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Entangled security: Science, co-production, and intra-active insecurity

Stefan Elbe[1]* and Gemma Buckland-Merrett[2]

[1]Department of International Relations, University of Sussex and [2]Centre for Global Health Policy, University of Sussex
*Corresponding author. Email: s.elbe@sussex.ac.uk

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Abstract

This article advances a new account of security as an intensely relational and ontologically entangled phenomenon that does not exist prior to, nor independently of, its intra-action with other phenomena and agencies. Security's 'entanglement' is demonstrated through an analysis of the protracted security concerns engendered by 'dangerous' scientific experiments performed with lethal H5N1 flu viruses. Utilising methodological approaches recently developed in the field of Science and Technology Studies (STS), the article explicates the intensely 'co-productive' dynamics at play between security and science in those experiments, and which ultimately reveal security to be a deeply relational phenomenon continuously emerging out of its engagement with other agencies. Recovering this deeper ontological entanglement, the article argues, necessitates a different approach to the study of security that does not commence by fixing the meaning and boundaries of security in advance. Rather, such an approach needs to analyse the diverse sites, dynamics, and processes through which security and insecurity come to intra-actively materialise in international relations. It also demands a fundamental reconsideration of many of the discipline's most prominent security theories. They are not merely conceptual tools for studying security, but crucial participants in its intra-active materialisation.

Keywords: Science; Security; Co-Production; Intra-Action; H5N1

Introduction

> Existence is not an individual affair.[1]

Scientific discoveries, it is often said, can either be put to 'good' or 'bad' use. Perhaps nothing exemplifies this dilemma more starkly than the discovery of nuclear fission in the twentieth century. Harnessing the power of the atom at once heralded the prospect of unleashing a revolutionary new source of peacetime energy, but it also paved the way for developing the most destructive weapons in human history. The subsequent creation – and use – of nuclear weapons would go on to shape the trajectory of twentieth-century history in profound ways.[2] Nuclear power therefore remains one of the best-known examples of the 'dual use' dilemma, whereby scientific and technological advances can be used to benefit humanity, but could also be misappropriated by hostile groups for more nefarious purposes.[3] This underlying problem of 'dual use' research

[1]Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007), p. ix.

[2]Rens Van Munster and Casper Sylvest, *Nuclear Realism: Global Political Thought during the Thermonuclear Revolution* (London: Routledge, 2016).

[3]Jeremy Youde, 'Safe for humanity: Taming biological research through norm awareness', *Contemporary Security Policy*, 34:2 (2013), pp. 258–77; Brian Rappert, 'Why has not there been more research of concern?', *Frontiers in Public Health*, 2:74

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has vexed scholars and practitioners ever since, giving rise to a variety of different meanings and applications of the concept over time.[4]

Other scientific discoveries with similarly revolutionary potential abound in the twenty-first century.[5] A particularly notorious example of such 'dual use' research surfaced more recently in the life sciences, when two separate virology research teams carried out controversial experiments with lethal H5N1 ('bird flu') viruses.[6] Natural outbreaks – and *human* deaths – from infection with such H5N1 'bird flu' viruses were first detected in Hong Kong in 1997, reappeared in 2003, and also spread to other countries. According to the World Health Organization (WHO), the mortality rate among people infected with H5N1 was around 60 per cent.[7] The only 'good' news was that persons contracting H5N1 appeared to be those in close and direct contact with infected birds. In other words, the virus did *not* seem to spread very efficiently between human beings – as would be necessary for setting off an infectious chain reaction and triggering a devastating new human pandemic.

This uneasy 'pre-pandemic' state of affairs generated an intriguing scientific question: is it actually possible for these deadly H5N1 viruses to ever mutate in ways that would trigger such a deadly new pandemic? In order to get a better understanding of the true extent of the pandemic threat, scientists essentially wanted to discover whether they could experimentally produce airborne-transmissible H5N1 viruses in their laboratories, or – as one commentator metaphorically put it – to deliberately give these deadly H5N1 viruses 'wings'.[8] Two scientific teams worked in parallel utilising different approaches for artificially introducing such viral mutations, but both teams ultimately succeeded in producing 'dangerous' airborne-transmissible H5N1 viruses in their university laboratories. When the scientists then also submitted their detailed scientific methods and findings for publication to prestigious scientific journals like *Science* and *Nature*, it triggered grave security concerns and provoked a major international controversy. The interests of 'science' and 'security' quickly became pitted against one another, as probing questions were raised about whether such 'dangerous' scientific experiments should have been ever carried out, whether their results should be openly published, and whether the power to make such decisions should ultimately rest with the scientific or security communities.[9]

This article does not seek to develop new answers to those much-debated questions. Rather, it revisits these controversial H5N1 experiments because they expose something deeper about the nature of security: its 'entangled' ontological nature. Closer analysis of these controversial life science experiments, via methodological approaches recently developed in Science and Technology Studies (STS), reveals security to be an intensely relational phenomenon that does not exist prior to, nor independently of, its intra-action with other agencies. In order to substantiate this argument, the article first sets out a new and 'entangled' account of security that draws upon the STS scholarship of Karen Barad. The article next demonstrates, through more detailed analysis of the

(2014); Dagmar Rychnovská, 'Governing dual-use knowledge: From the politics of responsible science to the ethicalization of security', *Security Dialogue*, 47:4 (2016), pp. 310–28.

[4]Ronald M. Atlas and Malcolm Dando, 'The dual-use dilemma for the life sciences: perspectives, conundrums, and global solutions', *Biosecurity and Bioterrorism: Biodefense Srategy, Practice, and Science*, 4:3 (2006), pp. 276–86; Jonathan E. Suk, Anna Zmorzynska, Iris Hunger *et al*., 'Dual-use research and technological diffusion: Reconsidering the bioterrorism threat spectrum', *PLoS Pathogens*, 7:1 (2011), e1001253; Jonathan Tucker, *Innovation, Dual Use and Security: Managing the Risks of Emerging Biological and Chemical Technologies* (Cambridge, MA: MIT Press, 2012).

[5]'Governance of Dual Use Research in the Life Sciences: Advancing Global Consensus on Research Oversight: Proceedings of a Workshop', National Academies of Sciences, Engineering, and Medicine (2018), available at: {https://doi.org/10.17226/25154} accessed 27 February 2019.

[6]Brett Edwards, James Revill, and Louise Bezuidenhout, 'From cases to capacity? A critical reflection on the role of "ethical dilemmas" in the development of dual-use governance', *Science and Engineering Ethics*, 20 (2014), pp. 571–82.

[7]WHO, 'FAQs: H5N1 Influenza', available at: {http://www.who.int/influenza/human_animal_interface/avian_influenza/h5n1_research/faqs/en/} accessed 27 February 2019.

[8]Martin Enserink, 'Controversial studies give a deadly flu virus wings', *Science* (2 December 2011).

[9]B. Maher, 'Bird-flu research: the biosecurity oversight', *Nature*, 485 (2012), pp. 431–4.

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H5N1 experiments, how security's ontological 'entanglement' can be analytically captured, illustrated, and explicated through the use of 'co-productive' STS methods. Finally, the article shows that the methodological recovery of security's deeper ontological 'entanglement' ultimately demands a different conceptual approach to the study of security. Unlike some of the disciplines, most influential theories of security (like realism and securitisation theory) that efface this ontological entanglement by conceptually fixing the boundaries of security from the outset, the study of 'entangled' security necessitates closer analysis of the diverse sites, dynamics, mechanisms, and processes through which security and insecurity come to intra-actively materialise in international relations. It also, the article concludes, requires a fundamental reconsideration of those prominent security theories. They are not merely conceptual tools for studying security, but crucial participants in its intra-active materialisation.

Entangled security: Towards a relational ontology of security

What is the nature of the relationship between security and science? Any prominent theory of security would readily concede that science plays an important role in security. Yet many of the field's most influential theories also tend to view science as a field that remains ontologically separate from, and largely subordinate to, the logics of security. Structural realism, for example, acknowledges that science can be a key factor in security dynamics, because scientific knowledge can engender new technologies capable of altering the distribution of power in the international system – as in the above case of nuclear weapons. Science is therefore clearly a significant factor for security in realist accounts, but it only really becomes relevant via an intermediary step of translation whereby new scientific knowledges first have to be intentionally converted into weaponised technologies (for example, the Manhattan Project in relation to nuclear science). What is more, in realist approaches to the study of security, science never really touches directly upon the underlying problem of anarchy, which remains the most fundamental source of insecurity in international politics.[10] In the realist tradition, Matthias Leese rightly argues, scientific discoveries leading to new technologies are seen 'as a variable that impacts power distribution, [but] not as a factor that could unhinge the anarchic nature of the international system in the first place'.[11] Science is clearly important, but it is ultimately something separate from, and even subordinate to, the overriding security logics of anarchy.

