

The Human Sciences in a Biological Age

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Abstract

We live, according to some, in the century of biology, where we now understand ourselves in radically new ways as the insights of genomics and neuroscience have opened up the workings of our bodies and our minds to new kinds of knowledge and intervention. Is a new figure of the human, and of the social, taking shape in the 21st century? With what consequences for the politics of life today? And with what implications, if any, for the social, cultural and human sciences? These are the issues that are discussed in this article, which argues that a new relation is required with the life sciences, beyond commentary and critique, if the social and human sciences are to revitalize themselves for the 21st century.

Keywords

biology, body, brain, ethics, human, social

What kinds of creatures do we think we are, we contemporary human beings?¹ How have we come to understand ourselves in these ways? And with what consequences? Of course, there is no single answer to such questions: multiple differences disturb all attempts to speak of a singular 'we'. Nevertheless, from their birth, the sciences of the social and moral orders have had their own views about the 'nature' of the human beings whose social and mental lives they studied. And, from their inception, these sciences have had to negotiate their relationship with 'biology'. Biology in two senses: (1) biology as the field of positive knowledge of living beings that we give that name; and (2) biology as the reality of those beings themselves – humans who are, after all, animals, living creatures, who are born, live, sicken and die. To think of the human as animal: over the second half of the 20th century, such ideas became associated with essentialism, determinism, reductionism, fatalism, with the naturalization of human delinquencies from sexism to warfare, and

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with a bloody legacy of horrors from racial science to eugenics. But in what some have termed 'the century of biology' (Venter and Cohen, 2004), this issue is being re-posed – in politics, in the life sciences and in the human sciences.

Contemporary biopolitics centres not on death but on 'life' – that is to say, it is organized around dilemmas concerning human vitality: human rights to life (a dignified life, a quality of life), the equality of all humans as particular kinds of living creatures (human rights), the value of life, the future of life, and what can be done to the lives of some to facilitate the lives of others (pre-implantation genetic diagnosis, stem cells, organ transplants, donations of body parts) (Rose, 2007). This focus on the vitality of the living body is also becoming central to the human sciences. Nowhere was 'the discursive turn' more problematic than when debates over 'the body' seemed to deny any powers to the bloody thing itself. But over the last decade a number of social theorists and feminist philosophers have come to realize that it is not reactionary to recognize the reality of our fleshly nature, and to examine the possibilities and constraints that flow from it (Blackman, 2008, 2010; Braidotti, 2002; Grosz, 1994; Massumi, 2002; Thrift, 2007; Wilson, 2004b). Along similar lines, a radical movement in philosophy is rethinking the place of the animal in contemporary thought, rethinking the founding distinction of the human sciences – that between us tool makers, sign makers, language speakers and other animals (e.g. Calarco, 2008; Daston and Mitman, 2005; Haraway, 1991, 2007; Wolfe, 2003). No longer are social theories thought progressive by virtue of their distance from the biological. Indeed the reverse assumption is common – it seems that 'constructivism' is *passé*, the linguistic turn has reached a dead end and a rhetoric of materiality is almost obligatory.²

Many things have led to this reframing of the human. Some have to do with the cycles of theoretical fashion in the human sciences. Some stem from a new sense of our precariousness as a species in the face of ecological threats and climate change. Others arise from a belief that the embodied nature of human beings generates creative forces that can lead to political resistance and change. Some of this work makes reference to developments in the life sciences. But most authors derive their instructions on bodies and brains from philosophy. And when those from the social and human sciences do turn to biology, there is an understandable tendency to draw upon books about the life sciences written for non-specialists, and to select those themes that match their theoretical or political aspirations. The specialist literature on such issues as genomics, epigenetics, neurogenesis and brain plasticity is large and growing, with new findings announced on a daily basis, with implications that are often hard to evaluate. And today, as never before, the sciences of the living are connected up in different ways with many other disciplines – from informatics to engineering, from mathematics and physics to complexity

science. Indeed, there is no one biology in this 'biological age'. But despite this heterogeneity, thought styles are emerging in many areas of contemporary biology that offer the opportunity for a new relationship between the human sciences and the life sciences. We can point to three key features of that biology that can underpin that new relationship.

