8

AFTERWORD: EVIDENCE AND EXPERIMENT

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In styles that range from the performatively paratactic and experimental, to scholarly sobriety and sharp sociocultural critique, these chapters engage issues concerning the contemporary uses and forms of experiment and the building and distribution of kinds of evidence in relation to new concepts and practices of experimentation within the contemporary biomedical sciences. They explore some less obvious ways in which knowledges and practices forged in this new 'megaphone' science resonate far beyond conventional spaces of research and are deeply and reciprocally entangled with the embodied self-fashioning of individual selves and group identities.[1] Everywhere, not only in postmodern theory or art, as Ian Hacking has reminded us, people are made up: but they are fashioned through highly reflexive and recursive knowledge-making practices deeply intertwined with and distributed across multiple agencies and cultural domains.[2] In this response, I will consider key themes explored in these chapters by bringing to bear on the discussion some earlier conceptualisations of experiment and evidence that still powerfully shape our cultural assumptions and I will consider briefly whether some further reflection on experimentalism in the arts may also usefully bear on key interdisciplinary questions for a future critical medical humanities.

Major shifts in the concepts, working practices and organisation of the biomedical sciences have prompted new ethnomethodological and conceptual work on experimental systems.[3] From Quine's concept of 'webs of belief' in which all knowledge systems are entangled, Hacking's reflections on representation and intervention, and the revival of interest in Ludwik Fleck's early work on scientific 'thought communities', meta-reflection on experiment in science has moved away from abstract post-positivist discussions of proof, to interest in the material-discursive organisation of knowledge systems.[4] How do experimental systems generate and consolidate what comes to be regarded as 'evidence'? Who are the agents and players, and what are the processes and instruments involved, their relations and their beneficiaries? No longer imagined as narrowly controlled, experiment in biomedicine now appears exploratory and open, involving an array of instruments, models, data, media, procedures, tacit practices and recursive moves that collapse distinctions between theory and practice, inside and outside, instrument and experimental subject, researcher and researched. Its new epistemic objects seem ill fitted to inherited epistemological categories. This new biosociality

opens up a plethora of critical challenges to the medical humanities, as well as unprecedented opportunities to negotiate new and exciting interdisciplinary entanglements.

Like the new natureculture of the post-genomic, epigenetic, the Anthropocene, neurobiological plasticity, distributed cognition and the digital humanities – key cultural and scientific contexts shaping contemporary medical practices – these chapters reflexively highlight their own artefactual nature and conceptual entanglement with the objects of their exploration in a way that pre-empts and guards against premature closure. Biomedical science itself, of course, is constantly under the biocapitalist pressure of closure encapsulated in the idea of translational research. So a critical medical humanities has an investment in the open that is positionally more difficult to achieve in the biomedical contexts it analyses. Metaphors and concepts of complexity, the network, recursivity, emergence, assemblage and reflexive embodiment central to systems biology – the fastest-growing area of the new genomic and post-genomic sciences – are now providing explanations and organising devices across many varied domains of contemporary culture.[5] But an important task for the medical humanities is to look at the many and different ways in which these concepts are assembled and put to practical uses. Just as informational concepts around life as a 'script' empowered the early development of molecular biology and genetics, in the new genomic biologies, the network, as a complex process of entanglement, is the organising trope slowly making redundant the concept of the gene as an entity.[6] How might the medical humanities find appropriate, open and dynamic interdisciplinary models and procedures with which to begin to get a firmer – more detailed and nuanced – handle on these concepts, motifs and models of biosocial complexity that are now distributed through increasing numbers of knowledge systems? The biomedical sciences are being transformed by the post-genomic understanding of cellular processes and epigenetics that have required abandonment of classic unidirectional models of genetic determination that rested on a realist construction of causality and a reductionist understanding of method. How far do these new complexity discourses in the life and environmental sciences, which have challenged epistemologies and the understanding of experimental and evidentiary processes, require a reappraisal on the part of the humanities about its own assumptions concerning experiment and knowledge? Several chapters note the need to find ways to overcome the tedious legacies of former realism versus anti-realism disputes that, culminating in the Science Wars of the 1990s, also deterred early medical humanities work from proper engagement with cultural and critical theory. But things have moved on. The concept of artefactual realism explored in relation to the new systems sciences is ceasing to be dismissed as an oxymoron or a weaselly metaphor, but is now engaged through a variety of cognate arguments from Barad's 'agential' realism, Harding and Longino's 'standpoint' realism, Dupré, Hacking and Cartwright's 'promiscuous' realism, to the various post-'critical realisms'.[7] All are seeking ways to overcome a situation where, if the sciences continue to refuse to relinquish the mystique of positivism, and the humanities refuse to continue to view science as a threat to empathy and human flourishing, the deep assumptions of 'two cultures' antagonisms will continue to sabotage or make difficult

