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A World without Causation: Big Data and the Coming of Age of Posthumanism

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Abstract

Advocates of Big Data assert that we are in the midst of an epistemological revolution, promising the displacement of the modernist methodological hegemony of causal analysis and theory generation. It is alleged that the growing 'deluge' of digitally generated data, and the development of computational algorithms to analyse them, has enabled new inductive ways of accessing everyday relational interactions through their 'datafication'. This article critically engages with these discourses of Big Data and complexity, particularly as they operate in the discipline of International Relations, where it is alleged that Big Data approaches have the potential for developing self-governing societal capacities for resilience and adaptation through the real-time reflexive awareness and management of risks and problems as they arise. The epistemological and ontological assumptions underpinning Big Data are then analysed to suggest that critical and posthumanist approaches have come of age through these discourses, enabling process-based and relational understandings to be translated into policy and governance practices. The article thus raises some questions for the development of critical approaches to new posthuman forms of governance and knowledge production.

Keywords

Big Data, posthumanism, causation

Introduction

The world appears to be overflowing with data, following the 'data deluge', highlighted by *The Economist* in 2010,[1] and it is increasingly alleged that data-driven knowledge – Big

1. 'Data, Data Everywhere', *The Economist*, 15 February 2010. Available at: http://www.economist.com/node/15557443. Last accessed 26 February 2015.

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Data – is capable of changing the ways in which knowledge of the world is produced and thus the ways in which it can be governed. In International Relations, Big Data discussions have largely been based on excitement with regard to the possibilities of applying the knowledge generated by Big Data and technological and computational change to problem-solving in the international arena, particularly in the possible prevention of – and speedy responses to – disaster, conflict, health and environmental problems.[2] However, the potential uses of the knowledge gleaned from Big Data have been focused upon rather than its specific nature as knowledge itself.

This article seeks to take the debate on Big Data in International Relations forward by foregrounding an analysis of Big Data's epistemological claims and their ontological assumptions, rather than engaging with Big Data from already well-established critical positions, largely developed in the fields of politics and sociology.[3] For many critical theorists, epistemological and ontological claims are secondary to concerns raised with regard to civil liberties, privacy, ownership and access issues,[4] or when concerns with issues of knowledge production are raised they tend to quickly dismiss the claims of Big Data advocates on the basis that practical limits, regarding both the quantity and quality

2. See, for example, Chris Poulin, 'Big Data Custodianship in a Global Society', *SAIS Review of International Affairs* 34, no. 1 (2014): 109–16; John Karlsrud, 'Peacekeeping 4.0: Harnessing the Potential of Big Data, Social Media, and Cyber Technologies', in *Cyberspace and International Relations: Theory, Prospects and Challenges, eds.* Jan-Frederik Kremer and Benedikt Müller (London: Springer, 2014), 141–60; Gill Allouche, 'Spy Craft and Disease: Big Data's Impact on the Global Stage', *Smart Data Collective*, 30 April 2014. Available at: http://smartdatacollective.com/gilallouche/197721/spy-craft-and-disease-big-datas-impact-global-stage, last accessed 26 February 2015; Jonathan Bays, 'Harnessing Big Data to Address the World's Problems', *McKinsey on Society*, n.d. Available at: http://voices.mckinseyonsociety.com/harnessing-big-data-to-address-the-worlds-problems/. Last accessed 26 February 2015.
3. In this respect, the article follows the approach of Bruno Latour who argues that, despite the deficiencies and constraints of data collection and its imbrication within power relations, Big Data nevertheless opens up a powerful methodological alternative for 'flatter' forms of social theorising. See, for example, Bruno Latour et al., '"The Whole is Always Smaller than Its Parts" – a Digital Test of Gabriel Tardes' Monads', *British Journal of Sociology* 63, no. 4 (2012): 590–615; Venturini and Latour, 'The Social Fabric: Digital Traces and Quali-quantitative Methods', in *Proceedings of Future En Seine 2009: The Digital Future of the City*, ed. Ewen Chardronnet (Paris: Cap Digital, 2010), 87–101.
4. Andrej J. Zwitter and Amelia Hadfield, 'Governing Big Data', *Politics and Governance* 2, no. 1 (2014): 1–2; danah boyd and Kate Crawford, 'Critical Questions for Big Data: Provocations for a Cultural, Technological, and Scholarly Phenomenon', *Information, Communication & Society* 15, no. 5 (2012): 662–79; Kate Crawford et al., *Big Data, Communities and Ethical Resilience: A Framework for Action*, 24 October 2013. Available at: http://poptech.org/system/uploaded_files/66/original/BellagioFramework.pdf. Last accessed 26 February 2015. Some IR academics are involved, for example, in the large European Union Framework 7 Programme, 'Increasing Resilience in Surveillance Societies' (IRISS) which focuses on the counterproductive aspects of intrusive state data gathering and new forms of resistance and evasion. See also the work of the engine room academic collective: https://www.theengineroom.org/responsible-data-a-conceptual-framework/. Last accessed 26 February 2015.

of the data available, mean that these claims cannot be met.[5] While not denying the salience of these critiques, this article seeks to open up an alternative critical space for discussion through highlighting the broader cultural and socio-political sensitivities (often obscured behind the discussion of technological advances in data generation) – heuristically assembled here under the rubric of posthumanism[6] – which underpin the radical epistemological and ontological claims made on behalf of Big Data. Thus it suggests that the attractiveness of Big Data lies less in the serendipitous development of technological possibilities than in the growing dominance of posthumanist trends in social science; trends that are increasingly influential in the policy and practice of International Relations. In conclusion, it suggests that the rise of posthumanist ontologies, reified in discussions of Big Data as a technique of knowledge production and of governance, profoundly constrain the possibilities for politics: reducing governance to an ongoing and technical process of adaptation, accepting the world as it is.