First, the contemporary life sciences – in genomics, in the understanding of the cell and the processes of development and differentiation, in molecular neuroscience – reveal multiple affinities between humans and other creatures, and throw new light on their differences.³ These issues now appear in a way that is not amenable to the simplifications of socio-biology, not least because, in the age of genomics and epigenomics, the old tropes of biological or genetic determinism can no longer be scientifically supported. Further, in the styles of thought of the contemporary life sciences there is a pervasive tension between the experimental reductionism that has always been anathema to the human sciences and an awareness of complexity and emergence – an open dynamism that is less familiar. On the 'reductionist' side of things, we have seen the rise of a molecular and neuromolecular style of thought that analyses all living processes in body and brain in terms of the material properties of cellular components – DNA bases, ion channels, membrane potentials and the like. This molecular vision of life can be traced to the 1930s. It was given great momentum by developments in molecular biology that followed Crick and Watson's work in the 1950s, and the invention of neuroscience by Francis Schmitt and others in the 1960s. And it has been made even more powerful by its convergence with the technologies of the information age, rendering living processes into digital elements that can be freed from organic origins and manipulated and circulated as mere data.

Yet alongside this reduction of life to the interaction of its smallest components, another style of thought has taken shape. This way of thinking construes vital properties as emergent, and living organisms as dynamic and complex systems, located in a dimension of temporality and development, and constitutively open to their milieu – a milieu that ranges in scale from the intracellular to psychological, biographical, social and cultural.⁴ One of the key conceptual struggles in the sciences of the living – which one can find in almost every area – concerns the relations between these two visions. The human sciences, with their grasp of the multiple ways that living organisms shape and are shaped by their milieu across space and time, could play an important role here, if they were willing.

Today, to deem something biological is not to assert destiny or fatalism, but opportunity. As the corporeal becomes construed not as mystery but as molecular mechanism, organisms, including human organisms, seem amenable to optimization by reverse engineering and reconfiguration at this molecular level. Hence, *second*, we have seen the 'technologization' of vitality in the life sciences. It is not only that to know is to

intervene, although that is crucial: one knows life today only by intervening in it. Gaston Bachelard's view is as true as it ever was: a concept 'becomes scientific according to the proportion to which it has become technical, to which it is accompanied by a technique of realization' (Bachelard, 1969 [1938]: 61, quoted from Rheinberger, 2005: 320–1). Intervention is not just to know, but also to do: knowing life at the molecular level has been intrinsically related to an enhanced capacity to act upon it at that level. Life itself – that is to say, the living of the living organism – seems to have become amenable to intervention and open to projects of control. Developments such as Ian Wilmut's cloning of Dolly by inserting the nucleus from a somatic cell taken from the mammary gland of one sheep into an unfertilized enucleated egg cell from another (Wilmut and Highfield, 2006) and Craig Venter's creation of Synthia – a bacterial cell controlled by a chemically synthesized genome (Gibson et al., 2010) – have led some to suggest that nothing is biologically impossible, and only our own imagination – and our own ethical and social constraints – set the limits on what we can do to our vital existence and that of other animals. Wilmut subtitles his autobiography 'Dolly and the Second Creation'. Venter, too, is routinely credited with such beliefs. These fantasies of omnipotence, while they inspire much utopian and dystopian speculation, grossly overestimate both our knowledge and our technical capacities. Nonetheless, a global bioeconomy has taken shape around the manipulation of biology, and biological knowledge has become highly capitalized. Paths to the creation of biological truths have been shaped by promises and predictions of the biovalue to be harvested – enhanced crop yields, bioenergy, bioremediation, and, of course, advanced medical and health technologies based on biology. Companies, nations and regions compete in this global bioeconomy, arguing that developments such as synthetic biology will underpin a new industrial revolution welding together the dreams of patients, politicians, researchers and capitalists in what Carlos Novas has termed 'a political economy of hope' (Novas, 2006).⁵