any genuinely new interdisciplinary frameworks and enterprises. It is time to break out of models of respectful integration, as well as those of subaltern mimicry, but with a critical awareness of the difficulties and challenges involved.

For at the heart of the disciplinary distribution of facts and values that Bruno Latour has called the 'modern settlement' is an assumption, primarily the legacy of positivism, of the non-epistemic status of the humanities in relation to science that legitimates and requires what Fitzgerald and Callard here refer to as the 'helpmeet' model of the medical humanities. I would go even further and suggest that the fetishisation of integration, albeit unintentionally, may ultimately serve to strengthen disciplinary foundationalisms that underpin assumptions of 'ownership' of particular domains of knowledge and practice; the desideratum of integration may insidiously preserve the knowledge hierarchies of the positivist legacy. The chapters gathered here, casuistically, theoretically, performatively, challenge models of integration, mimesis, generalisability and assumptions that true knowledge is simply reflective or correspondent. Refusing but recognising the lingering presence of disciplinary fact/value dualisms that position the humanities outside the fully epistemological, they also suggest that future challenges to the positivist legacy must extend beyond the favourite topoi of the medical humanities, such as the clinical encounter, that lend themselves to phenomenological analysis, the affective, the dialogic and the narrative. In preserving stereotypes of the appropriate strengths of the humanities, this narrowing of its appropriate domains and methodologies allows the perception of science as sole guarantor of properly evidenced knowledge to persist. A critical humanities that disrupts the processes that encourage such perceptions is not a new postmodernism in sheep's clothing; in no way are the expertise, efficacy and validity of science devalued. But exploration of the artefactual, of the role of technologies, processes of dissemination, instruments, in the assembling of biomedical knowledge reveals how there is no area that is not entangled with processes of observation and measurement. Exposure to alternative agencies, users, perspectives can produce not only different but equally valid kinds of knowledges, but also radically new epistemic objects. All seven of these chapters therefore call for a level playing field where knowledge is shared, assembled, distributed and entangled, but with different inflections that produce new epistemic objects, across the arts and the sciences. What is challenged is the model of interdisciplinarity that envisages pre-packaged individual disciplines retaining and contributing their particular strengths in constrained and appropriate spaces and simply reframing epistemic objects already securely positioned in other specific disciplines. What is called for instead is recognition of the necessary vagueness and fuzziness of the epistemic object as it is displaced from disciplinary ownership to enter a place of experimental exploration that may bring forth something new and radically different. Like high-energy physicists assembling the myriad differential traces left as various sensitive instruments move over the invisible surfaces of entities only observable through the effects of the instruments, new epistemic objects may also emerge whose identities are entirely a product of the experimental process. In this model of experiment and knowledge-making, the 'modern settlement' is completely unsettled.