Big Data

While there is no fixed definition of Big Data, analysts often mention the 3 'Vs' which characterise it: volume, velocity and variety. Big Data includes information from a multitude of sources, including social media, smart phones and mapping, visualising and recording equipment[7] and the number of data-sharing devices is growing exponentially. This hardware, collectively known as the 'Internet of Things', includes machine sensors and consumer-oriented devices such as connected thermostats, light bulbs, refrigerators, and wearable health monitors.[8] Data is thus being produced and used in increasingly

5. See, for example, Rob Kitchin, 'Big Data, New Epistemologies and Paradigm Shifts', *Big Data and Society* 1, no. 1 (2014): 1–12; boyd and Crawford, 'Critical Questions for Big Data'.
6. Posthuman understandings focus on process-orientated ontologies of becoming in which the human subject is much more 'attached' or relationally-embedded in the materiality of the world. This perspective is linked closely to speculative realism, to new materialist approaches and to actor network theory. See, for example, *Millennium: Journal of International Studies*, Special Issue 'Materialism and World Politics', 41, no. 3 (2013); Erika Cudworth and Stephen Hobden, *Posthuman International Relations: Complexity, Ecologism and Global Politics* (London: Zed Books, 2011); Rosi Braidotti, *The Posthuman* (Cambridge: Polity Press, 2013); Graham Harman, *Towards Speculative Realism: Essays and Lectures* (Winchester: Zero Books, 2010); Bruno Latour, *Reassembling the Social: An Introduction to Actor Network-Theory* (Oxford: Oxford University Press, 2005).
7. Google's Eric Schmidt claims that every two days now we create as much information as we did from the dawn of civilization up until 2003; see *TechCrunch*, 4 August 2010. Available at: http://techcrunch.com/2010/08/04/schmidt-data/. Last accessed 26 February 2015.
8. Jeff Bertolucci, '10 Powerful Facts About Big Data', *Information Week*, 10 June 2014. Available at: http://www.informationweek.com/big-data/big-data-analytics/10-powerful-facts-about-big-data/d/d-id/1269522. Last accessed 26 February 2015. As Evgeny Morozov notes: 'Thanks to sensors and internet connectivity, the most banal everyday objects have acquired tremendous power to regulate behaviour', 'The Rise of Data and the Death of Politics', *The Observer*, 30 July 2014. Available at: http://www.theguardian.com/technology/2014/jul/20/rise-of-data-death-of-politics-evgeny-morozov-algorithmic-regulation. Last accessed 26 February 2015.

diverse and innovative ways. The term 'Big Data' is capitalised to distinguish it (as a set of ideas and practices discursively cohered around a certain approach to knowledge production) from its use as a merely descriptive term for a large amount of data. Big Data thus is not used with reference to discussions about the volume of data per se; however, many authors argue that volume is relevant in terms of an analytical 'tipping point' or 'data threshold' where data gathering is no longer based upon selection and sampling with limited parameters but aspires to be exhaustive or becomes a closed data set, no longer requiring generative rules.[9]

Thus Big Data discursively refers to a qualitative shift in the meaning of data, in not just the amount of data (approaching exhaustiveness) but also its quality (approaching a dynamic, fine-grained relational richness). This data is very far from the abstract and reductionist constructions of data of the past:[10] but is increasingly understood as approaching 'reality' itself. Thus, Big Data transforms our everyday reality and our immediate relation to the things around us. This 'datafication' of everyday life is at the heart of Big Data: a way of accessing reality through bringing interactions and relationships to the surface and making them visible, readable and thereby governable, rather than seeking to understand hidden laws of causality.[11] Big Data is thereby generally understood to generate a different type of 'knowledge': more akin to the translation or interpretation of signs rather than that of understanding chains of causation.[12]

In science and computer sciences this increase in data gathering possibilities and development of computational capacity has enabled analysts to talk of a 'fourth paradigm' of knowledge production (beyond theory, experiment and simulation).[13] Thus Big

9. Alon Halevy, Peter Norvig and Fernando Pereira, 'The Unreasonable Effectiveness of Data', *IEEE Intelligent Systems* 24, no. 2 (2009): 8–12; 9. Available at: https://static.googleusercontent.com/media/research.google.com/en//pubs/archive/35179.pdf. Last accessed 26 February 2015.
10. See, for an excellent examination of the birth of statistical analysis, Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990).
11. Chris Anderson, 'The End of Theory: The Data Deluge Makes the Scientific Method Obsolete', *Wired Magazine* 16, no. 7, 23 June 2008. Available at: http://archive.wired.com/science/discoveries/magazine/16-07/pb_theory, last accessed 26 February 2015; Kenneth Neil Cukier and Viktor Mayer-Schoenberger, 'The Rise of Big Data: How It's Changing the Way We Think About the World', *Foreign Affairs*, May/June 2013. Available at: http://m.foreignaffairs.com/articles/139104/kenneth-neil-cukier-and-viktor-mayer-schoenberger/the-rise-of-big-data. Last accessed 26 February 2015.
12. Elena Esposito makes the useful analogy with pre-modern forms of prophetic or divinatory knowledge where surface phenomena are interpreted as signs rather than as causal effects. See 'Digital Prophecies and Web Intelligence', in *Privacy, Due Process and the Computational Turn: The Philosophy of Law meets the Philosophy of Technology*, eds. Mireille Hildebrandt and Katja de Vries (Abingdon: Routledge, 2013).
13. See Jim Gray's classic statement, cited in Wolfgang Pietsch, 'Big Data: The New Science of Complexity', in *6th Munich-Sydney-Tilburg Conference on Models and Decisions, Munich, 10–12 April 2013*, Philsci Archive, University of Pittsburgh, 2. Available at: http://philsci-archive.pitt.edu/9944/. Last accessed 26 February 2015.

Data appears to lack certain attributes of the modernist 'production process' of knowledge and appears as less mediated through conceptual apparatuses. As Rob Kitchin highlights, Big Data is unique in that its construction is not part of a conscious process of knowledge production.[14] Big Data is the mirror image, methodologically, of other large data gathering exercises, such as national censuses based upon 30 or 40 questions, designed to elicit comparative and analytical data for policy-making. Big Data is understood to be generated from complex life or reality itself in the data trails left from our digital footprints as we go about our everyday lives. The data is not generated through having a specific question or purpose in mind and is mostly a by-product or side-effect of activities undertaken in fields with technologically generated and stored records.[15] The analysis comes after the data is collected and stored, not prior to this. However, the fact that the data is not consciously generated, through the desire to test theories of models, is seen as an asset rather than a problem: 'Big Data analytics enables an entirely new epistemological approach for making sense of the world; rather than testing a theory by analysing relevant data, new data analytics seek to gain insights "born from the data"'.[16]

