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A New Perspective on the Achievement of Psychological Effects from Cyber Warfare Payloads: The Analogy of Parasitic Manipulation of Host Behavior

By Dr. Mils Hills*

I. INTRODUCTION

This paper represents a think piece exploring early considerations of a new way of understanding and countering decision-making influence affected by Cyber Warfare payloads (where ‘cyber’ implies the use of any technology between sender/recipient). The approach detailed uses a form of Analogical Research (AR) to extract value from a biological model, in this case the effects that parasites exercise on their hosts. There is a lot to learn from parasites and the response of infected organisms - and the analogy has (as it were) legs.

The author’s argument is that just as parasites manipulate their hosts’ behavior, if we think of the informational payload (memes) of cyber-warfare as *parasites*, then we could perhaps more effectively understand, counter or develop such artifacts.

The author originally stumbled upon the potential relevance from understanding the actions of parasites as a way of conceptualizing problematic human

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behavior: in particular, the phenomenon of suicide terrorism. Rather than falling back on various explanations rooted in conventional wisdom, pop psychology or oppression, the author suggests instead that behavior change could be thought of as the result of being 'infected' by the equivalent of a parasitic set of memes which transform the behavior and rationale of an individual thereby enabling them to choose to be a suicide bomber.

Parasites achieve their effects and conceal their existence through a myriad of subtle and sophisticated operations (endocrinal, neurochemical). If, for example, a parasite can transform the risk-taking behavior, preferential food choice and emotional reward of complex organisms, perhaps parasitic assemblages of memes could be changing the risk profile, preferential information sources and emotional rewards that suicide bombers (and their supporters) access and gain respectively.

Having consulted extensively in Information Warfare / Operations, cyber-security and the protection of commercial and strategic decision-makers the author is aware of the openness of defense and security practitioners and policy-makers to new ideas. Given a certain familiarity and a deep empathy with the challenges that face these communities, the author hopes that other share his enthusiasm for exploring the potency of any approach to the developing theatre of cyberspace. The author draws on his professional training in social anthropology to develop a new way of making (potential) sense of an established problem. The conclusion of this paper is to suggest that the parasitological analogy is an important and powerful one that offers the prospect of both better understanding threats and developing counter-measures. Not least, asymmetric thinking provides liberal democratic states

with competitive advantage by absorbing and exploiting innovative perspectives.

II. THE POWER OF ANALOGICAL RESEARCH (AR)

No matter how strong the urge or imperative, it's generally very difficult to credibly set out to 'think outside the box'. There has to be some catalyst or trigger from which new thoughts can spring. Author's 'writer's block'; the artist's blank canvas; the sculptor's uncarved block; the strategic leader with their on-tap 'blue sky thinker' ... all need initiation to begin work from some external source. This author finds biological analogies a powerful source of innovative thinking. Some years ago, in working closely with deeply technical experts in the domain of computer security, I floated the idea of drawing on the area of biology charged with understanding predator-prey interaction.

The lay-person might imagine that ecosystems change little and slowly and that battles between predator and prey alter little. However, this is proven not to be true. In Australia, the introduced Cane Toad (a failed form of biological control for a pest of the sugar cane – a failure because of the ability of the target pest beetle to climb sugar cane, a feat that toads have yet to master) proved a toxic invader of the native ecosystem. A voracious appetite, fast reproductive rate and highly toxic poison concealed within its skin made the toad a highly effective new entrant into Australian habitats.

On closer inspection, however, Australian indigenous wildlife responded incredibly rapidly to the arrival of the invader toad. Domestic species have quickly learned, for example, how to consume the edible parts of these large amphibians by not eating the parotid glands.

So, the learning point is that an ecosystem model of computer network security would ideally be made capable of learning about a completely new form of

security vulnerability - and dispatches it swiftly. If the lesson works in nature there is no reason why the principles cannot (by analogy) be translated into and implemented for an alternative type of ecosystem.

III. THE PROBLEM: UNDERSTANDING HOW CYBER WARFARE PAYLOADS MAY CHANGE HUMAN BEHAVIOR

Although we all like to consider ourselves as highly rational and sensible beings, the fact remains that if we expose ourselves to *objective* analysis (via some kind of reflection on practice; discussions with a therapist or counselor; re-examination of decisions), we will no doubt find that we are a lot less rational than we had hoped. Perceptions, beliefs, prejudices, assumptions, models, these and other artifacts guide, shape and constrain our decisions. How this operates as a cohesive whole is a tricky issue for interdisciplinary attention.

However, changing human behavior is something that we can focus on, specifically if it relates to problematic behavior. So, antisocial behavior in public places; unwanted employee activity; misfits ... these are all difficult phenomena that we would like to understand better and for which no easy answers exist.