But positivist assumptions die hard. For what is etymologically and, one might argue, ideologically at their core, is the concept of *positum* – to lay out – as if data collection and its processing through formal testing and rules of reasoning constitute the only method that can deliver proper and 'truthful' evidence of the world's structures and forms. In rigid or unreflective modes of positivism, the necessarily insufficient determination of any theory by data, or the existence of tacit assumptions that still underpin even the most rigorously 'purified' theory construction, or the entanglement with artefactual processes, are seen to have minimal bearing on what emerges as 'knowledge' of the world. Medicine's continuing adherence to this model is reflected in the modes of defence of Evidence-Based Medicine of the 1990s.[8] Though tempered with the humanistic and Hippocratic in clinical practice, disease is still regarded as an entity that is available for knowledge through a structured hierarchy of inquiry that runs from the gold standard of the randomised controlled clinical trial (RCT) all the way down to patient narratives and testimonies. So methodological scepticism is regarded as the appropriate epistemological stance for the researcher or clinician; a more radical scepticism that insists on the indeterminism of knowledge is ruled out of court as denying the possibility of accurate and stable evidence. The first experimental textbook, written by Claude Bernard in 1865, established the idea of controlled observation and testing through the use of manipulated models that might stand as proxies for natural objects and organisms outside the experimental system.[9] The nineteenth-century literary portrayal of the Promethean scientist – from Mary Shelley's Frankenstein to H. G. Wells's Dr Moreau – builds on the recognition of how the model confers on the scientist God-like powers to legislate for, manipulate and alter nature. But such assumptions underpin too E. O. Wilson's arguments for a 'consilience' between the sciences and the arts and humanities.[10] Like earlier arguments of the logical positivist unity of science movement of the 1930s, Wilson's version of integration – consilience – is built on the assumption of a mutual acceptance by the humanities and the sciences of a hierarchy of knowledge whose foundation lies in the fundamental building blocks of 'life', whose discovery is the work of science. His pronouncement that 'the genes have culture on a leash' is shorthand for an entire onto-epistemology.[11] But the operative concept holding all of this together, from early microbiology on, is the belief in the unity of life that legitimates the model's authority as proxy and source of generalisable evidence. Though the era of Big Data has seemed to privilege the statistical analysis of trends and correlations despite the fallibility of statistical frequencies, the idea of the experiment comes with a weight of positivist baggage trailing in its wake: the belief that it carries the most secure evidence, the explanation of the causal mechanisms of disease.

Positivism chooses to overlook the fact that theories never compare directly with models and that models never compare directly with empirical reality, for each is mutually entangled in the generation of the other and dependent on the nature of the experimental set-up.[12] Thomas Kuhn was the first philosopher of science to analyse the function of the model as the basic representative unit in science and to recognise its manipulation as an artefactual process producing a simulacrum entangled with and

in the world and therefore changing and having effects on it, rather than constituting the world's accurate and comprehensive representation of it.[13] This is true whether the model is regarded as a synecdoche representing a cut from nature or an analogue of its underlying processes. But as Carusi's chapter explores, contemporary systems biology makes unavoidable the way that the experimental space and the epistemic objects that emerge from it are specifically entangled, distributed, fragile, unstable and unpredictable. One might suggest, indeed, that the processes and objects described seem to have more in common with those of the experimental arts than those of positivist models in science. An interesting challenge for the new critical medical humanities might be to begin to find more ways to explore entanglements and overlappings of different models of experimental space across the sciences and humanities as part of a process of challenging the widespread assumption that only the resolutely *scientific* space is the producer of hard 'evidence'. Already the work on experimental practices examined above is exposing flaws in conventional views of scientific experiment, such as the dependence of the concept of the model as proxy on unwarranted beliefs in the unity and structural stability of living processes. From this perspective, from the molecular to the molar, all living nature, at every level of scale, would need to begin and remain essentially carved at the joints. Few would accept this assertion in bald terms and yet it underpins the classic idea of the scientific experiment that is still a powerful cultural imaginary; we need more interdisciplinary experiments with and on other kinds of experiments to expose the limitations, blindnesses and particularities of different experimental systems.

In the divvying up of the domains of art, science and morality that is the focus of Kant's three great *Critiques*, the function of the model that is a work of art is conceded to be important in allowing humans to bridge the gap between the phenomenal and the noumenal, bringing into existence, through the created imaginary world, the means to glimpse what might exist beyond the limits of the epistemologically known and which has, as yet, no determinable conceptual existence.[14] In this view, however, although art might imagine possibility, only science can offer probabilities close to truths concerning nature's actual processes. But this is a view of the separation of art and science now fundamentally challenged in the examination of the knowledge-making procedures of the new biosciences undertaken in these chapters. Models themselves now challenge what we agree is 'biologically real'. Models are no longer exclusively the specially bred denizens of the wetlab (such as mice, rats, macaques, *E. coli* and the tobacco mosaic virus); they are also mathematical, statistical and computational assemblages involving multiple symbol systems and media, and requiring new visual display technologies and systems that can more readily suggest the three-dimensional interconnectedness of complex systems than the conventional written scientific report or graphic tables and charts. The more distributed and complex processes of the modern laboratory – that might now involve numerous sites, thousands of scientists and multiple kinds of equipment, modelling and display – make it almost impossible to ignore the artefactual in the assembling of what is regarded as evidence, just as it becomes impossible to lay out a precise relation between the symbolic

import of the model and the set of conditions for which the model purports to stand or to bring into existence.