Wolfgang Pietsch usefully outlines how Big Data approaches differ methodologically from computer simulations, which rely (as does much of social science) on the deductive method: a sequence of theory-model-treatment-solver-results, derived from a general theory.[17] All computer simulations have in common a reliance on elaborate modelling assumptions that originate outside the computer, in terms of dynamic equations or rules of evolution, then specific values are assigned to the parameters and boundary conditions and translated into an algorithm to yield results. Rather than starting with the human and then going out to the world, the promise of Big Data is that the human comes into the picture relatively late in the process (if at all).[18] Instead of beginning deductively with an hypothesis or theory, which is then tested through experimentation and modelling, Big Data seeks to be more inductive and thereby to preserve more of the 'reality' left out by abstract and sometimes reductionist causal assumptions. The promise is that, with high levels of data generation and developments in computational analysis, the world (coded

14. Kitchin, 'Big Data, New Epistemologies and Paradigm Shifts', 2.
15. See also Cukier and Mayer-Schoenberger, 'The Rise of Big Data': 'Today, when we gather all the data, we do not need to know beforehand what we plan to use it for. Of course, it might not always be possible to collect all the data, but it is getting much more feasible to capture vastly more of a phenomenon than simply a sample and to aim for all of it. Big data is a matter not just of creating somewhat larger samples but of harnessing as much of the existing data as possible about what is being studied'.
16. Kitchin, 'Big Data, New Epistemologies and Paradigm Shifts', 2.
17. Pietsch, 'Big Data: The New Science of Complexity'.
18. As Aysadi (a Big Data computing firm working with the US Office of the Director of National Intelligence, amongst others) CEO, Gurjeet Singh states: '[C]ustomers can finally learn the answers to questions that they didn't know to ask in the first place. Simply stated… [it] is "digital serendipity"'. Cited in Liat Clark, 'No Questions Asked: Big Data Firm Maps Solutions Without Human Input', *Wired Magazine*, 16 January 2013. Available at: http://www.wired.co.uk/news/archive/2013-01/16/ayasdi-big-data-launch. Last accessed 26 February 2015.

through datafication) can begin to speak for itself without its (more than) fallible human interpreter. [19]

According to a much-cited article by former *Wired* editor, Chris Anderson, Big Data promises a world without the need for abstract theoretical models: 'Correlation supersedes causation, and science can advance even without coherent models, unified theories, or really any mechanistic explanation at all'.[20] In these accounts, theories of causation can be dispensed with and massive and real-time data trails can stand in as reliable knowledge of the relations on which policy and business decisions can be based. The possibility of data-intensive knowledge production informing policy developments has been broadly welcomed in International Relations, especially in the fields of disaster risk reduction, peacebuilding and resilience. The following sections draw out how Big Data is understood to assist in the development of new approaches to policy-making in the international sphere and the epistemological and ontological assumptions, which these depend upon. The article then considers the affinities that these assumptions share with critical and posthuman understandings, suggesting that the rise of Big Data can be understood as enabling posthumanism to come of age: to inform new ways of governing in the world based upon process-based understandings and relational ontologies.

The Governance of the Self [21]

This section is concerned with the claims made for Big Data in International Relations as a tool for problem-solving through community empowerment and capacity-building. International Relations theorists share much ground with colleagues in cognate disciplines in highlighting the empowering potential of Big Data as a way of democratising or redistributing and diversifying power and knowledge but, of course, also warn of the potential dangers of Big Data if it is misused by centralised authorities. It would not be difficult to scale up the Big Brother concerns to the global level.[22] However, understanding the

19. Ian Steadman, 'Big Data and the Death of the Theorist', *Wired Magazine*, 25 January 2013. Available at: http://www.wired.co.uk/news/archive/2013-01/25/big-data-end-of-theory. Last accessed 26 February 2015.
20. Anderson, 'The End of Theory'.
21. The title comes from Foucault's lecture series, which presciently engages with this shift to inner-directed knowledge and the need to tackle the 'deficit in the relationship of autonomy to oneself', *The Government of the Self and Others: Lectures at the Collège de France 1982-1983* (Basingstoke: Palgrave, 2010), 33; see also Peter Sloterdijk, *You Must Change Your Life: On Anthropotechnics* (Cambridge: Polity Press, 2013).
22. This is captured well in the 2014 Marvel Studios film *Captain America: The Winter Soldier*, in which World War II fascist ideologues infiltrate and take over the Earth's future global security governance with the aim of securing complete control through high-tech patrolling gunships informed by a data-mining algorithm that can identify and wipe-out all individuals who might become future threats. See also, Sheldon Himelfarb, 'Can Big Data Stop Wars Before They Happen?, *Foreign Policy*, 25 April 2014. Available at: http://www.foreignpolicy.com/articles/2014/04/25/can_big_data_stop_wars_preemptive_peace_technology_conflict, Last accessed 26 February 2015; Karlsrud, 'Peacekeeping 4.0'.

potential of Big Data on the basis of extensions of the Big Brother global state (in the form of international interventionist bodies) seems to run counter to general policy trends towards community responsibility and the need for community adaptation and resilience. Big Data discourses, in fact, suggest the outsourcing or redistribution of governmental agency rather than its centralisation. As Kate Crawford points out, it is 'the anxieties of Big Data' that seem most revealing:[23] there is a concern that data gathering is never going to be enough if governments govern in traditional ways. The discourse of Big Data seems to be inexorably drawn to reproducing its own methodological dynamic, data which cannot be used to govern from above, 'serendipitously' becomes a mechanism to enable governance 'from below'.

Not surprisingly, the rise of Big Data as a real-life policy solution (away from the commercial hype of deterministic predictions and total knowledge) is intimately linked not with the increase in governing responsibilities, based on centralised digital technologies of knowledge production and use, but the opposite: the conceived need to enable communities to govern themselves. The failure of centralised and bureaucratised forms of international intervention and external attempts to address international questions of peace, conflict, rights and development, has led to the imagination of Big Data as both an effective and an ethical substitute for traditional forms of international intervention, which are seen as too slow, too unwieldy and too reductionist to adequately engage with the concrete contextual realities of the world.[24] Big Data thus emerges not as a tool of international interveners equipped with predictive knowledge and able to redirect paths to development and peace but rather as a tool of local communities and 'civil societies', expected to generate their own knowledge of themselves and to act upon it accordingly.