There is much value in the work we now do to maintain ourselves as living beings. The medical and healthcare segments are the most lucrative zones of the global biotechnology market: in 2008 they generated 69 percent of the market's overall revenues. By 2011, the global market for pharmaceuticals was around \$500 billion, and that for medical devices about \$150 billion.⁶ This is indicative of a *third* feature of contemporary biology that calls for attention by the social and human sciences: the salience that the biological and the biomedical has achieved in practices of self-management and self-governance. Not just in 'the West' but also in many other regions, individuals are coming to understand themselves in the language of contemporary biomedicine, to judge themselves in terms of the norms articulated by biomedical experts, to modulate their bodies and minds with products that are the product of

biomedical belief systems, to use new reproductive technologies to manage procreation, to consider replacing worn out body parts with artificial hips and knees, to think about reducing risks of disease with diet and exercise, and to worry, individually and collectively, about Alzheimer's and the dementias, maybe even to take up Sudoku and mind gyms in the belief that if they act this way, they may be saved. In this sense, personhood itself is becoming increasingly somatic (Novas and Rose, 2000).

Over the 20th century, at least in the countries of Europe, North America and their colonies, individuals' sense of themselves was profoundly shaped by the rise of the psy sciences: assorted elements from the different schools of psychology became integral to their forms of life and to the way they were understood and governed by authorities (Rose, 1999). It is not surprising, then, that psychological conceptions of personhood became the often unarticulated presuppositions of the social and human sciences. But as the 20th century came to an end, another ethic came to the fore, linked to the belief that, while the domain of mind remained crucial, key features of our identity as persons were grounded in the flesh (Rose, 2007). In some respects, our bodies *were* our selves, although not quite in the sense meant by the Boston Women's Health Collective three decades earlier (Boston Women's Health Book Collective, 1978). Of course, there is nothing new about an emphasis on bodies, their management and their sculpting, action on the body in order to avert disease and maintain health (Porter, 1999). But today this somatic ethic is underpinned by an unparalleled truth discourse about the human body arising from the life sciences and biomedicine, disseminated through a network of injunctions from experts of the somatic, deemed to be a matter of state as well as of the individual, and embedded in multiple sites from home and school to workplace and leisure. To live well today is to live in the light of biomedicine.

Bookshelves groan under the weight of popular science discussing this new knowledge of our biology, and speculating about the implications for our capacity to understand and control everything from our cognitive capacities to ageing and death. The belief in the implications of advances in the life sciences for our everyday lives is exacerbated by the 'translational imperative' – the obligation on researchers in biology and biomedicine to promise to funders, to research assessors, to their university press offices and to the media that the results of their work on the fly, the worm, the mouse or the macaque will soon reach the clinic – usually 'in three to five years'. This is a fantasy of course. The more we know, the more we realize how little we know. Each dream of control over body or mind is soon met with downsides, side effects and disappointments. When it comes to human vitality, there is much that cannot be controlled or re-engineered according to our own desires, and much does remain 'biologically impossible'. There is no simple progression from the ability

to tackle simple problems to the conceptual and technological capacities needed to tackle complex ones, no golden path to ever-expanding powers, but many distinct and substantial biological barriers that are hardly understood, let alone overcome.⁷ Further, as I have already stressed, the life sciences do not constitute a homogeneous field, but a tangle of diverse and often incompatible disciplines and sub-disciplines, theories, concepts, arguments, bodies of evidence, experimental set-ups and so forth, riven with controversies over some rather fundamental issues. Nonetheless, despite the exaggeration, the idea that all living organisms, including humans, can be understood as biological beings, that their nature is not a matter of mystery but of mechanism, lies at the heart of the claim that this will be ‘the century of biology’. As does the further claim, even if it remains implicit, that so much that is specific about our humanity, our individual existence and collective arrangements can be understood in terms of our characteristics as specific kinds of living beings.⁸ How should those from the human and social sciences respond?