If a cyber-warfare payload (however delivered) achieves its effect – it changes human behavior either in a specifically desired way (e.g. a change of opinion on a political cause) or perhaps simply makes an existing process unreliable (e.g. introducing unexpected information into a decision-making process).

What one is very short of in general terms are neat conceptualizations of how information changes behavior. As progress in neuroscience develops, it is increasingly possible to map (in real time) how the brain *responds* to information – it's going to be problematic to understand *why* the brain accepts or seeks out specific information and actively undergoes pretty significant

changes (*cf.* from a teaching assistant to a committed suicide bomber). Note that in relation to the 7/7 bombers in the UK there is little in their backgrounds which mark them out as particularly vulnerable to radicalization [... they were] apparently well integrated into British society'.¹

“[T]he vast majority of suicide bombers, the 7/7 four included, show no sign of mental illness and have no criminal history. They are often better educated than their peers and hold respectable jobs.² The backgrounds of the 4 men appear largely unexceptional[...]. We do not know how Khan developed his extreme views or precisely when.”³

The power of the analogy on which I draw in this paper is not to explain *per se* exactly how the brain is influenced by information, rather to suggest that the analogy might provide us with enhanced understanding of how the brain *may be thought of* as being influenced. In itself, this may provide alternative understandings and insights for both offensive and defensive purposes.

By necessity, it is now vital for me to speedily explain some of the mechanisms by which parasites secure behavior change in their hosts

¹ House of Commons, *Report of the Official Account of the Bombings in London on 7th July 2005*, (May 11, 2006) <http://www.official-documents.gov.uk/document/hc0506/hc10/1087/1087.pdf>

² Michael Bond, *The Psychology of Bombers*, Prospect Magazine, (Jun. 30, 2007), <http://www.prospectmagazine.co.uk/magazine/thepsychologyofbombers/>

³ House of Commons, *Report of the Official Account of the Bombings in London on 7th July 2005*, (May 11, 2006) <http://www.official-documents.gov.uk/document/hc0506/hc10/1087/1087.pdf>

IV. CASE STUDIES OF SIGNIFICANT BEHAVIOR CHANGE ACHIEVED THROUGH NEUROTRANSMITTER MODIFICATION BY PARASITES

Although many parasites cause minimal changes in their host's behavior or health, some produce substantial alterations which are directly linked to the requirements of the parasite to continue their lifecycle (moving into another host for example). A good example is that of rats who are infected with *Toxoplasma gondii*. Here, the rodents "show an increase in their exploratory behavior, thereby increasing, at least indirectly, the likelihood of predation by feline definitive hosts".⁴ A different parasite - *Eimeria vermiformis* - produces a mirror image of this behavior change: where rats lose their normal wariness and risk-aversity when they encounter a potential predator. Instead, "this behavior becomes subdued, suggesting the possibility that the parasite is increasing the likelihood of the host's predation".⁵

What is most interesting, apart from the somewhat gruesome dimensions of such examples, is the means by which seemingly innate behaviors are overcome. Naturally, this has to be a complex mechanism to achieve such an outcome: "It appears that the abnormal behavior of the host is due, in part, to parasite-induced changes in the serotonin neuromodulatory system, and to an opioid-mediated

⁴ Albert O. Bush, Jacqueline C. Fernandez, Gerald W. Esch and J. Richard Seed, *Parasitism; The Diversity and Ecology of Animal Parasites*, 397 (Cambridge University Press, 2001).

⁵ Albert O. Bush, Jacqueline C. Fernandez, Gerald W. Esch and J. Richard Seed, *Parasitism; The Diversity and Ecology of Animal Parasites*, 397 (Cambridge University Press, 2001).

analgesia".⁶ Another way of describing this is as where the parasites "actively target the host's neuroendocrine systems".⁷

In other words, the fundamental behaviors and reactions of the host are overcome and re-programmed by the parasite. To transform a wary and cautious animal into a hasty and reckless one is quite an achievement. Add to that an increased ability to withstand pain by sensing it less without, I assume, fleeing - and the parasite has ensured that its host is as optimally likely to assist in achieving its next life stage (by sacrificing itself to a predator with retarded escape responses) as possible.

To unpack the complex mechanism – excretions from parasites interfere with normal neurotransmission. In the case of *Eimeria vermiformis*, it is the serotonin pathways in the brain which are modified. In the human brain, serotonin is responsible for regulating mood, appetite, sleep as well as being involved in processes of memory and learning. In the animal model, it influences how the gut works and how the animal perceives the availability of food. It also appears that many other activities can be enhanced or depressed as a response to the perception of food availability.

Serotonin is relevant in the case of the effects of the parasitic worm because it shapes the 'fight or flight' response of the rat. In other animals it modulates the response by enhancing it in socially dominant pack animals and inhibiting it in subordinates. The swarming

⁶ Albert O. Bush, Jacqueline C. Fernandez, Gerald W. Esch and J. Richard Seed, *Parasitism; The Diversity and Ecology of Animal Parasites*, 397 (Cambridge University Press, 2001).