In art, experiment has always been conceived in this way as exploratory, unpredictable, emergent and world-directed rather than mimetic.[15] Art is mostly defended as an expression of the singularity of individuals' experiences and history; only science deals in the universal and the directly generalisable. John Cage describes as experimental in music that which is indeterminate in outcome, for it includes and anticipates the listener as a co-participant in creating an emergent and therefore unpredictable meaning.[16] For the aesthetic theorist, Theodor Adorno, the motivation for experiment is provided 'when impulse can no longer find pre-established security in forms or content'.[17] Experimental art sets out to defamiliarise the world and lay bare its artefactual processes, but the new experimental processes in the contemporary biosciences also break up outmoded concepts that obscure rather than illuminate the world as they reify assumptions about nature as given, rather than recognising its artefactuality through multiple systems of experimental knowing. Experiment in the new biomedical sciences, like those of high-energy physics, also now acknowledges the final indeterminism of objects, their dynamic, recursive and decentred complexity and entanglement with their experimental systems. If one task for the critical medical humanities is to make more transparent those artefactual processes elided in order to render 'evidence' incontrovertible, and to explore its human effects, another is to find ways to share in and contribute its own multi-disciplinary experimental systems knowledge in the multi-modal and multi-media shaping of new intra-disciplinary epistemic objects.

This might include too thinking in new ways about historical experimentation, as in Scheid's fascinating chapter on the entanglement of a variety of historical webs of belief, from holism and traditional medicine to dialectical materialism, in the fashioning of biomedical systems science in contemporary China.[18] Literary texts also provide rich sources for rethinking the production of knowledge. George Eliot's famous image of the pier-glass (in her most scientifically engaged novel, *Middlemarch*, of 1874), whose rays illuminate a pattern of scratches on a surface of polished steel, has been read as a moral parable about egotistical blindness.[19] It might now be interpreted as a reflection on modelling and complexity and the artefactual building of knowledge. That her partner was G. H. Lewes, who was the first to describe, in 1874, the year of the novel's publication, emergence as the key mechanism of complex systems that seem to resist positivist reductionism, makes this interpretation even more plausible.[20]

There is a great deal of hype and hope around the post-genomic, though it is undeniable that the molar clinical gaze is now thoroughly entangled with the molecular; we think of ourselves increasingly as complex and intertwined. But a critical medical humanities also has work to do in exploring irresponsible and dangerous over-extrapolations of these new concepts of complexity and entanglement, and their embedding in specific contexts of biosociality. The kinds of analysis offered in the chapters by Viney and Rehmann-Sutter and Mahr suggest how the flattened agential hierarchies in theories of assemblage such as Actor Network Theory, for example, might usefully be reframed critically through historical work on earlier moments when hype

around new epistemological systems in biology licensed the objectification of people by other people as 'things', experimental models or data sources, with horrendous consequences.[21] Any metaphor or analogy that enables new ways of knowing inevitably obscures others and may indeed build unwarranted ontological assumptions on the back of its epistemological embeddings. Post-genomic techniques in systems biology were enabled by concepts and metaphors from cybernetics and then developed further with the appearance of the World Wide Web. But complexity and entanglement can become catch-all terms that rewrite the world in their own image, just as the central dogma of Crick and Watson turned the genome into a script-writing service for life. The new concepts of complexity and entanglement are everywhere and no more so than at the heart of the creation of a new risk culture with its centralised mechanisms for controlling risk and enhancing security. Complexity is a double-edged tool allowing systems biologies to escape charges of reductionism whilst enabling an extension of their reach, legitimised as 'science', to ever more domains of the lifeworld. In being critical, the medical humanities will need to be dynamic, experimental and riskier than this; in being entangled, it will need to be watchfully entangled. It will need to be one step ahead, even of this latest game in town.[22]

