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

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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' experiments that scientists performed with lethal H5N1 flu viruses. Utilizing methodological approaches recently developed in the field of Science and Technology Studies (STS), the article teases out 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 analyze the diverse sites, dynamics, and processes through which security and insecurity come to intra-actively materialize in international relations. It also demands a fundamental reconsideration of many of the discipline's most prominent security theories – not as mere conceptual tools for studying security, but as crucial sites in that intra-active materialization of security.

Entangled Security:

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Existence is not an individual affair.

– Karen Barad (2007: ix).

Introduction

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 (van Munster 2016). 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 (Youde 2013; Rappert 2014; Rychnovská 2016). This underlying problem of 'dual use' research has vexed scholars and practitioners ever since, giving rise to a variety of different meanings and applications of the concept over time (see Atlas and Dando 2006; Suk et al. 2011; Tucker 2012).

Other scientific discoveries with similarly revolutionary potential abound in the twenty-first century (NAS 2018). 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 (Edwards et al. 2014). Natural outbreaks – and *human* deaths – from infection with such H5N1 'bird flu' viruses were first detected in Hong Kong in 1997, re-appeared in 2003, and then began spreading to other countries. According to the World Health Organization (WHO), the mortality rate amongst people infected with H5N1 was around 60% (WHO 2011). The only 'good' news was that persons contracting H5N1 appeared to be those in close and direct contact with infected birds. The virus, in other words, 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.

   Yet this uneasy 'pre-pandemic' state of affairs also generated an intriguing scientific question: is it possible for these deadly H5N1 viruses to ever mutate in ways that would actually 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 find out 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' (Enserink 2011b). Two scientific teams worked in parallel utilizing 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 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' were quickly 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 (see Maher 2012).

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 in general: 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 recent STS scholarship of Karen Barad. The article next demonstrates, through more detailed analysis of the H5N1 experiments, how security's ontological 'entanglement' can be analytically teased out, illustrated and captured through the use of 'co-productive' STS methods. Finally, the article shows how 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 securitization 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 materialize in international relations. It also, the article concludes, requires a fundamental reconsideration of those prominent security theories – not only as mere conceptual

tools for studying security, but as crucial sites in that intra-active materialization of security.

1. 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 is ontologically separate from, and largely subordinate to, the logics of security. Structural realism, for example, acknowledges that science can be an 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 in security for realist accounts; but it mostly becomes relevant only via an intermediary step of translation whereby new scientific knowledges first have to be intentionally converted into weaponized technologies (e.g. the Manhatten 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 much more fundamental source of insecurity in international politics (Waltz 1979). 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' (Leese 2017: 3). Science is clearly important; but it is ultimately also something separate from, and even subordinate to, the overriding security logics of anarchy.

This same separate and subordinate way of thinking about the role of science in security can also be found in more 'critical' approaches to security like securitization

theory. There too science is considered to be an important factor, albeit again also one that is largely separate from – and ultimately subordinate to – security. Securitization theory affirms the important role of science when it acknowledges that scientists can underpin securitization moves by providing an 'authoritative assessment of threat for securitizing or desecuritizing moves' (Buzan et al. 1998: 72). Berling (2011: 385) has also usefully described in much greater 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' (see also Rychnovska et al. 2017: 3). Securitization theory too therefore accords science an important role, yet again it also conceives of this role largely as a secondary or subaltern one, principally geared toward epistemically 'confirming' or 'denying' the securitizing moves and speech acts made by securitizing actors in relation to other existential threats (Waever 2011: 474).

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. Crucially, according to the STS scholar 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' (Barad 2007: ix). 'Entanglement' here 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' (Barad 1996: 172). '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"' (Barad 2007: 135).

Working at the intersection the 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 (Barad 2007: 141). 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' (Barad 2007: 33). 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' (Barad 2007: 33). 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)' (Barad 2012a). 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*' (Barad 2007: 33).