In this discourse, the questions of privacy and intentionality lead not to an argument against the gathering of Big Data but to careful and strategic considerations of its use: 'to help build community resilience in the face of a range of stresses – environmental, political, social and economic.'[25] Thus, not only does Big Data ethically need to be owned and used by its producers, it is also argued that the producers of Big Data, in their concrete and relational interaction, are also in the best place to make use of Big Data findings: 'Large data collection and analysis may support communities by providing them with timely feedback loops on their immediate environment.'[26] The unmediated and context-specific nature of Big Data enable it to enable local communities to be proactive in their own governance, for example, in the ability to measure energy consumption, even located down to the energy consumption (from multiple sources of consumption) of individuals and households,[27] or in the local measurement of environmental attributes

23. Crawford, 'The Anxieties of Big Data', *The New Inquiry*, 30 May 2014. Available at: http://thenewinquiry.com/essays/the-anxieties-of-big-data/. Last accessed 26 February 2015.
24. See, for example, Ben Ramalingam, *Aid on the Edge of Chaos* (Oxford: Oxford University Press, 2013).
25. Crawford et al., *Big Data, Communities and Ethical Resilience*, 1.
26. Ibid.
27. See Annika Skoglund, 'Homo Clima: The Overdeveloped Resilience Facilitator', *Resilience: International Practices, Policies and Discourses* 2, no. 3 (2014): 151–67.

such as pollution, river levels and land use changes. Big Data is thus held to enable empowerment in new ways at the most micro levels due to the digitalisation or 'datafication' of life.[28]

Rather than centralising data produced through everyday interactions and applying algorithms that produce linear and reductive understandings, the aspiration of Big Data is that multiple data sources can enable individuals, households and societies to practice responsive and reflexive self-management in ways which were considered impossible before. In fields such as disaster risk reduction and disaster management the shift is already clear. Big Data is alleged to help knowledge enable the people themselves rather than for them to provide knowledge to others. Thus Big Data can potentially empower precisely those that are most marginal and vulnerable at the moments of highest risk. Open information flows contribute to the building of resilience by making communities aware of the risks and hazards they may encounter so that they can mobilise to protect themselves.[29]

Disasters, conflicts and other problems thus easily become reinterpreted as problems of knowledge and of knowledge/communication breakdowns within communities, with policy-makers arguing that at-risk communities need information as much as water, food and medicine, or shelter, and thereby that 'disaster is first of all seen as a crisis in communicating within a community – that is, as a difficulty for someone to get informed and to inform others'.[30] Thus, it is increasingly argued that Big Data should not merely be used by communities in response to disasters but could play a more preventive role. However, the preventive role of Big Data should not be confused with the linear predictions of reductionist models based on cause-and-effect theorising. It is this lack of theory that enables Big Data to be context dependent on local knowledge and correlations or factual information generated in real-time. As Robert Narvaez notes, international agencies are increasingly promoting a 'proactive stance towards the use of crowdsourcing, noting that crowdsourcing could be used extensively as a way to reduce the likelihoods of disasters taking place'.[31]

In these instances, Big Data goes from being an accidental by-product of digitalised exchanges and becomes a technique of governing through the inculcation of

28. See, for example, Nortje Marres, *Material Participation: Technology, the Environment and Everyday Politics* (Basingstoke: Palgrave Macmillan, 2012).
29. Joachim Ahrens and Patrick M. Rudolph, 'The Importance of Governance in Risk Reduction and Disaster Management', *Journal of Contingencies and Crisis Management* 14, no. 4 (2006): 207–20; 217.
30. Diane Coyle and Patrick Meier, *New Technologies in Emergencies and Conflicts: The Role of Information and Social Networks* (Washington, DC: United Nations Foundation and Vodafone Foundation, 2009), 17. Available at: http://www.globalproblems-globalsolutions-files.org/pdf/UNF_tech/emergency_tech_report2009/Tech_EmergencyTechReport_full.pdf. Last accessed 26 February 2015.
31. See Robert William M. Narvaez, 'Crowdsourcing for Disaster Preparedness: Realities and Opportunities' Unpublished MDev dissertation, Graduate Institute of International and Development Studies, Geneva, 2012, 47. Available at: https://www.academia.edu/2197984/Crowdsourcing_for_Disaster_Preparedness_Realities_and_Opportunities. Last accessed 26 February 2015.

self-knowledge. As Evgeny Morozov argues, Big Data approaches aspire to remove the need for governance on the basis of rules and laws, displacing this with real-time feedback mechanisms based on new forms of (datafied) self-awareness:

> If so much of our everyday behaviour is already captured, analysed and nudged, why stick with unempirical approaches to regulation? Why rely on laws when one has sensors and feedback mechanisms? If policy interventions are to be – to use the buzzwords of the day – "evidence-based" and "results-oriented", technology is here to help… suddenly, there's no need to develop procedures for governing every contingency, for – or so one hopes – algorithms and real-time, immediate feedback can do a better job than inflexible rules out of touch with reality.[32]

Narvaez's survey thus concludes that its advocates see Big Data not just as reflecting reality but as transforming it through enabling community self-awareness: 'building the capacity of vulnerable groups to be resilient by making themselves aware or inform themselves of the various surrounding risks and hazards, and in so doing be able to organize the proper formal and informal interventions'.[33]

The Limits of the Governance of the Self

It is important to note that in this perspective of Big Data as empowerment, the 'power' which Big Data promises local communities, in terms of capacity-building, relational awareness and resilience, is not the same type of power which governments claimed for themselves in the modernist era of linear cause-and-effect understandings. It is not the power to direct and shape societies based on the accumulation of causal knowledge. Unfortunately, what works for Google does not work so well for marginal and vulnerable people and communities that desperately need to transform their circumstances. The transformation of the world depends on the positing of causal connections and possibilities, tested through trial and error. As Pietsch insightfully argues:

> A mere correlation cannot tell how to effectively intervene in the world, e.g. the birth rate cannot be changed by increasing the population of storks, even though studies consistently show a significant correlation between both quantities. By contrast, headaches can be cured by taking acetylsalicylic acid because there is a direct causal connection.[34]

The 'gift' of Big Data does not seem to be very empowering for those who most need social change. Big Data can assist with the management of what exists, for example, redesigning transport or energy networks to meet peak demands or adapt to system breakdowns but it cannot provide more than technical assistance based upon knowing more about what exists in the here and now. The problem is that without causal assumptions it is not possible to formulate effective strategies and responses to problems of social,

32. Morozov, 'The Rise of Data and the Death of Politics'.
33. Narvaez, 'Crowdsourcing for Disaster Preparedness', 52.
34. Pietsch, 'Big Data: The New Science of Complexity'.