A very similar way of thinking about the role of science in security can also be found in more 'critical' approaches to security like securitisation theory. There too science is considered to be an important factor, albeit again also one that is largely separate from – and subordinate to – security. Securitisation theory affirms the important role of science when it acknowledges that scientists can underpin securitisation moves by providing an 'authoritative assessment of threat for securitizing or desecuritizing moves'.[12] Trine Villumsen Berling has also usefully described in more detail how scientists can 'objectify' security threats, and how 'scientific facts can be mobilized in securitization claims by securitizing actors in attempts to seek back-up in the objective, disinterested aura of the scientific vocation'.[13] Securitisation theory too therefore accords science an important role, but again it also conceives of this role largely as a secondary or subaltern one, principally geared towards epistemically 'confirming' or 'denying' the securitising moves and speech acts made by securitising actors in relation to other existential threats.[14]

[10]Kenneth Waltz, *Theory of International Politics* (Long Grove, IL: Waveland Press, 1997).

[11]Matthias Leese, 'How (Not) To Talk About Technology: IR Theory and the Search for Agency', paper presented at the Annual Convention of the European International Studies Association, Barcelona (13–16 September 2017), p. 3.

[12]Barry Buzan, Ole Wæver, and Jaap de Wilde, *Security: A New Framework for Analysis* (Boulder: Lynne Rienner Publishers, 1998), p. 72.

[13]Trine Villumsen Berling, 'Science and securitization: Objectivation, the authority of the speaker and mobilization of scientific facts', *Security Dialogue*, 42:4–5 (2011), p. 385; see also Rychnovská, 'Governing dual-use knowledge'.

[14]Ole Wæver, 'Politics, security, theory', *Security Dialogue*, 42:5 (2011), p. 474.

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The underlying relationship between security and science begins to look very differently, however, when approached from a more interdisciplinary perspective of Science and Technology Studies (STS). Bringing recent theoretical and methodological developments in the field of STS to bear upon the study of security directly challenges this widespread view of seeing 'security' and 'science' as ontologically separate fields, pointing instead towards a much more deeply 'entangled' relationship. According to Karen Barad, such 'entanglement' does not simply mean 'to be intertwined with another, as in the joining of separate entities'; rather it suggests a much more radical absence of 'an independent, self-contained existence'.[15] 'Entanglement', in other words, signifies a relationship so intensely and densely connected that it becomes difficult to speak about the existence of separate phenomena, requiring such phenomena to be thought of instead as forming a wider unified system, or even as a kind of 'nondualistic whole'.[16] 'What often appears as separate entities (and separate sets of concerns) with sharp edges', Barad argues, 'does not actually entail a relation of absolute exteriority at all', but a 'relation of exteriority "within"'.[17]

Working at the intersection the natural and social sciences, Barad thus invites her readers to think about the world as an extensive and 'lively' dynamism of forces in which all designated 'things' are constantly exchanging and diffracting, influencing, and working inseparably.[18] According to her novel onto-epistemological framework of agential realism, the world's 'primary ontological unit is not independent objects with independently determinate boundaries and properties but rather … phenomena [which] are the ontological inseparability of agentially intra-acting components'.[19] Whereas the more familiar notion of 'inter-action' assumes the existence of separate entities and agencies that precede their interaction, Barad's neologism 'recognizes that distinct agencies do not precede, but rather emerge through, their intra-action'.[20] Intra-action thus 'queers the familiar sense of causality … [and] generally unsettles the metaphysics of individualism (the belief that there are individually constituted agents or entities, as well as times and places)'.[21] Crucially, those agencies 'are distinct in a relational, not an absolute, sense, that is, *agencies are only distinct in relation to their mutual entanglement; they don't exist as individual elements*'.[22]

Barad is not directly concerned with the study of security in her work, which is principally oriented towards theorising the wider relationship between discursive practices and the material world.[23] That also marks the primary way her framework of agential realism has been appropriated by IR scholars to date.[24] Yet her underlying notion of ontological 'entanglement', with its corresponding emphasis on 'intra-active' materialisation, can also help to analytically explicate security's intensely relational ontological nature. Extending her conceptual framework of agential realism to the study of security (and its particular relationship to science) suggests that security, too, cannot be considered a pre-formed and ontologically separate field existing prior to its mutual interaction with science. Rather, 'security' materialises through 'science' via an intensely relational encounter (and vice versa): 'it is through specific agential intra-actions that the

[15]Barad, *Meeting the Universe Halfway*, p. ix.

[16]Karen Barad, 'Meeting the universe halfway: Realism and social constructivism without contradiction', in Lynn Hankinson Nelson and Jack Nelson (eds), *Feminism, Science, and the Philosophy of Science* (Dordrecht, Holland: Kluwer Press 1996), p. 172.

[17]Barad, *Meeting the Universe Halfway*, p. 135.

[18]Ibid., p. 141.

[19]Ibid., p. 33.

[20]Ibid.

[21]Karen Barad, 'Intra-action: an interview with Adam Kleinman', *Mousse*, 34 (2012), available at: {http://moussemagazine.it/product/mousse-34/} accessed 27 February 2019.

[22]Barad, *Meeting the Universe Halfway*, p. 33.

[23]Ibid., p. 28.

[24]See, for example, Claudia Aradau, 'Security that matters: Critical infrastructure and objects of protection', *Security Dialogue*, 41:5 (2010), pp. 491–514; and Vicki Squire, 'Reshaping critical geopolitics? The materialist challenge', *Review of International Studies*, 41:1 (2015), pp. 139–59.

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boundaries and properties of the components of phenomena become determinate and that particular concepts … become meaningful'.[25] The boundaries of security are never given or self-evident, but only become stabilised through continuous processes of intra-active materialisation.

How, then, can this deeper ontological entanglement be methodologically teased out, captured, and explored in the study of security? The idiom of 'co-production', widely deployed by STS scholars to highlight the inherent difficulties in separating science out from its wider social context, holds considerable methodological promise here. According to Sheila Jasanoff, who is widely credited with developing the notion, co-production essentially consists of 'the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it'.[26] Scholars working through this methodological idiom of co-production reject the view of science being divorced from social context, just as they also reject the opposite view of science being driven almost exclusively by social factors. In their view it is incorrect to assume that scientific knowledge comes into being independently of political thought and action, or that social institutions passively rearrange themselves to meet technology's insistent demands. Instead, co-production cultivates a more nuanced and finely calibrated sensibility in which science and technology are seen to simultaneously embed – and be embedded in – evolving societal practices, identities, norms, conventions, discourses, instruments, and institutions.[27]

Like Barad, STS scholars of co-production have so far only paid comparatively scant attention to the particular meanings, practices, and institutions of security, as much of their focus has revolved around the broader role of science in society.[28] Already this lacuna has led to calls for closer engagement between STS and security studies moving forward.[29] The controversial H5N1 experiments mark a valuable opportunity to do precisely that. Indeed, adopting a more interdisciplinary STS perspective will make it possible to show how the co-productive dynamics between science and security ultimately run so deep, that questions about what security is, what it means, and how it is to be achieved in the twenty-first century, can no longer be divorced from those of science. Security is a phenomenon not at all separate from science, but a profoundly relational one continuously emerging 'out of' its close engagement with other agencies and phenomena (like science). Bringing co-productive STS methods to bear on the study of security, in short, lays bare its deeper ontological entanglement.

Giving a deadly virus wings: Science *versus* security in the H5N1 controversy

The now infamous H5N1 research controversy first arose in the autumn of 2011, when it transpired that two separate virology teams had carried out scientific experiments deliberately introducing novel genetic mutations into lethal H5N1 viruses. The experiments had an important scientific objective: to ascertain whether it would ever be possible for H5N1 viruses to become

[25]Barad, *Meeting the Universe Halfway*, p. 139.

[26]Sheila Jasanoff, *States of Knowledge: The Co-production of Science and Social Order* (London: Routledge, 2004), p. 2.

[27]Ibid., pp. 2–3.

[28]For pioneering exceptions, see John Law and Michel Callon, 'The life and death of an aircraft: a network analysis of technical change', in Wiebe E. Bijker and John Law (eds), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge, MA: MIT Press, 1992), pp. 21–52; Shelley Hurt, 'The military's hidden hand: Examining the dual-use origins of biotechnology in the American context, 1969–1972', in Fred Block and Mathew Keller (eds), *State of Innovation: The US Government's Role in Technology Development* (Boulder: Paradigm Publishers, 2011); Rebecca Hester, 'Biology as opportunity: Hybrid rule from a molecular perspective', in Shelley Hurt and Ronnie Lipschutz (eds), *Hybrid Rule and State Formation: Public-Private Power in the 21st Century* (New York: Routledge, 2016), pp. 175–202; and Alison Howell, 'Neuroscience and war: Human enhancement, soldier rehabilitation, and the ethical limits of dual-use frameworks', *Millennium*, 45:2 (2017), pp. 133–50.