Barad is not directly concerned with the study of security in her work, which is principally oriented towards theorizing the wider relationship between discursive practices and the material world (Barad 2007: 28). That is also the main way in which her broader framework of agential realism has been appropriated by IR scholars to date (see Aradau 2010; Squire 2015). Yet her underlying notion of ontological

'entanglement', with its corresponding emphasis on 'intra-active' materialization, can also help to analytically capture the intensely relational ontological nature of security. Extending her conceptual framework of agential realism to the study of security (and its particular relationship to science) thus suggests that security, too, cannot really be considered a pre-formed and ontologically separate field that exists prior to its mutual interaction with science. Rather, 'security' materializes through 'science' via an intensely relational encounter (and vice versa): 'it is through specific agential intra-actions that the boundaries and properties of the components of phenomena become determinate and that particular concepts … become meaningful' (Barad 2007: 139). The boundaries of security are never given or self-evident, but only become stabilized through continuous processes of intra-active materialization.

How, then, can the study of security methodologically tease out, capture and explore this deeper ontological entanglement? The idiom of 'co-production', widely deployed by STS scholars to highlight the inherent difficulties in separating science out from its wider social context, shows 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' (Jasanoff 2004: 2). Scholars working through this methodological idiom of co-production reject the view of science as 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 (Jasanoff 2004:2-3).

Like Barad, scholars of co-production in STS 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 (for pioneering exceptions see Callon and Law 1992; Hurt 2011; Hester 2016; Howell 2017). This lacuna has already led some scholars to call for much closer engagement between STS and security studies (Rappert, Balmer and Stone 2008: 732). The controversial H5N1 experiments mark a valuable opportunity to do precisely that. Indeed, adopting a more interdisciplinary STS perspective to explore this scientific controversy can 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 thereby revealed to be 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 (in this case science). Bringing co-productive STS methods to bear on the study of security can, in short, divulge its deeper ontological entanglement.

2. 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 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 (Caduff 2015; Lakoff 2017; Elbe 2018).

Yet the dreaded H5N1 pandemic did not materialize. 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 experiments in order to answer this scientific 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 behaviors 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 utilizing 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 amongst 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' (Harmon 2011). 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 largely construing 'science' and 'security' as separate fields coming into direct conflict with one another, thus reflecting the wider view of 'science' and 'security' as separate phenomena also found in 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 (Selgelid 2016). Fouchier himself had reportedly warned that this is 'probably one of the most dangerous viruses you can make' (Enserink 2011a). Yet the scientists countered that discovering 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 further 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 (Enemark 2017a: 63). As one molecular biologist working on biosecurity issues argued unequivocally at the time: 'this work should never have been done' (Ebright, quoted in Enserink 2011a).

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 specialized US advisory board advising on 'dual use' research which 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 (NIH 2011). 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 one' (Enserink 2011a). 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 (Youde 2013).

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 60 days, so as to allow more time for discussion and deliberation (Fouchier et al. 2012). 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 came to 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 (WHO 2012). 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 (Shaw 2016; Enemark 2017b: 82-83). 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 (Enemark 2017a).

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, whilst 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 (NSABB 2012). Opinion remained more split on the Fouchier paper, however, with 12 members voting in favor 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 (Walsh 2012). Both scientific studies were therefore published in

the end, and in January 2013 (a whole year after announcing their initial 60-day voluntary moratorium) the scientists finally declared that they would now resume their experiments once again (Fouchier et al. 2013). 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, then, one of its most striking and notable aspects is undoubtedly how it largely portrayed science and security as separate professional fields with conflicting interests (Buchanan and Kelley 2013; Rappert 2014) – as if the two were engaged in some kind of zero-sum game (Enemark 2014; see also Smith 2014). Scholars and commentators thus argued how the controversy generated 'a fundamental question in the balance between academic freedom and biosecurity' (Enserink 2015; see also Lakoff 2012 and Rappert 2014: 4). Security officials (and even some scientists) were also fearful that publication of the data posed potentially significant dangers to national security (Hurlbut 2017: 9). Many other scientists, in turn, remained apprehensive 'that security motivated restrictions or oversight measures might unduly jeopardize the advancement of science' (Rappert 2014: 2). 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. This overarching narrative of

'science' versus 'security' in the public controversy thus came to embody and reflect the very same underlying view of science and security as separate phenomena that also runs through many prominent security theories – like realism and securitization theory.