economic and environmental threats. Big Data does not empower people to change their circumstances but merely to be more aware of them in order to adapt to them.[35]

A good example of this is the understanding of natural disasters, while disasters were traditionally perceived as sudden and short lived events, there is now a tendency to look upon disasters as continuous processes of gradual deterioration and growing vulnerability.[36] This shift towards understanding disasters as processes is particularly important with regard to the preventive role of Big Data.[37] As the United Nations Development Programme Coordinator of the Disaster Risk Reduction and Recovery Team states: 'Disaster risk can often be anticipated and contingencies developed. Recent large-scale natural disasters, such as the floods in Pakistan, earthquake in Haiti and drought in the Horn of Africa remind us that we need to put resilience to crises at the heart of development.'[38]

It is important to note, however, that the role of Big Data is not that of understanding and predicting disasters so as to prevent them but to enable communities to cope with them, through a better understanding of themselves. This process of inner-orientated knowledge replacing externally-orientated knowledge is captured well by Patrick Meier:

> Thanks to ICTs, social media and Big Data, we now have the opportunity to better characterize in real-time the social, economic and political processes… this doesn't mean that we have a perfect picture of the road to collapse; simply that our picture is clearer than ever before in human history. In other words, we can better measure our own resilience. Think of it as the Quantified Self movement applied to an entirely different scale, that of societies and cities. The point is that Big Data can provide us with more real-time feedback loops than ever before. And as scholars of complex systems know, feedback loops are critical for adaptation and change.[39]

35. See further, the critical work on resilience as adaptation, for example, Jonathan Joseph, 'Resilience as Embedded Neoliberalism: A Governmentality Approach', *Resilience: International Policies, Practices and Discourses* 1, no. 1 (2013): 38–52; Brad Evans and Julian Reid, *Resilient Life: The Art of Living Dangerously* (London: Polity Press, 2014); David Chandler, *Freedom vs Necessity in International Relations: Human-Centred Approaches to Security and Development* (London: Zed Books, 2013).
36. As Manuel Perlo Cohen states: '… a "natural" disaster is inevitable only insofar as the social conditions allow it. Disaster is the culmination of a process and continuum of a disconnect between human beings and their interrelations with the environment'. Risk, Vulnerability, and Disaster Prevention in Large Cities, *Lincoln Institute of Land Policy Working Paper*, 2000. Available at: www.alnap.org/pool/files/1348-666-perlo00pc1-final.pdf. Last accessed 26 February 2015.
37. Patrick Meier, 'How to Create Resilience Through Big Data', *iRevolution*, 11 January 2013. Available at: http://irevolution.net/2013/01/11/disaster-resilience-2-0/. Last accessed 26 February 2015.
38. Jo Scheuer, 'What We Call "Natural" Disasters Are Not Natural at All', United Nations Development Programme, 12 October 2012. Available at: http://www.undp.org/content/undp/en/home/ourperspective/ourperspectivearticles/2012/10/12/what-we-call-natural-disasters-are-not-natural-at-all-jo-scheuer/. Last accessed 26 February 2015.
39. Meier, 'How to Create Resilience Through Big Data'.

Big Data aims not at instrumental or causal knowledge but at the revealing of feedback loops in real-time, enabling unintended consequences to be better and more reflexively managed. Disaster risk reduction thus becomes a way of making communities more self-aware so that the unintended consequences of social interaction do not undermine coping capacities. Meier highlights that this process of self-monitoring or self-awareness is the essence of some of the UN's Global Pulse projects, for example, using Big Data for real-time awareness of food price changes for famine prevention. Big Data thus enables analysis of social media to access the digital 'nervous system' of social interaction, capturing 'the pulse of our social systems'.[40]

Thus, It would be more useful to see Big Data as reflexive knowledge rather than as causal knowledge. Big Data cannot help explain global warming but it can enable individuals and household to measure their own energy consumption through the datafication of household objects and complex production and supply chains. Big Data thereby datafies or materialises an individual or community's being in the world. This reflexive approach works to construct a pluralised and multiple world of self-organising and adaptive processes. The imaginary of Big Data is that the producers and consumers of knowledge and of governance would be indistinguishable; where both knowing and governing exist without external mediation, constituting a perfect harmonious and self-adapting system: often called 'community resilience'. In this discourse, increasingly articulated by governments and policy-makers, knowledge of causal connections is no longer relevant as communities adapt to the real-time appearances of the world, without necessarily understanding them. As Meier states:

> Connection technologies such as mobile phones allow individual[s]… to make necessary connections and decisions to self-organize and rapidly recover from disasters. With appropriate incentives, preparedness measures and policies, these local decisions can render a complex system more resilient. At the core here is behaviour change and thus the importance of understanding behaviour change models.[41]

Rather than engaging in external understandings of causality in the world, Big Data works on changing social behaviour by enabling greater adaptive reflexivity. If, through Big Data, we could detect and manage our own biorhythms and know the effects of poor eating or a lack of exercise, we could monitor our own health and not need costly medical interventions. Equally, if vulnerable and marginal communities could 'datafy' their own modes of being and relationships to their environments they would be able to augment their coping capacities and resilience without disasters or crises occurring. In essence, the imaginary of Big Data resolves the essential problem of modernity and modernist epistemologies, the problem of unintended consequences or side-effects caused by unknown causation, through work on the datafication of the self in its relational-embeddedness.[42] This is why disasters in current forms of resilience thinking are

40. Ibid.
41. Meier, 'How to Create Resilience Through Big Data'.
42. As Latour notes, digital technology enables the flat ontology of posthumanist approaches to become a viable project of knowledge production: 'levelling' both the micro-interactions of

understood to be 'transformative': revealing the unintended consequences of social planning which prevented proper awareness and responsiveness. Disasters themselves become a form of 'datafication', revealing the existence of poor modes of self-governance.[43]

Of course, it is not only the vulnerable and marginalised that Big Data enables to be self-aware and reflexive. Another high profile example of Big Data, as a methodology for adaptation rather than for intervention into causal processes, is the centrality of Big Data to policy and academic discussion of urban governance and urban planning: in discourses of 'smart', 'intelligent', 'resilient' or 'sentient' cities.[44] The increasing focus on cities that understand themselves and thereby govern themselves is driven by the technological possibilities of Big Data, where cities are understood as industrial and social hubs of complex interconnections, which through datafication can produce real-time knowledge of themselves. This reflexive awareness of cities' own 'vitality' – their own 'pulse' – then enables a second order of reflexivity or of artificial intelligent 'life':

> Perhaps one way in which we might consider this question is precisely through looking at how vitality develops when computational things are explicitly included in the contours of experience. Then it becomes clear that it has only gradually arisen, line by line, algorithm by algorithm, programme by programme. Cities are full of a whole new layer of emergent entities which, because they are underpinned by code using data as fuel, might be thought of as akin to sentient beings, in that they are able to produce some level of transference through correlation and measurement.[45]

The governance of the self, seemingly involves a different form of knowledge production and different forms of governance. This shift in understandings of knowledge, governance, power and agency is often captured in discussions of the posthuman.

