to the beginning of the 1990s in identifying agents that would specifically interact with the nervous system in a non-lethal way but would incapacitate the targets.

**Natasha Mitchell:** And of course we remember the CIA experiments with psychedelics.

**Mark Wheelis:** Yes, LSD was one of the major compounds investigated and tetra hydro cannabinoids were also investigated; a wide variety of pharmaceutical agents and many others.

**Natasha Mitchell:** Well certainly the brain has become the focus of a huge amount of public research in the civilian world since, and of pharmaceutical research for medications of the mind; we've had the decade of the brain – to what extent is all this excitement spilled into military circles more recently?

**Malcolm Dando:** Well I think that what you have to say is that all of those efforts following from the second world war ran into the problem that they didn't know enough about the nervous system and they couldn't generate enough different chemicals very easily to test a whole range of chemicals. What changes in the 1990s is that first of all you have much, much better understanding of the variety of the different types of neuro-receptors in the brain and you have the growth of forms of chemistry which allow you to generate huge ranges of different kinds of chemicals to test against those receptors. So there's a new thinking going on that maybe, maybe what we couldn't do 50 years ago we may be able to do now. And you have evidence of continuing interest in the military circles in being able to do that.

And I suppose the dog that's not barked so far is the use of a fentanyl type agent by Russian special forces to break the Moscow hostage siege. That indicated that at least one country must have had quite large stockpiles, at least some training and a willingness to use a form of incapacitant.

#### **Montage of archival news reports:**

We hostages in the cultural centre...

For the relatives and friends of those held inside, politics has suddenly become terrifyingly personal...

The number of dead keeps on rising as those in hospital fail to respond to treatment...

After the operation to free the hostages, authorities are still refusing to say what gas was used to disable the hostage takers before the assault began...

Doctors has no antidote...

The gas has now been identified by Russian authorities as an anaesthetic based on the opiate derivative fentanyl...

For Mark Pagnese, one of the actors on the stage, the emergency teams did what they could...

How can you imagine that special forces tell to doctors...

**Natasha Mitchell:** Mark Wheelis, remind us of the significance of the Moscow theatre storming. As you suggest, Malcolm, it's understood, not confirmed necessarily, that an opiate chemical fentanyl was used to incapacitate the hostage takers but also the hostages. Remind us of that situation that happened in 2002.

**Mark Wheelis:** That was in the fall of 2002 in October and about 50 Chechen separatists took somewhere between 800 and 900 theatregoers hostage in the Dubrovka theatre in Moscow. They demanded the withdrawal of Russian forces from Chechnya – a demand that the Russian federation clearly was not willing to meet. The Russian federation stalled for a couple of days and then by a mechanism that is still not well understood but which I think involved tunnelling down to the air-handling systems in the basement of the building, and then introduced this anaesthetic agent in aerosol form, probably as a fine powder, into the air-handling equipment. The agent was identified by the Russians as a derivative of the anaesthetic fentanyl but they were not more specific than that.

**Natasha Mitchell:** Over 100 hostages died.

**Mark Wheelis:** There were about...

**Natasha Mitchell:** But many more were saved as a result.

**Mark Wheelis:** 126 or 127 of the hostages died, I suspect it was a combination of fentanyl overdose and airway blockage when they collapsed unconscious. There's an unknown number, but probably quite a large number of survivors who had continuing long-term deleterious health effects.

**Natasha Mitchell:** What does that event actually raise for you, you have considerable concerns about what that was a harbinger of.

**Mark Wheelis:** Yeah, two major concerns I have about this. The first is – the one that Malcolm has just suggested – that it provides virtually definitive evidence that the Russian Federation did develop, produce, stockpile and train troops and use this chemical agent as a weapon in this situation. The precedent that one country has actually engaged in developing such a weapon is worrisome because it is likely to stimulate others to do the same.

**Natasha Mitchell:** And it raises human rights issues for you more broadly, doesn't it, too?

**Mark Wheelis:** Yeah, there are ethical questions I think, the broadest ethical question is the concerns of the ethics of manipulating human physiology without the permission of the people whose physiology is being manipulated. And more specific issues would extend down to the very specific issue for instance of the execution of the comatose hostage-takers; whether that is legal under international law or not.