[29]Brian Rappert, Brian Balmer, and John Stone, 'Science, technology, and the military: Priorities, preoccupations, and possibilities', in Edward J. Hackett, Olga Amsterdamska, Michael Lynch, and Judy Wajcman (eds), *The Handbook of Science and Technology Studies* (Cambridge: MIT Press, 2008), p. 732.

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more easily transmissible in mammals via airborne transmission mechanisms, so as to potentially trigger a devastating new pandemic. At the time, many governments around the world were anxiously bracing themselves for the prospect of such an imminent flu pandemic – especially after human deaths from the H5N1 virus reappeared in Hong Kong and also began spreading to other countries in 2003. The pandemic flu threat rapidly rose to the forefront of international diplomatic agendas, pandemic preparedness plans were hastily drawn up, epidemiological risks were mapped out, simulation exercises were carried out to test cross-government responses, and many countries also began stockpiling medicines and pre-pandemic vaccines against the looming H5N1 threat.[30]

Yet the dreaded H5N1 pandemic did not materialise. Although the H5N1 virus appeared very lethal in people who became infected, it did *not* seem to spread very efficiently or easily between human beings. That disjuncture generated an intriguing scientific question: would it actually be possible for deadly H5N1 viruses to ever spread via airborne transmission (like seasonal flu viruses) so as to trigger a new and devastating flu pandemic – or, are there underlying scientific reasons why that is quite unlikely and perhaps even biologically impossible? As virologists began to design new scientific experiments in order to answer this question, it quickly became evident that it would not be feasible (nor ethical) to conduct such experiments on human subjects, due to the lethal nature of the viruses. Any such experiments would have to be carried out on animals instead. Ferrets have long been the animal of choice for influenza scientists in this regard, because ferrets too are susceptible to human influenza viruses, and demonstrate quite similar behaviours to human beings in terms of their respiratory functions (like sneezing). Two separate laboratories thus began planning such new ferret experiments with H5N1 viruses – one located at the University of Wisconsin-Madison in the United States (led by Yoshihiro Kawaoka), and the other at the Erasmus Medical Centre in Rotterdam (led by Ron Fouchier).

Despite utilising quite different scientific approaches, both teams were eventually successful, and showed that the artificial introduction of less than a handful of mutations could produce airborne transmissible influenza viruses among ferrets. Speaking about his experiments at a scientific meeting in Malta in September 2011, Fouchier reportedly described how his team had effectively 'mutated the hell out of H5N1' and ended up producing 'a very dangerous virus'.[31] When both research teams then also submitted their detailed scientific methods and findings to leading journals (*Science*/Fouchier; *Nature*/Kawaoka) for publication, the experiments triggered a wave of serious security concerns, and became rapidly embroiled in an intense, multifaceted, and protracted international controversy about how to reconcile the competing interests of science and security.

That controversy ended up construing 'science' and 'security' largely as separate fields coming into direct conflict with one another, thus reflecting the wider view of 'science' and 'security' as separate phenomena that also run through many prominent security theories. Questions were openly raised, for example, about whether this kind of 'gain-of-function' (GOF) research should have ever been carried out in the first place.[32] Fouchier himself had reportedly warned that this is 'probably one of the most dangerous viruses you can make'.[33] Yet the scientists countered that discovering

[30]Carlo Caduff, *The Pandemic Perhaps: Dramatic Events in a Public Culture of Danger* (Oakland: University of California Press, 2015); Andrew Lakoff, *Unprepared: Global Health in a Time of Emergency* (Berkeley: University of California Press, 2017); Stefan Elbe, *Pandemics, Pills and Politics: Governing Global Health Security* (Baltimore: Johns Hopkins University Press, 2018).

[31]Katherine Harmon, 'What really happened in Malta this September when contagious bird flu was first announced?', *Scientific American* (30 December 2011), available at: {https://blogs.scientificamerican.com/observations/what-really-happened-in-malta-this-september-when-contagious-bird-flu-was-first-announced} accessed 24 March 2017.

[32]Michael J. Selgelid, 'Gain-of-function research: Ethical analysis', *Science and Engineering Ethics*, 22:4 (2016), pp. 923–64.

[33]Martin Enserink, 'Scientists brace for media storm around controversial flu studies', *Science* (20 November 2011), available at: {http://www.sciencemag.org/news/2011/11/scientists-brace-media-storm-around-controversial-flu-studies} accessed 24 March 2017.

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which specific mutations could generate more transmissible viruses would also help with future risk assessments of H5N1, as well as the design of new medicines and vaccines down the line. Other scientists contested those claimed benefits, and, even if true, any such benefits would still have to be weighed up against the potentially catastrophic risk that these 'dangerous' viruses might accidentally escape from the laboratory one day.[34] As one molecular biologist working on biosecurity issues argued unequivocally at the time: 'this work should never have been done'.[35]

Science and security also came into conflict around a closely related and second axis: the question of whether the findings of such research should then be openly published, especially in light of ongoing concerns about bioterrorism. In the autumn of 2011 the two scientific manuscripts were thus referred to the National Science Advisory Board on Biosecurity (NSABB), a specialised US advisory board advising on 'dual use' research that had been created in 2005 in response to the influential Fink Report, following a string of developments in the life sciences raising wider 'dual use' concerns. After spending hundreds of hours deliberating over how to best deal with the prospect of the pending H5N1 publications, the NSABB came to the unanimous recommendation (on 20 December 2011) that these studies should *not* be published in their current form.[36] This momentous decision, made for the first time in the history of the NSABB, was largely due to concerns about the potential for nefarious appropriation of such viruses as novel bioweapons. As NSABB chair Paul Keim put it at the time: 'I can't think of another pathogenic organism that is as scary as this on.'[37] Those highly charged decisions thus triggered a second axis of contestation around the ethics of scientific publishing, and about how the outcomes of such gain-of-function experiments should be most appropriately reported upon in light of percolating concerns about bioterrorism.[38]

Yet a third axis in the controversy opened up around broader issues of power, authority, and governance. Who would be the ultimate arbiter of all these questions – the scientists themselves, the security community, or perhaps a third party? In this case the scientists had initially pushed ahead without much public debate. NSABB then tried to 'apply the brakes', after the fact, by recommending redaction of the manuscripts. In order to allow for more time to reflect on these sensitive issues, the scientists leading those studies then published a letter on 20 January 2012, announcing that they would voluntarily delay their research for sixty days, so as to allow more time for discussion and deliberation.[39] That was followed by the decision of the World Health Organization (WHO) to hold emergency meetings of its own in February 2012, in order to also address the wider international dimensions of the controversy. The WHO consultation took a very different view from NSABB, concluding that it would still be preferable from a public health perspective to have full disclosure of the papers.[40] All the while the Dutch government even went so far as to invoke security legislation (in the form of export control orders) to impede the publication of the Fouchier manuscript.[41] It marked the first time in Europe that an export permit had been required before submitting a scientific manuscript to an international journal for publication.[42]

[34]Christian Enemark, *Biosecurity Dilemmas: Dreaded Diseases, Ethical Responses, and the Health of Nations* (Washington, DC: Georgetown University Press, 2017), p. 63.

[35]Ebright, quoted in Enserink, 'Controversial studies give a deadly flu virus wings'.

[36]National Institutes of Health, ' Press Statement on the NSABB Review of H5N1 Research' (20 December 2011), available at: {https://www.nih.gov/news-events/news-releases/press-statement-nsabb-review-h5n1-research} accessed 18 May 2017.

[37]Quoted in Enserink, 'Controversial studies give a deadly flu virus wings'.

[38]Youde, 'Safe for humanity'.

[39]Ron A. Fouchier *et al.*, 'Pause on avian flu transmission research', *Science*, 335 (2012), pp. 400–01.

[40]WHO, 'Report on Technical Consultation on H5N1 Research Issues' (16–17 February 2012), available at: {http://www.who.int/influenza/human_animal_interface/mtg_report_h5n1.pdf?ua=1}, accessed 18 May 2017.

[41]Robert Shaw, 'Export controls and the life sciences: Controversy or opportunity', *Science & Society*, 17:4 (2016), pp. 474–80; Enemark, *Biosecurity Dilemmas*, pp. 82–3.