Biology and Sociology

Biology and sociology were born close together in the first half of the 19th century: biology in 1802, as the name for a new science of living entities – dividing nature into two ‘kingdoms’ – those possessed of life and those without it; sociology, as the scientific study of the development of human societies, conventionally ascribed to Comte in 1839. From birth, sociology has been haunted by biology. Across the 19th century there was a double move – on one hand, attempts *to differentiate* the sciences of the moral or social order from the strictly biological – to argue that the laws of association among human beings were ‘*sui generis*’. And, on the other, *to model* sociology on biology, to think of the social order as in some way or other analogous to the biological realm, with structures, functions, organic connections between parts, subject to laws of development that could be described in the language of evolution, and having a potential only possible for living entities: to be normal or pathological, healthy or sick.⁹

While the styles of thought of the biology of the 19th century infused the new science of sociology, the social sciences grew, at least in part, because of their biopolitical role. That is to say, they claimed to be able to provide the ‘know-how’ to govern those aspects of the individual and collective lives of human beings arising from, their nature as living beings – racial types, sexual desire, procreation, disease and epidemics in towns and cities, and of course the whole problem of the population, of its rates of increase and decline, of the consequences of differential fertility, degeneracy, eugenics... One only needs to list them for the intensity of those relations between the social sciences and the government

of humans as biological, vital, living creatures to become clear. This question was central to sociology as it became a discipline in the first half of the 20th century. Despite much vagueness as to what sociology actually was (Abrams, 1981; Rocquin, 2006), the sciences of society in the first half of the 20th century remained haunted by biology. This was not just in the notion that society could be pictured as a kind of organism, or in the recurring themes of social evolution. Their recurrent question was biological – a question of population (Osborne and Rose, 2008). Population was often addressed in terms of eugenics, though not always as we think of this now. At the London School of Economics, for example, William Beveridge, as Director of the LSE from 1919 to 1937, sought funding for a professorship in ‘social biology (genetics, population, vital statistics, heredity, eugenics and dysgenics)’ to ‘complet[e] the circle of the social sciences’.¹⁰ But he appointed Lancelot Hogben – a fierce opponent of eugenicists – because he believed that population problems could only be properly understood once the ‘rubbish about allegedly biological laws of population growth’ was sorted out: ‘human genetics was a morass of surmise and superstition . . . The rationalisation of race prejudice by appeal to biological principles was then plausible only because human genetics was so immature’ (quoted in Keynes, 2001). Alexander Carr-Saunders, successor to Beveridge as Director of LSE, who was a key figure in many official bodies exploring the question of population,¹¹ wrote extensively on eugenics and was president of the Eugenics Society between 1949 and 1953. While he was consistently critical of that form of eugenics which ‘calls to mind proposals for getting rid of persons with undesirable innate qualities and for encouraging the bringing into the world of well-endowed children’ (Carr-Saunders, 1926: 18), he concluded his Hobhouse memorial Lecture in Cambridge in 1942 under the title *The Biological Basis of Human Nature*:

It is nearly eighty years since Galton set the eugenic movement on foot. He may . . . have been overhasty [but] it appears that we now have sufficient information upon which to begin to take action if we so wish . . . The Romans, it has been said, prided themselves on being the degenerate descendants of the gods; we pride ourselves on being the very creditable descendants of apes. We shall cease to be a credit to our ancestors if we allow our genetic inheritance to deteriorate. (Carr-Saunders, 1942: 24)

When John Maynard Keynes presented Carr-Saunders with the first Galton medal in 1946 – 1946! – Keynes described Galton as ‘the founder of the most important, significant and, I would add, *genuine* branch of sociology which exists, namely eugenics’ (Blacker and Glass, 1967: 368).¹²