Big Data and the Construction of the Posthuman

The view of Big Data as empowering and capacity-building relies upon the reconstruction of societies as self-governing, as self-reproducing or autopoietic. However, this approach to self-government appears to be very different to modernist approaches of top-down governance, based on cause-and-effect understandings of policy interventions. In this framework, in which Big Data methodologies and understandings are central, the power of self-governance and autonomy does not stem from a development of liberal forms of power and knowledge but from their rejection. 'Smart', 'resilient' or 'sentient'

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individuals and the consequences of these interactions through the tracing of the (previously unknowable) networks and interconnections. See, for example, Latour et al., 'The whole is always smaller than its parts', 599.

43. See, for example, Andrea ó Súilleabháin, 'Building Urban Resilience in Bangkok: Q&A with Apiwat Ratanawaraha', *Global Observatory*, 13 August 2014. Available at: http://theglobalobservatory.org/interviews/801-building-resilience-in-bangkok-apiwat-ratanawaraha.html. Last accessed 26 February 2015.
44. Nigel Thrift, 'The "Sentient" City and What it May Portend', *Big Data & Society* 1, no. 1 (2014): 1–21; 8.
45. Ibid, 10.

cities, for example, are not successful because of a development of cause-and-effect understandings, which can then be operated upon by centralised authorities. The 'conscious' or 'cognitive' self-awareness of the 'sentient' city is understood to be very different from that of human cognition or self-awareness.[46] It is therefore quite important to understand how this process works and how it is reflected in increasingly influential intellectual understandings.

Data enables our embedded relationalities to become knowable. The more our interrelations become datafied and become transparent and readable the more we can understand the chains of contingent, complex and emergent causality which previously were invisible. The visibility of the complex world removes the need for causal theory and for top-down forms of governance on the basis of cause-and-effect. The self-awareness of a datafied world thereby blurs forever the distinction between human and nonhuman and subject and object. Big Data thereby articulates a properly posthuman ontology of self-governing, autopoietic assemblages of the technological and the social. Whereas the 'human' of modernist construction sought to govern through unravelling the mysteries of causation, the posthuman of our present world seeks to govern through enabling the relational reality of the world to become transparent, thus eliminating unintended consequences.

Nigel Thrift, cited above, has clearly highlighted the intimate connections between posthumanism and Big Data approaches:

> …human beings can no longer be considered as the only actors. Rather than acting as simple relays, what might be called the world of things (within which I include the material surfaces made possible by Big Data) comes to occupy a central place, confirming the tenets of speculative realism but no longer in abstracto.[47]

Here, Big Data materially changes the way the world is and how it is understood and governed. For Thrift, new technologies 'make this kind of relationality easier to initiate and conjugate', they are enfolded within emerging processes and essentially turn abstract constructions of relational ontologies into a perceivable social reality.[48] Bruno Latour's work can also be read in a similar vein, where he suggests that Big Data enables access to a much 'flatter' reality, where the modernist divisions between quantitative and qualitative methods no longer needs to apply and that the 'statistical shortcuts' that constituted the 'fictive division' between the two levels of micro-interactions and macro-structures are no longer necessary.[49] This two-level or dualist approach, which has traditionally

46. In fact, there has recently been a reaction against the loss of vision and political possibilities involved in the 'smart city' imaginary. See, for example, Adam Greenfield, 'The smartest cities rely on citizen cunning and unglamorous technology', *The Guardian*, 22 December 2014. Available at: http://www.theguardian.com/cities/2014/dec/22/the-smartest-cities-rely-on-citizen-cunning-and-unglamorous-technology, last accessed 26 February 2015; Jesper Pagh and Malene Freudendal-Pedersen, 'Projects, Power, and Politics: A Conversation with Bent Flyvbjerg', *Twentyfirst* 3 (2014): 62-75.
47. Thrift, 'The "Sentient" City', 7.
48. Ibid.
49. Venturini and Latour, 'The Social Fabric'.

dominated social theorising, works well, according to Latour, to describe emerged phenomena but not for grasping phenomena in their emergence, in real-time. The need for abstractions at the higher level of the 'general', 'collective' or the 'social' disappear as the real-time interactions and connections can be assembled to enable the study of the concrete and the individual to encompass ever larger collectivities or assemblages (both human and non-human).[50]

Big Data does not work on the basis of extrapolating from limited or selected data on the basis of rules or regularities which emerge (the basis of Hacking's critique of the power of statistical probabilities) but works the other way around, not 'up' to general laws but 'down' to the contextualisation of the individual case, thereby promising personalised or individualised health care, political campaigning or product purchasing information.[51] Big Data 'drills' or 'mines' down from the mass of data to the individual case rather than fitting the individual into a set of deterministic or causal understandings based on selecting a small number of social or cultural attributes. Big Data is thereby representative of other shifts both in social theory and in computational analysis, which tend to focus on the enrichment of smaller or micro-level descriptive analysis rather than macro-level theory-building. Even traditional modelling techniques are shifting from equation or parametric modelling based on a limited number of parameters dependent on linear relationships to non-parametric modelling based on data-driven computational power. The knowledge and causal power generated are therefore highly context dependent and not capable of being integrated into broader theoretical understandings or government levers of policy intervention.