3. Security/Science: The Co-Production of Security *and* Science

Beneath the public surface of this controversy, however, there also lurk a myriad of subtler dynamics through which 'security' and 'science' actually 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 U.S. 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 much wider 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' (Hurt 2011: 52). 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 (Kay 2000: 10).

This culture of extensive public funding for scientific research became further entrenched amidst 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 (Vettel 2006). 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) in the process. Between 1957 and 1963 the budget of the National Institutes of Health (NIH) thus increased by an average of 40 percent annually, increasing fiscal appropriations from $98 million 1956 to $930 million in 1963 (Kay 2000: 13). This 'Sputnik Effect', whereby the United States feared it was being outpaced by its principal geopolitical adversary, was critical to entrenching the culture of extensive *public* funding for basic science research in the United States (Bartfai and Lees 2013: 173). Those financial connections between security and the life sciences would remain salient throughout the 1970s, as government officials became acutely aware that a dynamic biotechnology industry (with the heavy involvement of scientists and universities) would also help to create a 'reservoir' of expertise and technology to draw upon for defensive security purposes areas (Hurt 2011; Hurt 2016; Hester 2016).

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 (Kay 1993, 2000; Vettel 2006). 'The entire history of molecular biology', Michael Kenney reminds his readers, is one 'of federal funding of "basic research"' (Kenney 1986: 241). The life sciences would simply not be recognizable in their current form without the crucial role played by the national security state (Weiss 2014). 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' (Mukerji 1989: 4). All of this brings into relief a fascinating

set of intermingled 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 much 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 characterized by increased globalization, 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 globalized 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 (Elbe 2009, 2010; Kamradt-Scott and McInnes 2012). Life scientists even encouraged this transformation in threat perceptions, with an influential scientific movement from the early 1990s (led by prominent scientists like Joshua Lederberg) actively warning governments about the renewed threat posed by such emerging and re-emerging infectious disease outbreaks (King 2002: 766-67; King 2004; Lakoff 2008). Those underlying transformations in understandings of national security 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 (Elbe 2010; Rushton and Youde 2014).

The controversial H5N1 experiments were squarely rooted within this rapidly evolving health security agenda. After all, the experiments were explicitly designed to improve scientific understanding of the threat of pandemic flu by elucidating the molecular processes involved in viral transmission (Bennett 2015) – indicating that scientists had already internalized such security logics at the very point of conceiving these experiments. Andrew Lakoff further highlights how the US government's 2005 *Pandemic Influenza Preparedness and Response Plan* also explicitly pointed to the need for more basic scientific research on influenza, and envisioned that the National Institutes of Health (NIH) would actively support more scientific research on the virus and its virulence (Lakoff 2016: 2). The controversial 'gain-of-function' experiments performed by the Kawaoka and Fouchier teams were thus 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' (Herfst et al. 2012: 1535; see also Imai et al. 2012: 420). From their very inception, the controversial H5N1 experiments were therefore funded, justified, rationalized, 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 much 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 been

internalized by the scientists prior to carrying them out. Security considerations generated the scientific question at the center 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, merely forms the first half of the story, because there are also further, mirroring and equally powerful 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.

4. From Twins to Triplets: Dangerous Science and Dual Use Research of Concern

Just as security considerations formed the broader social 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 quickly fed back into the very same 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 and exacerbated widely percolating fears about the pandemic flu threat. The experiments thus seemed to scientifically 'prove' that H5N1 viruses do in fact 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 pandemics in humans' (Herfst et al. 2012: 1541). The paper of Kawaoka's team similarly confirmed 'the pandemic potential of viruses', and emphasized 'the need to prepare for potential pandemics ….' (Imai et al. 2012: 427, 420). 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 experiments revealed how only a few key mutations (around a handful) would in fact be needed for the viruses to become 'airborne'. More worryingly still, and as the studies further pointed out, some of those critical mutations had already been spotted occurring in nature. Overall, Fouchier thus reportedly put it in the simplest but most poignant of terms at an international scientific conference in

Malta, it was 'very bad news' (Harmon 2011). 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' (Davis 2005). 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 (see also Everts 2013). 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 through 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 utilize 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 U.S. postal system in September 2001 (King 2003). 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 (Franz and Zajtchuk 2002).