From the 1950s, things changed in the light of the murderous consequences that seemed to be associated with conceiving of human qualities in biological terms. Many post-war continental philosophers argued that Nazi Germany was characterized by a spiritualization of the biological, and biologization of the spiritual – the animalization of human character, will, value and virtue. This seemed to reveal, for all time, the consequences of a way of thinking in which the person and the body became seen as one, where the central task of politics was the shaping of the biological life of the race and the nation. It is true that biological metaphors remained common in the sociologies of the 1950s and 1960s – for example, in Talcott Parsons' fascination with ideas of organic and homeostatic systems, and his metaphorical and typological uses of the language of functions and of evolution. However, by the 1970s it became sociological common sense that fatalism, determinism, reductionism, sexism – a naturalization and legitimation of existing relations of power – would follow inescapably from any engagement with the reality of human biology – as either an ontological question – what were humans really like? – or as an epistemological one – what can biology tell us about the forms of life that humans have made for themselves? Human biology was relevant only in that it provided the preconditions for language, meaning and culture, whose form and content must be accounted for in non-biological terms. The controversies that flowed, notably over race and intelligence, seemed to confirm this negative judgement on those who imported vulgar biological notions into their diagnoses of the social (Kamin, 1974; Lewontin et al., 1984), as did the simplifications of sociobiology, evolutionary psychology and doctrines of 'the selfish gene' (Rose and Rose, 2000). The evidence of two centuries seemed to place references to the biological on the side of a reactionary politics that tied humans to a fixed nature – to be progressive, to aim for social change, justice and equality, required keeping biology in its place.

And yet, as the 20th century closed, there were signs that this sociological common sense was coming into question.¹³ While many initial concerns with the theme of embodiment elided that fleshy, bloody, animal thing itself (famously Butler, 1993), the living body was directly at issue in the many ethnographic studies that traced the ways in which biological knowledge was managed, lived, employed, contested, intricately into the lives of women in reproduction, kinship and parenthood (Franklin, 1995; Martin, 1987; Rapp, 1999), and others that examined the new relations between biological knowledge, medical intervention and the management of bodies, in sites ranging from HIV and AIDS to brain death (Epstein, 1996; Lock, 2002; Martin, 1994). It became common sense to argue that the capacities of 'the body' were shaped by cultural expectations, its normalities and pathologies were 'socially constructed', and features once considered natural – gender, sexuality,

race, age, disability and so forth – were actually performed according to cultural scripts.

Many participants in these debates have recently become critical of their overly discursive nature and sought to return to some version of materialism (Bennett, 2010). The tortuous attempts to recognize the ‘agency’ of non-human entities – scallops, bacteria, climate and the like (hardly startling news to any social historian) – speaks volumes about the wayward conceptual pathways previously taken in the field of science studies.¹⁴ Others sought more directly to reintegrate themes from biology, and, in the words of Elizabeth Grosz:

to redress the foreclosure, the denial, of the biological forces that press on and produce life, and thus, ironically, to overturn the repression of the materiality in its most complex forms that has dominated the humanities and social sciences in their exclusive focus on cultural construction at the expense of natural production. (Grosz, 2005: 44)¹⁵

Thus Grosz herself has turned to Darwin and evolution to reconsider ontology, and to help her conceive of life as a ‘ceaseless becoming’ in which ‘essence is transformed into existence, the past and the present are superseded and overwritten by the future’ (Grosz, 2005: 36). Elizabeth Wilson has looked to Silvan Tomkins’ conception of universal innate affect systems, together with elements drawn from theories of neural networks and more visceral versions of psychoanalysis to reclaim aspects of biology for feminism, as in her project for ‘gut feminism’, that aims to conceptualize the ‘sedimentations’ of the neurochemical, affective, ideational and social in both the experience of depression and in its pharmacological treatment (Wilson, 1998, 2004a, 2010, 2011).