**Natasha Mitchell:** Malcolm Dando, under the existing international chemical weapons conventions was there any discussion about this Moscow siege?

**Malcolm Dando:** As I understand it, the whole issue of non-lethal agents and the implications for the convention, despite some state parties and certainly some NGOs attempting to bring the question up, it was not brought to the floor. The problem is that the international regime, the governance regime for chemical and biological agents is in a fairly fragile state. We have the 1925 Geneva Protocol which effectively banned first-use of both chemical and biological agents. We have the 1975 Biological and Toxic Weapons Convention, we have the 1995 Chemical Weapons Convention, which is a much stronger modern instrument with a major international organisation to look after it. But with a certain amount of ambiguity in one of the key parts of the convention.

One of the exemptions for peaceful purposes reads, 'law enforcement, including domestic riot control' – there's a worry law enforcement chemicals could be developed and could be argued to be legal, rather than a blanket ban, and what you'll end up with under the impact of the revolution in the life sciences is the erosion of the strongest element we have in the prohibition regime.

**Mark Wheelis:** These kinds of ambiguities are often found in international instruments because they facilitate agreement. But they can later come back to haunt one, as in this case. There is a lack of political will to actually close what we might view as a loophole because there are some countries that would like to keep it open. The Russian Federation clearly has already gone down this path and used this agent. There is some indication that some Special Forces units in the United States military may be equipped with knockout agents as well. There are noises from China about the utility of these weapons, Israel has used fentanyl as an assassination weapon and, once developed, we may see them being used by military forces in conditions that are not arguably law-enforcement.

**Natasha Mitchell:** And on ABC Radio National and Radio Australia and as podcast, this is *All in the Mind*, Natasha Mitchell this week with you on bioterrorism and the brain. I'm joined by Dr Mark Wheelis, a microbiologist at the University of California, Davis, and Malcolm Dando, Professor of International Security at the University of Bradford.

Well fentanyl really is at the tip of the iceberg you're arguing here because in military terms there's interest in so-called calmatives, in dissociative agents, in equilibrium agents – these are the terms that are being used. What would some of the potential cognitive impacts be, I mean we're talking about depression, panic, aren't we.

**Malcolm Dando:** Let me just mention one possibility. One of the systems that we know a great deal about in the brain is the circuit which deals with fear, based on the amygdala. More and more we understand how that fear system works in human beings. Some people have worried that – for good reasons, to try and treat people who are suffering from post-traumatic stress disorder it's been found that you can use a chemical to interfere with that fear system and perhaps help people break the cycle of repeated nightmares, anxieties and so on which are connected with post-traumatic stress disorder – some people have worried if you could do that, you may then be able to send people off to do terrible things and wipe out their memory of what they've done. That's a possibility I suppose. I think much more worrying from my point of view would be that if you can find ways in which you can diminish the fear circuit, pretty well certainly you can do the other thing – you can raise the level of fear amongst people and anxiety amongst people very greatly.

**Mark Wheelis:** For right now I think the primary interest is likely to be in two kinds of agents, the primary military interest. The first would be the calmatives, or the knockout compounds like fentanyl anaesthetic used in Moscow. The proponents of these weapons will often say that they're humane because they will replace lethal force with non-lethal force. But the history of the use of for instance riot control agents doesn't bear that out. In the Vietnam War the United States used huge amounts of tear gas as a weapon by military forces operating in Vietnam. The ostensible reason for this was that it was used where civilians and enemy forces were intermixed to protect the civilians. An army review conducted after the war found no evidence that this was a use in Vietnam. Instead what they found was that the tear gas was used for a variety of purposes, one of which was enhancing lethal force. So the potential for these non-lethal agents to actually increase the lethality of warfare is a very real problem.

The second kind of agent that I would be particularly worried about at this time would be agents that could enhance the effectiveness of interrogation.

**Natasha Mitchell:** You refer to agents that might cause acute depression, might cause psychosis, pain, panic – a whole range of states. How is this an extrapolation from how we're using neuropharmacology now?