Big Data's appeal appears to be exactly that it promises to overcome the limits of theorising and modelling: the gap between abstract theory and concrete reality. Big Data or data-intensive science clearly focuses more on the materiality of the world than the subjective constructions of this reality in theories or models, which tend to assume linear causal chains of connection. Big Data science for these reasons has been described as 'horizontal' rather than vertical or hierarchical.[52] It consciously presupposes a flatter ontology of agency and causality and therefore does not intend to make causal claims in the manner of modernist understandings of linearity and universality. This would seem to precisely fit Bruno Latour's perspective (following Tarde) regarding an actor network approach:

> In the tired old debate pitting a naturalistic versus an interpretative social science, a strange idea appears: that if we stick to the individual, the local, the situated, you will detect only qualities, while if we move towards the structural and towards the distant, we will begin to gather quantities. For Tarde the situation is almost exactly the opposite: the more we get into the intimacy of the individual, the more discrete quantities we'll find; and if we move away

50. See, for example, Latour et al., 'The whole is always smaller than its parts'; Venturini and Latour, 'The Social Fabric'.
51. See, for example, Megan Williams, 'Will Big Data Have A Direct Impact On Patient Care?', *Business Solutions*, 18 August 2014. Available at: http://www.bsminfo.com/doc/will-big-data-have-a-direct-impact-on-patient-care-0001. Last accessed 26 February 2015.
52. See, for example, Wolfgang Pietsch, 'Big Data: The New Science of Complexity'.

> from the individual towards the aggregate we might begin to lose quantities, more and more, along the way because we lack the instruments to collect enough of their quantitative evaluations.[53]

The point about Big Data is that no data should be excluded. There is no need for data reduction; in fact the more data there is the less need there is for models and theories to bridge the gap between the particular and the general at the risk of subsuming the concrete under the abstract. The radical inversion at play in the shift from theories and rules to letting the concrete data do the work, to have the agency, and thus to blur or make meaningless the subject/object divide of modernist knowledge production can be highlighted simply in the case of language translation. The rules-based approach models the complex hierarchy of grammatical rules for both languages and translates using a conventional dictionary. The data-driven approach ignores grammatical structure and rules and instead works on the basis of concrete context in terms of word frequency and location.

Data-driven approaches thus no longer rely on specialist knowledge and expertise: algorithms based on mass data sets take the 'knowledge' out of knowledge production. Whether this concerns language translation, political election information or sales and marketing. As Anderson has stated: 'That's why Google can translate languages without actually "knowing" them (given equal corpus data, Google can translate Klingon into Farsi as easily as it can translate French into German). And why it can match ads to content without any knowledge or assumptions about the ads or the content'.[54]

The implication is that the promise of Big Data, putting the concrete context at the centre, really does provide unmediated access to the real, multiple and complex world. Given enough data and computing power, the reductionist categorisations upon which causal decision-making was made – for example, in election campaign targeting, upon traditional variables of race, gender, class and location – disappear from the picture. The more individuals are characterised in terms of a large number of parameters the more the 'real' individual emerges rather than the reductionist model of the individual. The more the 'real' emerges, the less need there is for causal models and theories that depend on reductionist generalisations that abstract from reality in problematic ways. The promise of Big Data is that of actor network theory: the 'externalities', which Bruno Latour has argued are left out of modernist thinking, are 'brought back in'.[55]

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53. Latour, 'Tarde's Idea of Quantification', in *The Social after Gabriel Tarde: Debates and Assessments*, ed. Matei Candea (London: Routledge, 2010), 145–62; 149. Available at: http://www.bruno-latour.fr/sites/default/files/116-CANDEA-TARDE-FR.pdf, Last accessed 26 February 2015; see also, Bruno Latour, 'Gabriel Tarde and the End of the Social', in *The Social in Question: New Bearings in History and the Social Sciences*, ed. Patrick Joyce (London: Routledge, 2002), 117–32. Available at: http://bruno-latour.fr/sites/default/files/82-TARDE-JOYCE-SOCIAL-GB.pdf. Last accessed 26 February 2015.
54. Anderson, 'The End of Theory'.
55. Latour, 'Is Re-modernization Occurring – And If So, How to Prove It? A Commentary on Ulrich Beck', *Theory, Culture & Society* 20, no. 2 (2003): 35–48.

The Posthuman World

The epistemological shift towards the 'data' and away from causal theory is therefore deeply connected to a broader ontological shift in the understanding of the world and its problems: the shift to relational ontologies or complexity. For much of the Big Data discussions, this shift to inductive reasoning – or to letting the 'data' do the work instead of the theorist – is understood as a product of having better access to reality: the availability of data and of computing power therefore enables knowledge production without the mediation of models and theories to fill the gap between what is known and how it might be understood. For the theorists critical of Big Data as a method of knowledge production, these technologies inevitably fail to fill the gap and instead continue to enable the constitution of simplifying and reductionist knowledge claims based on pattern recognition and correlations. The critical position thus essentially shares the ontological perspective of complexity and the critique of causal understandings, merely questioning whether Big Data delivers upon its posthuman claims.

This article's concern was not to survey the range of meanings implied in the understanding of Big Data as a method or approach – Big Data is clearly a messy and emerging concept, sometimes used to intimate the extension of causal understandings and reductionist knowledge claims and other times to question these; sometimes conflated with technological innovation or the development of social media and sometimes clearly concerned with the epistemological implications of emerging causality.[56] Instead, the object has been to highlight the growing consensus that modernist forms of knowledge production, seeking to add to a universal store of understanding and to derive rules of causation, which can enable instrumental or means-ends policy practices, have been increasingly problematised both in academic discussion over the policy problem-solving potential of Big Data and in the critical conceptual approaches to the technologically driven possibilities of letting the data 'speak for itself'.

This emerging consensus appears to confirm the coming of age of posthuman approaches: policy and conceptual understandings which focus upon embedded relationality and reject metaphysical individualist understandings of objective and universal knowledge from a 'God's eye view'.[57] Modernist approaches to knowledge, and the linear, reductionist and universalist assumptions upon which they are based, have been roundly rejected by critical, feminist, post-colonial, post-structuralist, pragmatist, speculative realist, actor network and new materialist approaches, which are popular throughout the social sciences. Big Data approaches thereby confirm or reinforce posthuman understandings rather than being constitutive of them. Big Data discursively enables

56. See, for example, Annemarie Mol, on the multiple uses and meanings associated with phenomenon, which enables an assemblage of meanings to take a coherent shape, *The Body Multiple: Ontology in Medical Practice* (London: Duke University Press, 2002).

57. Donna Haraway, 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspectives', *Feminist Studies* 14, no. 3 (1988): 575–99; Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (London: Free Association Books, 1991), 188–96; see also Charlotte Epstein, 'The Postcolonial Perspective: An Introduction', *International Theory* 6, no. 2 (2014): 294–311.

posthuman approaches to come of age: to make the transition from the critical margin to become central to government thinking and the transformation of policy-making and understanding. Thus, the rise of Big Data should not be seen as merely about the possibilities of increased computing power and the crossing of the data 'threshold', alleged to enable unmediated real-time feedback and reflexive self-awareness to replace 'top-down' forms of governance based on causal and linear understandings.