[42]Christian Enemark, 'Influenza virus research and EU export regulations: Publication, proliferation, and pandemic risks', *Medical Law Review*, 25:2 (2017), pp. 293–313.

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The entire H5N1 controversy was only diffused, in the end, by some perceived 'backtracking' on behalf of the NSABB. Thus, in March 2012, NSABB received a security briefing about the bioterrorism threat from the intelligence community, while the scientists concurrently came under pressure to make some key revisions to their papers. NSABB finally reconsidered the (now revised) manuscripts on 29 March 2012, and the next day the board voted 19-0 that the Kawaoka paper should be published.[43] Opinion remained more split on the Fouchier paper, however, with 12 members voting in favour of publication and 6 against – as it was felt that the manner in which 'his' experiments had been carried out might prove comparatively more useful to potential terrorists.[44] Both scientific studies were therefore published in the end, and in January 2013 (a whole year after announcing their initial sixty-day voluntary moratorium) the scientists finally declared that they would now resume their experiments.[45] By that point in time, the H5N1 controversy had become a crowded site of conflicting political interest and competencies – with a dense myriad of diverse stakeholders and institutions at loggerheads about whether this should ultimately be dealt with by scientists or by governments, by health or security experts, nationally or internationally, and whether a trusted international mechanism for making decisions on such matters could ever be found. The question of whose voice would – and should – prevail thus formed a final axis of debate running through the entire controversy.

In looking back at this whole H5N1 controversy with the benefit of hindsight, one of its most striking and notable aspects is thus undoubtedly how it largely portrayed science and security as separate professional fields with conflicting interests[46] – as if the two were engaged in some kind of zero-sum game.[47] Scholars and commentators argued how the controversy generated 'a fundamental question in the balance between academic freedom and biosecurity'.[48] Security officials (and even some scientists) feared that publication of the data posed potentially significant dangers to national security.[49] Many other scientists, in turn, remained apprehensive 'that security motivated restrictions or oversight measures might unduly jeopardize the advancement of science'.[50] The whole controversy essentially boiled down to the question of whether scientists would have to circumscribe their practices in order to accommodate an overarching set of security concerns, or whether scientific autonomy should be preserved as far as possible. Overall, this 'science' versus 'security' narrative in the H5N1 controversy thus reflected an ontologically separatist understanding of their relationship very similar to the one that also runs through many prominent security theories like realism and securitisation theory.

[43]National Science Advisory Board for Biosecurity, 'Statement about March 29–30, 2012 Meeting of the National Science Advisory Board for Biosecurity to Review Revised Manuscripts on Transmissibility of A/H5N1 Influenza Virus', available at: {http://www.virology.ws/NSABB_statement_march_2012.pdf} accessed 17 May 2017.

[44]Bryan Walsh, 'H5N1 paper published: Deadly, transmissible bird flu could be closer than thought', *Time* (3 May 2012).

[45]Ron A. M. Fouchier, Adolfo García-Sastre, Yoshihiro Kawaoka *et al.*, 'H5N1 virus: Transmission studies resume for avian flu', *Nature*, 493 (2013).

[46]Allen Buchanan and Maureen C. Kelley, 'Biodefence and the production of knowledge: Rethinking the problem', *Journal of Medical Ethics*, 39:4 (2013), pp. 195–204; Rappert, 'Why has not there been more research of concern?'.

[47]Christian Enemark, 'Life science research as a security risk', in Simon Rushton and Jeremy Youde (eds), *Routledge Handbook of Global Health Security* (London: Routledge, 2014), pp. 130–40; Frank L. Smith III, *American Biodefense: How Dangerous Ideas About Biological Weapons Shape National Security* (Ithaca and London: Cornell University Press, 2014).

[48]Martin Enserink, 'Dutch appeals court dodges decision on hotly debated H5N1 papers', *Science* (16 July 2015); Andrew Lakoff, 'The risks of preparedness: Mutant bird flu', *Public Culture*, 24:3:68 (2012), pp. 457–64; Rappert, 'Why has not there been more research of concern?', p. 4.

[49]J. Benjamin Hurlbut, 'A science that knows no country: Pandemic preparedness, global risk, sovereign science', *Big Data & Society*, 4:2 (2017), p. 9.

[50]Rappert, 'Why has not there been more research of concern?', p. 2.

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Security/science: the co-production of security *and* science

Beneath the public surface of this controversy, however, lurk a myriad of subtler dynamics through which 'security' and 'science' also powerfully 'co-produce' one another through those experiments. A revealing entry point for excavating those deeper processes of co-production rests in the fact that both scientific experiments were publicly funded by the US National Institutes of Health (NIH). From their very inception, the H5N1 experiments were thus already embedded in a wider US culture of public funding for scientific research. The historical origins of this culture of public funding, in turn, are closely tied to a broader set of geopolitical and security dynamics. One of the enduring lessons the United States government had taken away from the Second World War, for example, was 'that technological superiority alters the balance of world power'.[51] During the 1950s more than half of all federal funds for the biological and medical sciences thus came from the military-controlled Atomic Energy Commission (AEC) and the Department of Defense – funding a mixture of nuclear, space and biological research.[52]

This culture of extensive public funding for scientific research became further entrenched amid the intense geopolitical rivalry between the United States and the Soviet Union during the Cold War. The Soviet Union's successful launch of an unmanned space satellite on 4 October 1957, followed by the launch of Sputnik II only a month later, sent shock waves through the American political establishment, and triggered pervasive feelings of insecurity in the United States.[53] President Eisenhower responded with significant public investment in education and science, creating a new White House Office for Science and Technology, and also quintupling the funding for the National Science Foundation (NSF). Between 1957 and 1963 the budget of the National Institutes of Health (NIH) increased by an average of 40 per cent annually, increasing fiscal appropriations from $98 million 1956 to $930 million in 1963.[54] This 'Sputnik Effect', whereby the United States feared its principal geopolitical adversary was outpacing it, was critical to entrenching the culture of extensive *public* funding for basic science research in the United States.[55] Those financial connections between security and the life sciences remained salient throughout the 1970s, as government officials became acutely aware that a dynamic biotechnology industry (with the heavy involvement of scientists and universities) would help to create a 'reservoir' of expertise and technology to draw upon for defensive security purposes areas.[56]

It is impossible, then, to account for the ways in which the fields of microbiology and the life sciences have flourished in the United States over recent decades without due consideration for the broader security context of the Second World War, and later also the Cold War, that initially engendered and then sustained this culture of extensive public funding for the life sciences.[57] 'The entire history of molecular biology', Michael Kenney reminds his readers, is one 'of federal funding of "basic research"'.[58] The life sciences would simply not be recognisable in their current form without the crucial role played by the national security state.[59] Or, as Chandra Mukerji argues in *A Fragile Power*, science 'gains much of its financing and most if its social power because of its usefulness to government'.[60] All of this brings into relief a fascinating set of intermingled

[51]Hurt, 'The military's hidden hand', p. 52.

[52]Lily Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford: Stanford University Press, 2000), p. 10.

[53]Eric Vettel, *Biotech: The Counterculture Origins of an Industry* (Philadelphia: University of Pennsylvania Press, 2006).

[54]Kay, *Who Wrote the Book of Life?*, p. 13.

[55]Tamas Bartfai and Graham Lees, *The Future of Drug Discovery: Who Decides Which Diseases to Treat* (London: Academic Press, 2013), p. 173.

[56]Hurt, 'The military's hidden hand'; Shelley Hurt, 'What's at stake in the privatization debate?', in Hurt and Lipschutz (eds), *Hybrid Rule and State Formation*; Hester, 'Biology as opportunity'.

[57]Lily Kay, *The Molecular Vision of Life: Caltech, the Rockefeller Foundation and the Rise of the New Biology* (New York: Oxford University Press, 1993); Kay, *Who Wrote the Book of Life?*; Vettel, *Biotech*.

[58]Martin Kenney, *Biotechnology: The University-Industrial Complex* (Yale: Yale University Press, 1986), p. 241.

[59]Linda Weiss, *America Inc.?: Innovation and Enterprise in the National Security State* (Ithaca, NY: Cornell University Press, 2014).

[60]Chandra Mukerji, *A Fragile Power: Scientists and the State* (Princeton: Princeton University Press, 1989), p. 4.

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genealogies whereby geopolitical insecurities initially drove a culture of greater public funding for scientific research in the United States, including funding for life scientists to generate new scientific knowledge about microbial threats.