**Mark Wheelis:** Well I don't know that we know much about how the military is using neuropharmacology, if they are, but there are repeated accounts from people released from detention in Guantanamo and elsewhere of having been forcibly medicated. So there is a possibility that there is already some experimentation with chemical agents as adjuncts to interrogation. Such chemical agents wouldn't necessarily be torture, it would depend on the nature of the effect they had. For instance the hormone oxytocin can increase the trustiness of a person exposed to it. And so it could be used to soften up detainees and encourage them to be candid with interrogators. It's not painful, it doesn't hurt but it is a manipulation of their physiology, it's arguably an invasion of their human integrity and I would think it certainly is contrary to Geneva Conventions.

Other kinds of agents that cause acute depression which could of course then be instantly removed by a reversal of the chemical effect – would amount to chemical torture but would perhaps be extremely effective. Perhaps more effective than physical torture such as water-boarding or things like that, isolation, stress positions, loud noises, the kinds of things that are the repertoire of at least some interrogators.

**Natasha Mitchell:** Mark Wheelis, you also ponder a more hypothetical perhaps Brave New World scenario about what could happen if bioweapons got into the hands of dictators.

**Mark Wheelis:** Well yes, if we go down the road of targeting human physiology for hostile purposes by the good guys we have to assume that the bad guys will also gain access to this kind of weaponry and will use it for their purposes. Terrorists, criminals and the like, dictators and hostile regimes will also have the potential of access to these weapons and they may well be able to use them more effectively than we do. For instance our use of some of these compounds is likely to be constrained by international treaties, it is constrained by rules of engagement – but there's no reason to think that necessarily everybody would be constrained by those kinds of things.

**Natasha Mitchell:** Despite those constraints though I was interested to read that the processes for approval for chemical weapons for military use are certainly not as arduous or demanding as maybe equivalent chemicals being approved for therapeutic use.

**Mark Wheelis:** Exactly. There's a very complex convoluted, expensive and time-consuming process of drug approval to get a pharmaceutical compound to the market for therapy. There's no comparable route for the approval of weapons systems, so it would be possible certainly to move much more rapidly for the development of a knockout agent for law enforcement or military use than it would be to develop the same agent as an anaesthetic for the operating room, for example.

**Natasha Mitchell:** Malcolm Dando.

**Malcolm Dando:** I was wondering if I might walk you a little down the nightmare road that we might get to if we don't stop the application of this kind of understanding for military and other purposes.

**Natasha Mitchell:** You paint a quite dire future scenario – give us that scenario.

**Malcolm Dando:** Up until the turn of the century we knew that there was a very unpleasant but really quite common sleep disease called narcolepsy. People all of a sudden lose all their muscle tone and collapse. We had no idea really what the cause was. And the important thing to understand is how quickly we got to understand the cause. Two particular groups doing research in the late 90s discovered that there was a particular neuropeptide that we didn't know anything about previously. Very quickly after that it was shown that narcolepsy is almost always connected in human beings with a deficiency in these neuropeptides. Because it doesn't seem to be a genetic disease it looks as though it could well be some kind of auto-immune disease. So you have the frightening prospect that if one could understand how to initiate it, as an autoimmune disease, you would have an absolutely frightening weapon in which you could use to initiate narcolepsy an auto-immune disease amongst forces that are of another country.

**Natasha Mitchell:** That said though, despite all the progress and perhaps the hype too in the neurosciences, the challenge is still there, we still have a comparatively fleeting understanding of the mechanisms by which our brain actually produces behaviour. So I wonder if we are at risk of cultivating paranoia here.

**Malcolm Dando:** It's a question of looking at what's happening in the civil research and asking yourself, is there something major going on here? And I would suggest one thing you might want to do is go and look at the number of Nobel Prizes that have been awarded to people in neurosciences since 1990 and ask yourself why there are so many. And what's the significance of the ones that are being awarded. And then ask yourself where are the major funders of research in the life sciences, how fast is this thing likely to go on? And I would suggest that if you look at that as coolly and as logically as you can you have to come to the conclusion that neuroscience is one of the areas where there are extremely rapid developments taking place. Another indicator is the growth of the new discipline of neuroethics; people not worrying about the kind of deliberate misuse we're talking about, but worrying about the implications of the rate of change in our understanding.