It would therefore seem that the rapid rise of Big Data approaches to policy-making cannot be deterministically explained as a technological phenomenon: technological advances could easily have been used to expand causal understandings (as they have throughout modernity). It would also suggest that Big Data should not necessarily be understood as a revolution in epistemological or ontological understanding. As Nigel Thrift, Bruno Latour and others have noted, Big Data approaches share the methodological and ontological assumptions of currently fashionable social science understandings, which have similarly rejected the search for causal connections and the development of social theory.[58] At the level of epistemological assumptions, Big Data offers a broader variety of research techniques, reliant on computer generated data and analytics, but is essentially indistinguishable from actor network or other critical and empirically-driven approaches. Big Data approaches insist on 'following the data' while actor network theorists deploy their ethnographic skills and insist on 'following the actor'. Reading Halevy et al., on the methodology of Big Data it is difficult not to bring to mind the work of Bruno Latour:

> So, follow the data. Choose a representation that can use unsupervised learning on unlabelled data, which is so much more plentiful than labelled data. Represent all the data with a nonparametric model rather than trying to summarize it with a parametric model, because with very large data sources, the data holds a lot of detail… See how far you can go by tying together the words that are already there, rather than by inventing new concepts with clusters of words. Now go out and gather some data, and see what it can do.[59]

Or, to take another example, it is worth considering the striking similarity in the epistemological claims made in John Law's influential book *After Method: Mess in Social Science Research*, first published in 2004, and those made ten years later in the prestigious US foreign policy journal *Foreign Affairs*, which argues that:

> [Big Data] requires three profound changes in how we approach data. The first is to collect and use a lot of data rather than settle for small amounts or samples, as statisticians have done for well over a century. The second is to shed our preference for highly curated and pristine data

58. For further on the critical rejection of social theory see Kai Koddenbrock, 'Strategies of Critique in International Relations: From Foucault and Latour towards Marx', *European Journal of International Relations* (OnlineFirst, 26 August 2014). Available at: http://ejt.sagepub.com/content/early/2014/08/23/1354066114538854.abstract. Last accessed 26 February 2015

59. Halevy et al., 'The Unreasonable Effectiveness of Data', 12. For a comparison with Latour, see in particular his *Reassembling the Social*.

> and instead accept messiness: in an increasing number of situations, a bit of inaccuracy can be tolerated, because the benefits of using vastly more data of variable quality outweigh the costs of using smaller amounts of very exact data. Third, in many instances, we will need to give up our quest to discover the cause of things, in return for accepting correlations.[60]

In epistemological and ontological terms the desire to grasp the messiness of the world and to understand knowledge as highly contextualised means that Big Data approaches discursively turn posthumanism into a mainstream research agenda. Big Data welcomes the heterogeneity and multiplicity of the world, as datafication enables more and more attributes and social practices, including body movements and pulse rates, to become part of the complex micro-picture. Perhaps, most importantly, Big Data ontologically asserts that the world is complex, not bound by generic laws and rules but by feedback loops and changes through iterative and complex relational processes.

Conclusion

If we do now truly live in a posthuman world and Big Data has discursively enabled posthumanism to inform the imaginary of new forms of governance and self-governance then the question of critique is sharply posed. As suggested above, it seems unsatisfactory to critique claims made for Big Data as failing to escape the reductionist traps of modernist thinking, especially as these approaches increasingly move towards much more reflexive and process-based understandings. It also seems a little problematic merely to flag up the dangers of Big Data approaches removing the world of politics and decision-making and installing a technological dystopia of adaptation (although these points are made above).[61] Posthumanism is what it says on the tin: it is an assertion that governing the world on the basis of the politics of modernity (top-down, cause-and-effect understandings) is dangerous, false and hubristic and does nothing to remove the hierarchies, inequalities, injustice and suffering of the world. Posthumanism cannot really be critically engaged with on the basis that it rejects the ontological and epistemological assumptions of human-centred or Enlightenment thought.

Perhaps the best that can be done, and this article should be seen as a step towards this, is to use the insights of posthumanist approaches to problematise the assertions that the world we live in today is immune to theory and causal understandings. The world is no more necessarily complex than it was linear; the human subject is no more necessarily relationally embedded than it was constructed as an autonomous and abstract individual. If modernity and the modern human were social constructs then so is postmodernity and the posthuman. Posthumanist perspectives agree that it took a lot of work to construct the world in linear ways and to construct the human as separable from the world and to imagine the modernist binaries and cuts which enabled modernist forms of governance. Perhaps, posthumanists might be equally willing to undertake the painstaking approaches

60. Cukier and Mayer-Schoenberger, 'The Rise of Big Data'.
61. See the work of Evgeny Morozov, in particular, *To Save Everything, Click Here* (London: Allen Lane, 2013).

of genealogical reconstruction necessary to reveal the processes at play in the construction of the world as complex and posthuman. Modernist conceptions of knowledge and of governance, agency and the human subject have not just collapsed as if by magic, as if the world revealed its true self to science and technology; their demise is the contingent reflection of real material and subjective processes.

It seems to me that the research project of critical International Relations could be to critically engage with the ontological assumptions of complexity and emergent causality which enable the current constructions of the human subject, distributive agency and new practices and imaginaries of self-governance and adaptation. The insights of critical and posthumanist thought should enable a thorough engagement and deconstruction of the posthuman universal: the research hinterlands or assemblages which have enabled posthumanism to become the new doxa or commonsense of the world.[62] Karen Barad's insights about the social materiality of ways of seeing, doing and being in the world can also lead us to question the idea that shifts in knowledge production can be reduced either to the materiality of the instruments of investigation or to the individual subjectivity of the funder or researcher.[63] Now that posthumanism has come of age, there is a danger that the confinement of intellectual enquiry to the production of situated and embedded knowledge, whether through high tech algorithms or through ethnographic methods, will make the world intellectually a sterile place. For those of us who do not wish to merely describe the world, as it emerges in forms amenable to posthuman understanding and to posthuman forms of governance, the task of revitalising a critical approach has never been more urgent.

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62. John Law, *After Method: Mess in Social Science Research* (Abingdon: Routledge, 2004).
63. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (London: Duke University Press, 2007).