Here the 'successful' H5N1 experiments now raised additional security concerns by opening up the prospect of this scientific knowledge also 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' (Enserink 2011a). 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' (Caduff 2015: 110). As news of the experiments spread, analysts in the U.S. intelligence community thus quickly scrambled to assess the potential security ramifications of the pending publication of these experiments (Vogel 2013/14: 40-41). Yet all of this also 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 specter of a bioterrorist attack by developing a scientific 'road map' for how to design airborne transmissible H5N1 viruses.

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 (Enemark 2017b: 51). 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 (Enemark 2017b: 30-31). 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 (GAO 2016: 1). 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 realize 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. The dangers emanating from the H5N1 experiments seemed to be qualitatively different from the 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 was carried out in military research laboratories, without the intention of disseminating the findings publicly (Osterholm 2017: 114). 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 (Connel and Rappert 2016: 258). 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 (Samimian-Darash et al. 2016).

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 element that shapes health security discourses, to fast becoming a central *object* and even target of such security discourses. New conceptual vocabularies now

began to emerge 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 now 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 (see Lipsitch and Inglesby 2014). Funding for such 'gain of function' experiments on influenza, SARS and MERS viruses was eventually even 'paused' altogether by the Obama administration in 2014, so as to allow more time for new guidelines to be developed (Selgelid 2016: 923). Such new government policies for regulating the dangers posed by scientific research were then introduced – like the new *Framework for Guiding Funding Decisions about Proposed Research Involving Enhanced Potential Pandemic Pathogens* (HHS 2017).

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, moreover, 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' (Porter 2016: 23).

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 weaponized and/or used to epistemically objectivise securitizing 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 sharp 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, these co-productive dynamics between science and security run sufficiently deep to point towards an 'ontological inseparability of agentially intra-acting components' (Barad 2007: 33), making it necessary to think of them as forming part of an ontologically entangled whole: 'entangled' security.

5. Entanglement, Co-Production and Intra-Active Security Studies

What, then, does the wider study of security gain from recovering this ontological entanglement? This deeper 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 does this, for example, 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 (see, for example, Walt 1991, 2010). Delimiting the meaning of security in this way inevitably leads to the

exclusion of many non-military phenomena (e.g. 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' (see Walt 1991; Buzan et al. 1998: 3-4).

On a deeper level, moreover, the whole political edifice of formal 'anarchy' that is 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 initially 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. For realist theories, security is therefore essentially concerned with the management of the insecurity that ultimately 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 securitization 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 very particular 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 (see Buzan et al. 1998). Notwithstanding this radically different

methodological staring point, securitization theory too 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 ….' (Waever 2011: 469).

As with structural realism, moreover, achieving such stable meaning and 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*' (Buzan et al. 1998: 27). 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 (see also Waever 2011: 469). Yet it can only do so at the 'cost' of analytically excluding all the instances where actors may mobilize 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 (see Huysmans 2011). 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, securitization theory then also relies upon a second and even wider act of ontological 'dis-entanglement' in order to tightly delimit the theoretical framework – the separation between the fields of 'security' and 'politics'. Security, according to securitization 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' (Buzan et al. 1998: 23; see also Williams 2003). In a way that demonstrates both the scholarly desire to (but also the inherent ontological instability of) separating security out in this way, securitization theorists argue that 'although in one sense securitization is a further intensification of politicization …, in another sense it is *opposed to* politicization' (Buzan et al. 1998: 29; emphasis added). 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', securitization theory too ends up separating security out ontologically through a set of exclusionary moves. Securitization theory has to 'draw the line' (Buzan et al. 1998: 21) between security and other spaces where issues are 'merely' politicized or even non-politicized, by offering an 'operational method for distinguishing the process of securitization from that of politicisation ….' (Buzan et al. 1998: vii). Again, however, that 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 simply unable to capture security's deeper ontological entanglement. More worryingly still, their powerful conceptual 'dis-