Beyond these broader historical connections between security dynamics and public funding for science, there are also more immediate ways in which the notorious H5N1 experiments were directly embedded in security considerations. The fall of the Berlin Wall and the end of the Cold War ushered in significant transformations in US security policy. Transitioning out of the geopolitical context of the bi-polar rivalry of the Cold War, and moving into an era characterised by increased globalisation, intensified security concerns about the United States' vulnerably to a range of health-based threats. Starting with HIV/AIDS and SARS, national security agendas gradually became much more preoccupied with biological threats and dangers linked to new forms of epidemiological connectivity and interdependence brought about by the rapid movement of goods, people, and livestock across international borders within the context of an increasingly globalised world economy. In a way that would have been pretty much unimaginable during the Cold War, naturally occurring infectious disease threats like pandemic flu became the unlikely bedfellows of more established security threats like terrorism, nuclear proliferation, and 'rogue' states.[61] Life scientists actively encouraged this transformation in threat perceptions, with an influential scientific movement from the early 1990s (led by prominent scientists like Joshua Lederberg) warning governments about the renewed threat posed by such emerging and re-emerging infectious disease outbreaks.[62] Those underlying transformations in understandings of national security eventually culminated in the rise of 'health security' as a critical component of security policy concerned with protecting populations from an array of biological dangers – both naturally occurring and intentionally released ones.[63]

The controversial H5N1 experiments were squarely rooted within this rapidly evolving health security agenda. The experiments, after all, were explicitly designed to improve scientific understanding of the threat of pandemic flu by elucidating the molecular processes involved in viral transmission – indicating that scientists had already internalised such security logics at the very point of conceiving these experiments.[64] Andrew Lakoff further highlights how the US government's 2005 *Pandemic Influenza Preparedness and Response Plan* explicitly pointed to the need for more basic scientific research on influenza, envisioning that the National Institutes of Health (NIH) would actively support more scientific research on the virus and its virulence.[65] The controversial 'gain-of-function' experiments performed by the Kawaoka and Fouchier teams were thus also born within the immediate context of a governmental security agenda preoccupied with mitigating an array of health-based threats. The subject matter of the experiments, Fouchier's team argued plainly, were 'a key question for pandemic preparedness'.[66] From their

[61]Stefan Elbe, *Virus Alert: Security, Governmentality, and the AIDS Pandemic* (Columbia: Columbia University Press, 2009); Stefan Elbe, *Security and Global Health: Towards the Medicalization of Insecurity* (Cambridge: Polity Press, 2010); Adam Kamradt-Scott and Colin McInnes, 'The securitisation of pandemic influenza: Framing, security and public policy', *Global Public Health*, 7:2 (2012), pp. 95–110.

[62]Nicholas King, 'Security, disease, commerce: Ideologies of postcolonial global health', *Social Studies of Science*, 32:5–6 (2002), pp. 766–7; Nicholas King, 'The scale politics of emerging diseases', *Osiris*, 19 (2004), pp. 62–76; Andrew Lakoff, 'From population to vital system: National security and the changing object of public health', in Andrew Lakoff and Stephen J. Collier (eds), *Biosecurity Interventions: Global Health and Security in Question* (Columbia: Columbia University Press, 2008), pp. 33–60.

[63]Elbe, *Security and Global Health*; Rushton and Youde (eds), *Routledge Handbook of Global Health Security*.

[64]Gaymon Bennett, 'The malicious and the uncertain: Biosecurity, self-justification, and the arts of living', in Limor Samimian-Darash and Paul Rabinow (eds), *Modes of Uncertainty: Anthropological Cases* (Chicago: University of Chicago Press, 2015), pp. 123–44.

[65]Andrew Lakoff, 'A fragile assemblage: Mutant bird flu and the limits of risk assessment', *Social Studies of Science*, 47:3 (2016), pp. 376–97.

[66]Sander Herfst, Eefje Schrauwen, Martin Linster *et al*., 'Airborne transmission of Influenza A/H5N1 virus between ferrets', *Science*, 336 (2012), p. 1535; see also Masaki Imai, Tokiko Watanabe, Masato Hatta *et al*., 'Experimental adaptation of an influenza H5HA reassortment H5 HA/H1N1 virus in ferrets', *Nature*, 486 (2012), pp. 420–8.

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very inception, the controversial H5N1 experiments were therefore funded, justified, rationalised, carried out, and publicly legitimated on the basis that they would help strengthen health security – by better understanding which mutations are key for a pandemic virus to emerge, and by assisting with the design of new medical countermeasures like vaccines and antivirals.

These subtler connections begin to paint a more nuanced picture around the underlying relationship between security and science. Whereas received accounts largely convey a picture of science and security as being separate fields, security considerations in fact permeated those experiments to their core and had already been internalised by the scientists prior to carrying them out. Security considerations generated the scientific question at the centre of those experiments: can lethal flu viruses become airborne transmissible in mammals? Security considerations installed the wider culture of public funding necessary for materially carrying out the experiments. Security considerations drove the research design in terms of using animal models rather than human beings (for whom it would be too dangerous). Security considerations shaped the specific laboratory environments within which the experiments were carried out – in that the laboratories had to possess heightened security features, measures, and protocols. Security considerations eventually even led to differential assessments regarding the two manuscripts, with many more NSABB members objecting to the Fouchier paper than to the Kawaoka paper because of the different ways in which the mutations had been introduced.

Closer analysis of the H5N1 experiments through the methodological STS idiom of co-production reveals, then, that those experiments are not simply an instance of science *versus* security. Rather, it is also one of science *emerging out of* security – or of science/security. What we have come to know scientifically about H5N1 viruses through these controversial experiments is directly and deeply conditioned by what we mean by security, and how we seek to achieve it in the twenty-first century. All of this, moreover, only forms the first half of the story, because there are also further, equally powerful and mirroring dynamics of co-production simultaneously working in the opposite direction. The co-productive forces at play between security and science in those fateful H5N1 experiments ultimately cut both ways.

From twins to triplets: Dangerous science and dual use research of concern

Just as security considerations formed the broader context out of which the controversial H5N1 experiments first emerged, so too those same scientific experiments then also began to shape, influence and bound contemporary understandings of security – especially once the new scientific knowledge generated by those 'successful' H5N1 experiments began to quickly feed back into the very health security agendas that had engendered them in the first place. These additional processes of co-production come into relief once we turn our attention away from the *genesis* of those experiments, to also consider some of their wider political *effects*.

First and foremost, the results of the H5N1 experiments confirmed widely percolating fears about the pandemic flu threat. The experiments seemed to scientifically 'prove' that H5N1 viruses do have the potential to become airborne transmissible in mammals. 'Viruses', the Fouchier manuscript warned unequivocally, 'have the potential to evolve directly to transmit by aerosol or repository droplets between mammals, without reassortment in any intermediate host, and thus pose a risk of becoming pandemic in humans'.[67] The paper of Kawaoka's team similarly confirmed 'the pandemic potential of viruses', and emphasised 'the need to prepare for potential pandemics'.[68] The experiments thus confirmed scientifically that the pandemic threat was indeed very 'real', and that H5N1 viruses could acquire the ability to transmit via airborne routes.

More than that, the scientific experiments suggested that the H5N1 pandemic flu threat was actually *more* serious than had been thought prior to the experiments. That is because the

[67]Herfst *et al.*, 'Airborne transmission of Influenza A/H5N1', p. 1541.
[68]Imai *et al.*, 'Experimental adaptation of an influenza H5HA reassortment', pp. 427, 420.

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experiments further revealed how only a few key mutations (around a handful) would be needed for the viruses to become 'airborne'. More worryingly still, and as the studies also pointed out, some of those critical mutations had already been spotted occurring in nature. The H5N1 experiments therefore did not merely confirm the pandemic threat, they also exacerbated fears about it. Overall, as Fouchier reportedly put it in the simplest but most poignant of terms at an international scientific conference in Malta, it was 'very bad news'.[69] If anyone had doubted the reality of the H5N1 threat, the scientific experiments seemed to deliver the 'objective' scientific 'proof' that H5N1 was indeed something that governments would have to keep worrying about. Moving forward, avian flu would remain, as Mike Davis had warned all along, 'the monster at our door'.[70] All of this was happening, moreover, just as political attention on pandemic threats was beginning to wane in the aftermath of the perceived overreaction by health institutions to the outbreak of pandemic H1N1 'swine flu' influenza in 2009–10.[71] Security, then, does not just generate a need for more science; science conversely also generates the need for more security.