**Mark Wheelis:** It's also worth remembering that there are already psycho-active chemicals or other kinds of non-lethal chemicals that work via the central nervous system being used for hostile purposes. The use of gamma-amino butyric acid and Rohypnol, for instance, to facilitate date rape is

a world wide problem. Criminals are using pepper spray in increasing numbers. We think of pepper spray as a personal protection or as an agent of police, but increasingly terrorists, bank robbers and others are using pepper spray as an offensive weapon for their purposes.

**Natasha Mitchell:** If these malign applications were indeed a possibility, these malign applications of neuroscience, if they were a reality, how do we contain that application? Because I guess we could advocate a neo-Luddite approach couldn't we, and contain the actual science.

**Mark Wheelis:** That would be an effective way of dealing with the problem but the benign therapeutic applications of this work are enormous in dealing with mental illness and other illnesses that are rooted in the central nervous system. So the civil science will go on for sure for perfectly legitimate reasonable reasons. The challenge is to prevent that science, which is the same science, from being misused while retaining our ability to enjoy its benefits.

**Natasha Mitchell:** How do we do that and, I guess, what responsibilities are you placing on biologists themselves, because that's certainly an interest for you isn't it Mark?

**Mark Wheelis:** I do think that there is an increasing responsibility for biologists to be more aware that as they participate in what some have called the century of biology or the age of biology, they engage a moral obligation as well, to take some responsibility for the application of their work. I'd like to see individual scientists as well as the scientific professional societies become more engaged in these discussions, actively engaged in policy-making to try to effect meaningful limits on the malign applications while preserving the beneficial applications.

**Natasha Mitchell:** You point to the anti-biological warfare activism of the microbiological societies in the 1960s but Mark, it's a very different era now isn't it.

**Mark Wheelis:** It is indeed, science is bigger, there are many, many more people involved, the competition is much greater, the rewards are much greater, the time from discovery to application is much greater, there's an entire segment of industry that didn't exist back then, the biotechnology industry. So the challenges are I think very much greater. But I do think that that's a useful precedent; the American Society for Microbiology became very active in the very late 1960s in posing biological weaponry and I think it was influential. I would like to see neuroscientists and immunologists and others engage the same kinds of issues with the same kind of fervour now.

**Natasha Mitchell:** Malcolm, there's clearly an impetus for these questions to be addressed, are they on the agenda for the upcoming review conference for the chemical weapons convention in 2008?

**Malcolm Dando:** I would have thought that at the present time there's practically no eye-level attention to this issue in most countries. This kind of discussion we are having with you is really quite unusual.

**Mark Wheelis:** I agree with you that we don't want to over-estimate the threat; we're not looking at somebody in the next year or two murdering thousands of people with a novel neuro-transmitter or something like that. But we are looking, within a decade I would say, but certainly not much more than a decade, of a greatly expanded capability to manipulate human physiology for whatever purposes one has.

**Natasha Mitchell:** A final question – how can we be assured that the chemical weapons convention is indeed keeping up with the pace of scientific and technological change in this field, when it comes to understanding the biology of the nervous system?

**Mark Wheelis:** The chemical weapons convention and the biological weapons convention are both robust because they speak to the use of compounds and they don't simply list compounds that are banned or things like that. So a neuropeptide or so that had toxic effects on the body would be, even if it's not yet discovered, would still fall under the purview the chemical weapons convention with the one proviso of the ambiguity for law enforcements purposes.

**Natasha Mitchell:** Malcolm Dando and Mark Wheelis – my thanks for joining me on the program today, it's a very important and very interesting issue to discuss.

**Mark Wheelis:** Thank you Natasha, it's been a pleasure.

**Malcolm Dando:** Thank you.

**Natasha Mitchell:** And Dr Mark Wheelis is a microbiologist and senior lecturer at the University of California, Davis, and Malcolm Dando is professor of International Security at the University of Bradford in the UK. And together they're co-editors of *Deadly Cultures: Biological Weapons* since 1945, published by Harvard University Press.

Catch the show again as podcastable or streaming audio on our website [abc.net.au/rn/allinthemind](http://abc.net.au/rn/allinthemind). Transcripts, links and more there as well as our email for your comments always welcome. Thanks today to producer Anita Barraud and to sound engineer Alex Stinson. I'm Natasha Mitchell, next week more confronting insights into science on the edge, the neurobiology of suicide. Join you next week – take care.