entanglements' end up actively contributing to the further occlusion of this deeper ontological entanglement. At best, those prominent security theories can achieve a '*local* resolution *within* the phenomenon of the inherent ontological indeterminacy' (Barad 2003: 815); 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,' Barad argues, 'without taking responsibility and being accountable for the constitutive effects of these exclusions' (Barad 2007: 58).

Greater atunedness to 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 ought to be approached and studied as 'a phenomenon that is constituted and reconstituted out of historically and culturally specific iterative intra-actions ….' (Barad 2007: 217). 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 stabilized and destabilized over time (Barad 2012a). Moving forward, the field of Security Studies thus needs to examine much more closely the manifold processes through which security comes to intra-actively materialize 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 materialization are not at all confined

to the ones found to be at play here between security and science. Considerable *prima facie* evidence has already accumulated to suggest that 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 environmental security, for example, have described what they call the 'climatization' of security (Oels 2012). Scholars of health security have similarly produced alternative accounts of the 'medicalization', 'governmentalization' and 'pharmaceuticalization' of security (Elbe 2009, 2010, 2018). Others still have also analyzed the 'ethicalization' of security (Rychnovska 2016), the 'genderization' of security (Hoogensen and Rottem 2004), the 'economization' of security (Ruehle 2013), and so forth. These (so far largely disparate) accounts collectively 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 materializes in intra-action with other agencies, and is always already part of a wider 'entanglement – the ontological inseparability – of intra-acting agencies' (Barad 2012a).

Conclusion

The controversial H5N1 experiments ultimately disrupt and challenge the conventional understanding of the security-science relationship found within many of the field's most prominent security theories. Analyzing those experiments with the help of interdisciplinary STS methods shows 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 recognized. This 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' (Barad 2012a).

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' (Barad 2007: 178). For that very 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' (Barad 2012a). Instead of occluding security's ontological entanglement, it could therefore be highly productive to mobilize co-productive STS methods much more widely in Security Studies, so as to develop a broader range of analyses into the diverse dynamics, processes, mechanisms and sites through which security comes to intra-actively materialize in international relations.

Teasing out this intricate materialization of security will inevitably entail the opening up 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 materialization of security can unfold through public controversies. With the added benefit of hindsight, it is striking just how much intense 'boundary work' that controversy performed in terms of drawing sharp, and even

binary, dividing lines between 'science' and 'security' (see Gieryn 1983; Barad 2007: 140). The H5N1 controversy therefore played a critical social 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 stabilized 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 50 million deaths (Osterholm 2017: 115). 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 (Couzin-Frankel 2002). Nor has the H5N1 controversy proved to be the last such controversy. Similar concerns were triggered once again in 2017, when it emerged that an American biotechnology company successfully synthesized 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' (Koblentz 2017). The cumulative frequency of such scientific controversies suggests that they are highly significant sites where 'security' materializes intra-actively in world politics. Yet because 'different intra-actions produce different phenomena' (Barad 2007: 58), it will be just as important to deploy co-productive methods much more widely in order to also closely study all the additional dynamics, mechanisms, sites and processes through which security intra-

actively materializes 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 materialization. The materialization of security is not something that just happens 'out there' in the world, but occurs through our scholarly theories and conceptualizations of security as well. Theories of security are not just analytical tools for studying security, but themselves perform agential 'cuts' that help enact 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' (Barad 2007: 140). 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 (Barad 2007: 19, 116; Hollin et al. 2017). 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' (Barad 2012b).

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_' (Barad 2003: 816). 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' (Barad 2007: 247). As scholars of security we are ultimately part of, and also have responsibility for, the phenomena we try to understand.

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