All the more so, because the new scientific knowledge created by the H5N1 experiments concurrently intensified a second set of insecurities. By scientifically succeeding in giving the lethal viruses metaphorical 'wings', the H5N1 experiments now also opened up the possibility that nefarious actors might utilise this novel knowledge in order to develop devastating new bioweapons. Security concerns about the threat of bioterrorism were already escalating in the United States following the mailing of Anthrax letters via the US postal system in September 2001.[72] The combination of groups willing to adopt terrorist methods, coupled with a proliferation of knowledge about how to biologically manipulate pathogens, spurred governments into thinking much more carefully about how they would cope with a future *deliberate* biological release. By the time of the H5N1 controversy, such fears had already moved to the register of 'not if, but when and how extensive' in the United States.[73]

Here the 'successful' H5N1 experiments raised additional security concerns by opening up the prospect of this scientific knowledge being used to develop a deadly new type of 'bird flu' bioweapon. As the vocal NSABB member Michael Osterholm intervened particularly forcefully at the time, 'We don't want to give bad guys a road map on how to make bad bugs really bad.'[74] In what appeared to be a deeply worrying twist, scientific research initially undertaken in the name of protecting the security of citizens against the threat of *natural* outbreaks, had ended up running the risk of exacerbating the threat of a *deliberate* release of a dangerous new virus by hostile groups. 'The circulation of information', Carlo Caduff astutely observes, 'now seemed more dangerous than the circulation of microbes.'[75] As news of the experiments spread, analysts in the US intelligence community thus quickly scrambled to assess the potential security ramifications of the pending publication of these experiments.[76] All of this means that the results of the H5N1 experiments did not just stoke one type of insecurity, but two concurrent biological threats: the threat of a naturally occurring H5N1 pandemic by scientifically confirming its possibility, and the lingering spectre of a bioterrorist attack by developing a scientific 'road map' for how to design airborne transmissible H5N1 viruses.

[69]Harmon, 'What really happened in Malta this September'.

[70]Mike Davis, *The Monster at our Door: The Global Threat of Avian Influenza* (New York and London: The New Press, 2005).

[71]See also Jonathan Everts, 'Announcing swine flu and the interpretation of pandemic anxiety', *Antipode*, 45:4 (2013), pp. 809–25.

[72]Nicholas B. King, 'The influence of anxiety: September 11, bioterrorism, and American public health', *Journal of the History of Medicine and Allied Sciences*, 58:4 (2003), pp. 433–41.

[73]David Franz and Russ Zajtchuk, 'Biological terrorism: Understanding the threat, preparation, and medical response', *Disease-a-Month*, 48:8 (2002), pp. 493–564.

[74]Quoted in Enserink, 'Scientists brace for media storm'.

[75]Caduff, *The Pandemic Perhaps*, p. 110

[76]Kathleen Vogel, 'Expert knowledge in intelligence assessments: Bird flu and bioterrorism', *International Security*, 38:3 (2013), pp. 40–1.

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The H5N1 experiments even engendered a third and final form of insecurity – and perhaps the most significant one of all. Short of the deliberate misappropriation of this scientific knowledge by nefarious groups, the newly created and airborne-transmissible viruses might simply escape from one of the scientific laboratories via an unfortunate *accident*. Concerns about laboratory biosafety date back as far as the 1960s.[77] There have been long-held suspicions, for example, that an outbreak of H1N1 influenza in the 1970s originated through an accidental escape from a military facility in western Siberia.[78] In China, moreover, two researchers were exposed to severe acute respiratory syndrome (SARS) coronavirus samples that were incompletely inactivated, leading to several infections and one death in 2004.[79] Biosafety concerns are certainly not new therefore, but they mostly remained a specialist background issue not commanding anything near the level of public attention accorded to the 'twin' threats of pandemics and bioterrorism at the heart of the burgeoning health security agenda.

This balance began to shift with all the protracted public attention now engulfing the H5N1 experiments. As more and more people began to realise that science itself can also be dangerous, the issue of laboratory safety – or biosafety – acquired far greater political salience as a third crucial axis of 'biological danger' on the health security agenda. These dangers emanating from the H5N1 experiments seemed to be qualitatively different from earlier experiences during the Cold War era, when governments sought to clandestinely work with lethal pathogens for the purposes of harming other militaries and populations. Such work was usually highly classified and carried out in military research laboratories, without the intention of disseminating the findings publicly.[80] The H5N1 experiments, by contrast, were performed in university laboratories with every intention of openly publishing the results – rapidly projecting biosafety consideration to the forefront of the health security agenda.[81] Science itself was now becoming much more widely perceived as a potential source of danger, and scientists would therefore have to expect much more scrutiny of these kinds of experiments moving forward.[82]

By this point in the controversy science's role in security was undergoing a critical process of transformation. Science was shifting from being considered an important but external element shaping health security discourses, to fast becoming a central *object* and even target of such security discourses. New conceptual vocabularies now emerged in order to better identify, capture, and label these kinds of 'dangerous' scientific experiments – like dual use research of concern (DURC), or gain-of-function (GOF) research. These kinds of experiments also became subjected to much more detailed risk assessments, via complex risk-benefit calculations aimed at determining the actual chances that such a dangerous virus might 'get out' of the lab.[83] Funding for such 'gain of function' experiments on influenza, SARS, and MERS viruses was eventually 'paused' altogether by the Obama administration in 2014, so as to allow more time for new biosecurity guidelines to be developed.[84] Such new government policies for regulating the dangers posed by scientific research were subsequently introduced – like the new 'Framework for Guiding

[77]Enemark, *Biosecurity Dilemmas*, p. 51.

[78]Ibid., pp. 30–1.

[79]US Government Accountability Office, 'High-Containment Laboratories: Improved Oversight of Dangerous Pathogens Needed to Mitigate Risk' (30 August 2016), available at: {http://www.gao.gov/products/GAO-16-642} accessed 23 September 2016.

[80]Michael Osterholm and Mark Olshaker, *Deadliest Enemy: Our War Against Hiller Germs* (London: Hachette, 2017), p. 114.

[81]Nancy Connell and Brian Rappert, 'Searching for cures or creating pandemics in the lab', in Filippa Lentzos (eds), *Biological Threats in the 21st Century* (London: Imperial College Press, 2016), p. 258.

[82]Limor Samimian-Darash, Hadas Henner-Shapira, and Tal Davikohttp, 'Biosecurity as a boundary object: Science, society, and the state', *Security Dialogue*, 47:4 (2016), pp. 329–47.

[83]See Marc Lipsitch and Tom V. Inglesby, 'Moratorium on research intended to create novel potential pandemic pathogens', *mBio*, 5:6 (2014), e02366-14.

[84]Selgelid, 'Gain-of-function research', p. 923.

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Funding Decisions about Proposed Research Involving Enhanced Potential Pandemic Pathogens'.[85]

All of this suggests that the controversial H5N1 experiments 'did' much more, in the end, than just intensify and exacerbate existing health security concerns. In a further unexpected twist, the efforts of scientists to improve the security of populations by advancing scientific knowledge about lethal H5N1 viruses ended up generating *new* dangers of its own. Those new 'scientific' insecurities, in turn, would go on to engender a corresponding set of novel security concepts, discourses, and practices aimed at better managing the dangers posed by those kinds of scientific practices. 'The mutant flu controversy', Natalie Porter argues, 'indicates a nascent set of transformations in the life sciences, wherein biosecurity concerns engender new mechanisms for appropriating and controlling research on experimental organisms.'[86]

At precisely this moment, moreover, when science '*itself*' becomes the danger against which we must be secured, we finally also reach the zenith of co-production in the H5N1 experiments. Science can no longer be seen merely as a separate, secondary factor in security that is capable of being intentionally weaponised and/or used to epistemically objectivise securitising moves; rather, science is revealed to be much more deeply and directly entangled in the contemporary constitution of security, which must now also entail protecting people from the dangers emerging in the course of scientific research. The ontological boundaries between 'security' and 'science' that run through the controversy (as well as many of our prominent security theories) begin to dissolve, as it no longer remains possible to account for what security is (and therefore also what it means, and how it is achieved) *without* considering the *constitutive* role of science. Science and security are instead shown to continuously bleed into one another, to mutually reinforce one another, and ultimately even to emerge out of one another. In the end, the co-productive dynamics between science and security run sufficiently deep to point towards an 'ontological inseparability of agentially intra-acting components',[87] making it necessary to think of them as forming part of an ontologically entangled whole: 'entangled' security.