⁷ Jenny Carolyn Shaw, Wayne J. Korzan, Russ E. Carpenter, Armand M. Kuris, Kevin D. Lafferty, Cliff H. Summers, CH and Øyvind Øverli, *Parasite manipulation of brain monoamines in California killifish (Fundulus parvipinnis) by the trematode Euhaplorchis californiensis*, 276 PROC. R. SOC. B, 1137, 1137-1146 (2009).

of normally non-social locusts is also triggered by serotonin – but only when food supply is perceived to have declined. In addition to the increased ‘gregariousness’ of these locusts, they undergo physical transformation: a darkening in color changes and increase in muscle size. Indeed, swarming and non-swarming locusts look so different that they were originally thought to be separate species.⁸

California Killifish – infected by another form of parasitic worm – change their normally cautious behavior by frequently surfacing and flipping over to reveal their shiny silver bellies. This increases the chances of predation by seabirds – by a factor of thirty – ensuring that the worm is passed on to the bird vector.⁹ Shaw, the parasitologist leading the study of killifish, concludes that a drop in serotonin raises levels of aggressive behavior, whilst a concomitant rise in dopamine makes them more restless. Together, an effect is produced whereby infected fish “display four times as many conspicuous swimming behaviors as uninfected ones”.¹⁰

All of these are examples of very profound behavioral changes. In terms of maintaining my analogy, my contention is that a package of ideas (memes) could exercise profound changes if they could produce changes in brain chemistry. We already know both anecdotally

⁸ BBC News, *Locust swarms 'high' on serotonin*, (Jan. 29, 2009), <http://news.bbc.co.uk/1/hi/sci/tech/7858996.stm>

⁹ New Scientist, *Prozac may counter parasite mind control*, (Dec. 17, 2008), <http://www.newscientist.com/article/dn16283-prozac-may-counter-parasite-mind-control.html>

¹⁰ Jenny Carolyn Shaw, Wayne J. Korzan, Russ E. Carpenter, Armand M. Kuris, Kevin D. Lafferty, Cliff H. Summers, CH and Øyvind Øverli, *Parasite manipulation of brain monoamines in California killifish (Fundulus parvipinnis) by the trematode Euhaplorchis californiensis*, 276 PROC. R. SOC. B, 1138, 1137-1146 (2009).

and with reference to scientific evidence that what we believe does influence our brain chemistry. Behavior could be modified to, say, become satiated by achieving new objectives, alter perception of risk and pursue a radically different lifestyle. Many of us force such changes when we undergo some lifestyle modification (e.g. giving up smoking; deciding to lose weight; acquiring qualifications and a radically different career). We could, therefore, be said to be actively self-infecting ourselves with alternative sets of memes.

Sometimes these are effective and 'stick', other times less so. I am not claiming that there is any likelihood that those who become infected with pro-suicide bombing (or similarly deviant ideas) are necessarily any different from the rest of us. However, there may well be contextual factors which make it more likely that some individuals adopt such bundles of memes than others.

This paper is an outline contribution that sketches initial thinking in an effort to stimulate responses to enhance and focus my further work in this area. Given that a great deal of terrorist (and terrorist-sympathizer) recruitment and handling is undertaken using 'cyber' means (in other words, any form of communication depending on the mediation of computers), the analogy of parasitic infection seems to 'fit' with the speed with which individuals can apparently become committed to a violent cause.

In terms of further thinking, the following topics (among others) suggest themselves to me as being worthy of further consideration, not least by looking into analogies of terrorist recruitment and self- / group-reinforcing actions in, for example, workplace deviant behavior:

- What can we speculatively consider might be the effects and causes of other neurochemical effects?
- What changes on perception and behavior might we explore?
- In what ways might changes in emotional state be achieved?
- What further insights might we analogically explore from animal models?
- How might we understand and model the ‘lifecycle’ of infection by memes which shapes information-seeking and satiation but is still far from connection to active pursuit of violence and self-sacrifice?
- What can we learn for individual / systemic counter-radicalization from the responses of biological systems to parasitic infection?
- What might be the contextual (genetic?) predispositions and conditions that make people susceptible to infection by memes which contribute to achieving deviant behavior?

V. CONCLUSION

This paper set out to demonstrate solely that there may be some benefit in exploring a biological analogy for the future better understanding of the recruitment and motivation of suicide terrorists. The author has identified some potential value in the benefits of a radically different perspective to conceptualizing the mechanisms and individual effects and benefits of radicalization. From applying this biologically-inspired approach, it is hoped that new and innovative concepts for application in policy, doctrine and operations will be produced. Further strands of research and development have been identified and collaboration with other scholars and practitioners is actively welcomed.