Notes

1. 'Megaphone science' is the term used in Hilary Rose and Stephen Rose, *Genes, Cells and Brains: Bioscience's Promethean Promise* (London: Verso, 2012).
2. Ian Hacking, 'Making Up People', in Thomas C. Heller (ed.), *Reconstructing Individualism* (Stanford: Stanford University Press, 1986), pp. 222–36.
3. See, in particular, Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, NC, and London: Duke University Press, 2007); Peter Gallison and Bruce Hevly, *Big Science: The Growth of Large-Scale Research* (Stanford: Stanford University Press, 1992); Sandra Harding, *Whose Science? Whose Knowledge?* (Ithaca, NY: Cornell University Press, 1991); Karen Knorr-Ketina, *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge, MA, and London: Harvard University Press, 1999); Helen Longino, *The Fate of Knowledge* (Princeton: Princeton University Press, 2001); Joseph Rouse, *How Scientific Practices Matter: Reclaiming Philosophical Naturalism* (Chicago and London: Chicago University Press, 2002); Hans-Jörg Rheinberger, *An Epistemology of the Concrete: Twentieth-Century Histories of Life* (Durham, NC, and London: Duke University Press, 2010).
4. W. V. O. Quine, 'Two Dogmas of Empiricism', Philosophical Review 60 (1959), pp. 20–43; Ian Hacking, *Representing and Intervening: Topics in the Philosophy of Natural Science* (Cambridge: Cambridge University Press, 1983); Ludwik Fleck, *The Genesis and Development of a Scientific Fact*, ed. T. J. Trenn and R. K. Merton (Chicago: University of Chicago Press, 1979 [1935]).
5. See Hallam Stevens, 'Networks: Representations and Tools in Postgenomics', in Sarah S. Richardson and Hallam Stevens (eds), *Postgenomics: Perspectives on Biology after the Genome* (Durham, NC, and London: Duke University Press, 2015).
6. See John Dupré, *Processes of Life: Essays in the Philosophy of Biology* (Oxford: Oxford University Press, 2012).

7. See Dupré, *Processes of Life*; Ian Hacking, *The Social Construction of What?* (Cambridge, MA, and London: Harvard University Press, 1999); Nancy Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983).
8. See John Armstrong Muir Gray, *Evidence-based Health Care and Public Health* (Edinburgh: Churchill Livingstone, 2009).
9. Claude Bernard, *Introduction to Experimental Medicine* (London: Dover, 2003 [1865]).
10. E. O. Wilson, *Consilience: The Unity of Knowledge* (New York and London: Little, Brown, 1998).
11. E. O. Wilson, *On Human Nature* (Cambridge, MA, and London: Harvard University Press, 1978), p. 167.
12. See Knorr-Ketina, *Epistemic Cultures*, for a discussion of experimental differences between physics and biological sciences.
13. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: Chicago University Press, 1962).
14. Immanuel Kant, *Critique of Judgement*, trans. James Creed Meredith (Oxford: Oxford University Press, 2007).
15. The major exception to this is Zola's justification of the experimental novel as extending the research methods of naturalist science in his *The Experimental Novel and Other Essays*, trans. Belle M. Sheraton (New York: Cassell, 1893).
16. John Cage, *Silence: Lectures and Writings* (Middletown: Wesleyan University Press, 1961).
17. Theodor W. Adorno, *Aesthetic Theory* (London: Bloomsbury, 2013), p. 23.
18. See also Britta Timm Knudsen and Lisa Blackman, 'Researching Affect and Embodied Hauntologies: Exploring an Analytics of Experimentation', in Carsten Stage (ed.), *Affective Methodologies* (London: Palgrave–Macmillan, 2015).
19. George Eliot, *Middlemarch* (London: Penguin Classics, 2012).
20. G. H. Lewes, *Problems of Life and Mind: First Series,* 2 (London: Trübner, 1875).
21. See Bruno Latour, *Reassembling the Social: An Introduction to Actor Network Theory* (Oxford: Oxford University Press, 2007).
22. The research underpinning this essay was funded by a Leverhulme award F/DO128?BF.