Entanglement, co-production, and intra-active security studies

What does the study of security gain from recovering this deeper ontological entanglement? Security's profound entanglement suggests – more generally – that there is always an inevitable 'cost' or 'loss' involved when theories of security attempt to fix the conceptual boundaries of security in their efforts to tightly delimit security as an independent field of analytical enquiry. Structural realism, for example, does this when it narrowly construes security as the threat, use, and control of military force as the primary driver of survival under the political logics of anarchy.[88] Delimiting the meaning of security in this way inevitably leads to the exclusion of many non-military phenomena (for example, climate change) that are also widely seen to pose significant threats to people and societies, which is why this exclusionary move has historically formed the target for some of the most penetrating critiques of the realist theory of security – particularly the debates between the 'narrowers' and the 'wideners'.[89]

[85]Department of Health and Human Services, 'Framework for Guiding Funding Decisions about Proposed Research Involving Enhanced Potential Pandemic Pathogens' (2017), available at: {https://www.phe.gov/s3/dualuse/Documents/p3co.pdf} accessed 27 February 2019.

[86]Natalie Hannah Porter, 'Ferreting things out: Biosecurity, pandemic flu and the transformation of experimental systems', *BioSocieties*, 11:1 (2016), p. 23.

[87]Barad, *Meeting the Universe Halfway*, p. 33.

[88]See, for example, Stephen M. Walt, 'The renaissance of security studies', *International Studies Quarterly*, 35:2 (1991), pp. 211–39; Stephen M. Walt, 'Realism and security', *Oxford Research Encyclopaedia of International Studies* (2010), available at: {http://internationalstudies.oxfordre.com/view/10.1093/acrefore/9780190846626.001.0001/acrefore-9780190846626-e-286?print=pdf} accessed 27 February 2019.

[89]See Walt, 'The renaissance of security studies'; Barry Buzan and Lene Hansen, *The Evolution of International Security Studies* (Cambridge: Cambridge University Press, 2009), pp. 3–4.

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On a deeper level, moreover, the whole political edifice of formal 'anarchy' that remains so central to realist approaches, and which leads them to prioritise analysis of armed force, is itself the result of an extreme act of *political* separation. The political anarchy that states must manage through armed force only comes to exist because all states are seen to be politically and legally separate from one another, and are taken as independent units that do not acknowledge any higher and common form of political authority. In realist accounts, security is therefore essentially concerned with managing the insecurity that derives from a *double* form of extreme onto-political separation. Realist approaches can delimit the meaning of security quite tightly for analytical purposes, but only at the cost of effacing an array of deeper entanglements in which security is always already implicated – in its case all the threats posed by non-military dangers, as well as the all the other forms of transnational connectivity (ecological, financial, epidemiological, etc.) that ultimately shape peoples' security around the world.

This same 'cost' or 'loss' also afflicts more 'critical' approaches like securitisation theory. There too the meaning of security is again fixed at the outset (albeit very differently) in the form of a fairly tightly delineated speech act – with a specific grammar consisting of referent objects of security, claims about existential threats to those referent objects, calls for the adoption of emergency measures, and so forth.[90] Notwithstanding this radically different methodological staring point, securitisation theory also consciously and deliberately delimits the 'form' of security because, according to one of its leading proponents, 'only through clearly defined operations does anything emerge with clarity; even the limit of a concept is more informative than the lack of any clear distinction'.[91]

As with structural realism, moreover, achieving such stable meaning and ontological boundaries of security only becomes possible through a series of exclusionary processes that end up effacing some of security's deeper entanglement with other phenomena. According to the Copenhagen School, the security speech act is thus 'not defined by uttering the word *security*. What is essential is the designation of an existential threat requiring emergency action or special measures and the acceptance of that designation by a significant audience'.[92] Focusing on this highly specific discursive grammar of the 'security' speech act certainly endows the framework with a high degree of analytical focus that it can then carry over across many different sectors of security.[93] Yet it can only do so at the 'cost' of analytically excluding all the instances where actors may mobilise the term 'security' in ways that do not readily conform to this particular grammar, but which may still be politically significant – whether these are wider claims about environmental security, health security, and human security that do not, for instance, explicitly call for the adoption of 'extraordinary' measures; or all those little security 'nothings' that do not pass the threshold of the formal speech act grammar but are nevertheless highly significant politically.[94] Here, too, there is thus a significant degree of loss involved in conceptually delimiting the boundaries of security from the outset.

Like structural realism, moreover, securitisation theory then also relies upon a second (and even wider) act of ontological 'dis-entanglement' in order to tightly delimit its theoretical framework – the separation between the fields of 'security' and 'politics'. Security, according to securitisation theory, 'is the move that takes politics beyond the established rules of the game and frames the issue either as a special kind of politics or as above politics'.[95] In a way that demonstrates both the scholarly desire to (but also the inherent ontological instability of) separating

[90]See Buzan, Wæver, and de Wilde, *Security*.

[91]Wæver, 'Politics, security, theory', p. 469.

[92]Buzan, Wæver, and de Wilde, *Security*, p. 27.

[93]See also, Wæver, 'Politics, security, theory', p. 469.

[94]See, Jef Huysmans, 'What's in an act? On security speech acts and little security nothings', *Security Dialogue*, 42:4–5 (2011), pp. 371–83.

[95]Buzan, Wæver, and de Wilde, *Security*, p. 23; See also, Michael C. Williams, 'Words, images, enemies: Securitization and international politics', *International Studies Quarterly*, 47:4 (2003), pp. 511–31.

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security out in this way, securitisation theorists argue that 'although in one sense securitization is a further intensification of politicization …, in another sense it is *opposed to* politicization'.[96] In order to establish itself as an alternative analytical framework for studying security, and to plot a 'viable' path between the 'narrowers' and the 'wideners', securitisation theory too ends up separating security out ontologically through a set of exclusionary moves. Securitisation theory has to 'draw the line'[97] between security and other spaces where issues are 'merely' politicised or even non-politicised, by offering an 'operational method for distinguishing the process of securitization from that of politicisation'.[98] Again, however, that also leads to an analytical of loss in terms of the rich entanglements that frequently traverse politics and security. As with structural realism, moreover, these two ontological separations – between the formal speech act and mere utterances of the word 'security', as well as between the wider domains of security and politics – have formed the basis for many of the theory's major critiques over the past two decades.

By conceptually fixing the boundaries of security in advance, then, some of the discipline's most influential theories of security are unable to capture security's deeper ontological entanglement. More worryingly still, their powerful conceptual 'dis-entanglements' actively contribute to its occlusion. At best, those prominent security theories can achieve a '*local* resolution *within* the phenomenon of the inherent ontological indeterminacy';[99] and there will thus always be a degree of onto-epistemic loss involved in so doing. 'One can't simply bracket (or ignore) certain issues', Karen Barad argues, 'without taking responsibility and being accountable for the constitutive effects of these exclusions.'[100]

Greater understanding of security's entangled ontological nature, by contrast, suggests – to paraphrase Barad – that security 'is not a pre-existing object of investigation with inherent properties'; rather it needs to be approached and studied as 'a phenomenon that is constituted and reconstituted out of historically and culturally specific iterative intra-actions'.[101] That ultimately necessitates a very different approach to the study of security – one that accepts and acknowledges its deeper ontological entanglement, rather than trying to exclude, efface, or otherwise occlude it. In practical terms, this means resisting the temptation to commence the study of security by positing a set of fixed differences that set security apart from other fields or phenomena, and becoming much more sensitive to the subtle ways in which the differences between security and other fields are continuously made and remade, as well as stabilised and destabilised over time.[102] Moving forward, the field of Security Studies must examine more closely the manifold processes through which security comes to intra-actively materialise in international relations.

That work has already commenced here by analysing the specific intra-action between security and science unfolding within the context of the controversial H5N1 experiments. Yet those processes of intra-active materialisation are not confined to the ones between security and science. Considerable *prima facie* evidence has already accumulated to suggest they occur in many other areas of security as well. Several security scholars working across diverse domains have shown (albeit in very different ways) that 'security' is continuously shaped and contoured by its mutual engagement with an array of wider agencies and phenomena, even if they have not explicitly approached or framed their studies in the spirit of agential realism. Scholars of

[96]Buzan, Wæver, and de Wilde, *Security*, p. 29, emphasis added

[97]Ibid., p. 21.

[98]Buzan, Wæver, and de Wilde, *Security*, p. vii.

[99]Karen Barad, 'Posthumanist performativity: Toward an understanding of how matter comes to matter', *Signs: Journal of Women in Culture and Society*, 28:3 (2003), p. 815.

[100]Barad, *Meeting the Universe Halfway*, p. 58.

[101]Ibid., p. 217.

[102]Karen Barad, 'Matter feels, converses, suffers, desires, yearns and remembers', in Rick Dolphijn and Iris van der Tuin (eds), *New Materialism: Interviews & Cartographies* (Open Humanities Press, 2012), pp. 48–70.

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environmental security, for example, have described what they call the 'climatization' of security.[103] Scholars of health security have similarly produced alternative accounts of the 'medicalization', 'pharmaceuticalization', and 'governmentalization' of security.[104] Others still have also analysed the 'ethicalization' of security,[105] the 'genderization' of security,[106] the 'economization' of security,[107] and so forth. Collectively, these (so far largely disparate) accounts suggest that what is true about the particular relationship between security and science, is also true about the ontological nature of security much more generally. 'Security' continuously materialises in intra-action with other agencies, and is always already part of a wider 'entanglement – the ontological inseparability – of intra-acting agencies'.[108]

Conclusion

The controversial H5N1 experiments challenge and disrupt the conventional understanding of the security-science relationship found within many of the field's most prominent security theories. Analysing those experiments with the help of interdisciplinary STS methods reveals that science is not merely a secondary, if clearly important, factor in security. Rather, science can also be directly constitutive of security and insecurity in international relations – rendering the 'two' domains ontologically much more deeply and powerfully entangled than is generally recognised. That is not to suggest that science can be treated as a unified field, nor that 'that there are no separations or differentiations', but it is to suggest 'that they only exist within relations'.[109]

If that is true, then moving forward the field of Security Studies needs to approach the scholarly study of security as a much more intensely relational and ontologically entangled phenomenon that does not exist prior to, nor independently of, its intra-action with other agencies. Security's 'mattering' is always a 'boundary articulation' that enacts 'a resolution within the phenomenon of some inherent ontological indeterminacies to the exclusion of others. That is, intra-actions enact "agential separability" – the condition of exteriority-within-phenomena.'[110] For that reason agential realism also 'does not start with a set of given or fixed differences, but rather makes inquiries into how differences are made and remade, stabilized and destabilized, as well as their materializing effects and constitutive exclusions'.[111] Rather than occluding security's ontological entanglement, in other words, it could be highly productive to mobilise co-productive STS methods more widely in Security Studies, to develop a broader range of analyses into the diverse dynamics, processes, mechanisms, and sites through which security comes to intra-actively materialise in international relations.

Teasing out this intricate materialisation of security will inevitably entail the opening up of new, and by disciplinary standards quite unconventional, sites of study. In the specific case of the intra-action between security and science, for example, we have already seen that this materialisation of security can unfold through public controversies. With the added benefit of hindsight, it is striking just how much intense 'boundary work' that controversy actually performed in terms

[103]Angela Oels, '"Securitization" of climate change to "climatization" of the security field: Comparing three theoretical perspectives', in Jürgen Scheffran *et al.* (eds), *Climate Change, Human Security and Violent Conflict, Hexagon Series on Human and Environmental Security and Peace* (Berlin: Springer-Verlag, 2012).

[104]Elbe, *Virus Alert*; Elbe, *Security and Global Health*; Elbe, *Pandemics, Pills and Politics*.

[105]Rychnovska, 'Governing dual-use knowledge'.

[106]Gunhild Hoogensen Gjørv and Svein Vigeland Rottem, 'Gender identity and the subject of security', *Security Dialogue*, 35:2 (2014), pp. 155–71.

[107]Michael Rühle, 'The economization of security: a challenge to transatlantic cohesion', *American Foreign Policy Interests*, 35:1 (2013), pp. 15–20.

[108]Barad, 'Intra-action'.

[109]Ibid.

[110]Ibid.

[111]Ibid.

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of drawing sharp, and even binary, dividing lines between 'science' and 'security'.[112] The H5N1 controversy therefore played a critical role in actively 'disentangling' security from science, and in 'producing' them as separate fields and phenomena. If we are to study how differences are continuously made and stabilised around security, then the public controversy around the H5N1 experiments represents a highly pertinent site where the ontological separation of security from other agencies has been effected (in the case of science).

All the more so because the H5N1 controversy is far from being the only such controversy. Prior to those notorious H5N1 experiments, a different scientific paper submitted to the journal *Science* had already caused similar controversy by detailing how research groups reconstructed the 1918 H1N1 influenza virus, which caused more than an estimated fifty million deaths.[113] Before that, yet another controversy erupted when researchers created a poliovirus from scratch, using publicly available sequence information and components acquired through online 'mail order' sites.[114] Nor has the H5N1 controversy proved the last such controversy. Similar concerns were triggered once again in 2017, when it emerged that an American biotechnology company successfully synthesised horsepox virus in its efforts to develop a safer vaccine against smallpox, but which could also increase the risk of smallpox being reintroduced into the human population and leading to a potential global health 'disaster'.[115] The cumulative frequency of such scientific controversies suggests that they are highly significant sites where 'security' materialises intra-actively in world politics. Yet because 'different intra-actions produce different phenomena',[116] it will be just as important to deploy co-productive methods more widely in order to closely study all the additional dynamics, mechanisms, sites, and processes through which security intra-actively materialises in relation to other agencies in international relations – like environmental security, cyber security, energy security, and so forth.

This ongoing study of 'entangled' security finally also entails cultivating a different scholarly ethos in the theoretical exploration of security – one that acknowledges the ways in which our theories are themselves always already part of its intra-active materialisation. The materialisation of security is not something that just happens 'out there' in the world, but also unfolds through our scholarly theories and conceptualisations of security. Theories of security are not just analytical tools for studying security, but crucial participants in its intra-active materialisation that perform agential 'cuts' enacting the separability of 'security' in international relations. Our security theories are 'not mere observing instruments but boundary drawing practices – specific material (re)configurations of the world – which come to matter'.[117] A scientific analogy drawn from quantum physics may be helpful here. According to the famous Danish physicist Nils Bohr, whose thinking on particle physics serves as a key inspiration for Barad, 'uncertainty' is not just epistemic (as it was for his interlocutor Heisenberg) but ontic – in the sense that a given particle does not exist in a fixed state prior to the act of measurement; it only begins to take on properties through the process of observation.[118] In Barad's reading, 'Bohr is saying that things are indeterminate; there are no things before the measurement, and that the very act of measurement produces determinate boundaries and properties of things.'[119]

[112]See Thomas F. Gieryn, 'Boundary-work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists', *American Sociological Review* (1983), pp. 781–95; Barad, *Meeting the Universe Halfway*, p. 140.

[113]Osterholm and Olshaker, *Deadliest Enemy*, p. 115.

[114]Jennifer Couzin-Frankel, 'Poliovirus baked from scratch', *Science* (11 July 2002), available at: {http://www.sciencemag.org/news/2002/07/poliovirus-baked-scratch} accessed 27 February 2019.

[115]Gregory D. Koblentz, 'The de novo synthesis of horsepox virus: Implications for biosecurity and recommendations for preventing the reemergence of smallpox', *Health Security*, 15:6 (2017), pp. 620–8.

[116]Barad, *Meeting the Universe Halfway*, p. 58.

[117]Ibid., p. 140.

[118]Barad, *Meeting the Universe Halfway*, pp. 19, 116; Gregory Hollin, Isla Forsyth, Eva Giraud, and Tracey Potts, '(Dis)entangling Barad: Materialisms and ethics', *Social Studies of Science*, 47:6 (2017), pp. 918–41.

[119]Barad, 'Matter feels, converses, suffers, desires, yearns and remembers'.

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In many ways our scholarly theories of security 'do' the same thing to 'security' that Bohr argues measurement 'does' to a particle. The discipline's leading security theories also enact particular agential cuts that separate 'security' out from its radically entangled state, and begin to endow it with particular properties. Those theories too must therefore be considered apparatuses, which 'are not mere static arrangements *in* the world, but rather … *dynamic (re)configurings of the world, specific agential practices/intra-actions/performances through which specific exclusionary boundaries are enacted*'.[120] If that is true, then our knowledge about security will always remain imperfect at best, and 'our knowledge-making practices are [themselves] material enactments that contribute to, and are part of, the phenomenon we describe'.[121] As scholars of security we are ultimately part of, and have responsibility for, the phenomena we try to understand.

Author ORCIDs. Stefan Elbe, 0000-0002-5567-5262

Stefan Elbe is Professor of International Relations and Director of the Centre for Global Health Policy at the University of Sussex. He is author of *Pandemics, Pills and Politics: Governing Global Health Security* (Johns Hopkins University Press, 2018); *Security and Global Health* (Polity, 2010), *Virus Alert: Security, Governmentality and the AIDS Pandemic* (Columbia University Press, 2009); and *Strategic Implications of HIV/AIDS* (Oxford University Press, 2003).

Gemma Buckland-Merrett is an Epidemiologist with a multidisciplinary background in immunology, infectious disease, and public health. She has worked globally in academic, NGO, and government institutions leading and conducting research on infectious disease surveillance, health system strengthening, and access to medicines.

[120]Barad, 'Posthumanist performativity', p. 816.
[121]Barad, *Meeting the Universe Halfway*, p. 247.

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