Others have been less careful in their ‘borrowing’ from the biological.¹⁶ This is especially the case with many protagonists of the contemporary turn to ‘affect’.¹⁷ It is becoming commonplace for those from the social and human sciences to allude to biological arguments to support their claim that human beings are not individuated, conscious and rational, but rather are enmeshed in sensations and contagions, shaped by affective and non-cognitive force fields (Connolly, 2002; Massumi, 2002). For example, Brian Massumi alludes ‘fleetingly’, as Ruth Leys (2011) puts it, to various findings concerning the role of the autonomic nervous system supposed to derive from contemporary neuroscience, and supports his belief in the bodily character of thought by reference to the highly dubious conclusions that Benjamin Libet draws from his experiments on volition (Libet et al., 1983, 1999). He uses Libet’s argument that there is a half-second delay between a decision being manifested in brain process and it entering conscious awareness to give empirical support to a philosophical argument drawn from Spinoza and Deleuze, with added

support from Gilbert Simondon (Massumi, 2002).¹⁸ Libet's bizarre reasoning, and his extrapolations from a highly simplistic and artificial laboratory set-up to general claims about the absence of free will in human actions and intentions in the everyday world, remain unquestioned. Nigel Thrift also frames his 'non-representational theory' through a critique of the rejection of biology by social theory:

distance from biology is no longer seen as a prime marker of social and cultural theory... It has become increasingly evident that the biological constitution of being ... has to be taken into account if performative force is ever to be understood, and in particular, the dynamics of birth (and creativity) rather than death. (Thrift, 2007: 174)¹⁹

This is asserted via a mind-bending amalgam of the usual suspects from philosophy – Agamben, Bergson, Deleuze and Guattari, William James, Spinoza and Whitehead – together with references to Simondon and von Uexküll and a few biologists or neuroscientists: LeDoux, Damasio, Ekman, the famous autistic Temple Grandin, Libet, and of course the Buddhist neuroscientist Francisco Varela. These figures are called upon to support the argument that it is only by recognizing the true nature of human corporeality and the power of the affective that we will be able to free ourselves from an overly intellectualist and rationalist account of contemporary politics, economics and culture. Only then will we be able to grasp, and perhaps to intensify, the non-conscious, non-intellectual level forces that inspire resistance, creativity and hope. Biology is translated into ontology, ontology is transmuted into politics. We have seen a similar move in recent history, appealing to a different biology, with political consequences that, to say the least, should give us pause.

A strange form of conceptual gerrymandering seems to underpin such 'liberation biology': biological claims evade critical interrogation where they seem to give support to a pre-given philosophical ethopolitics. This is a mirror image of the notorious tendency of life scientists to support socio-political arguments by transposing their research on flies or mice directly to the realm of human society and culture. Is there a more intellectually rigorous way to connect the human sciences and the life sciences? A few sociologists have called for a 'material-corporeal' sociology that thinks in terms of an interplay between the biophysiological properties of the human bodies, their shaping by social practices, and their organization by cultural and linguistic forces which shape individual lived experiences and identities (Newton, 2003; Williams, 1999). These modest sociological endeavours are attentive to evidence from biomedicine when they discuss the role of such issues as emotion, stress and social inequality in accounting for ill health, and muster evidence from research

on psychosomatic conditions and the role of hormones and the immune system. But such analyses usually conclude merely with the general claim that human bodies are simultaneously biological and social. They find it difficult to conceptualize the role that the social sciences might actually play in their relations with life scientists. Should we do what the life sciences often ask of us – supply them with the ‘factors’ and ‘variables’ that make up the ‘socio-ome’? Or should we resist the belief that the organism, the living individual, is distinct from its eternal milieu and only ‘interacts’ with it in the form of ‘inputs’ and ‘influences’?²⁰ Is there another way of approaching this issue of the relations between the human sciences and biology? Might things look different if we approached it from the direction of the life sciences themselves?

Open Biology, Open Vitality

Of course, even in the 1970s and 1980s, some sociologists sought to recognize the biological nature of human beings without lapsing into reductionism and determinism. Thus *Social Relations and Human Attributes*, written by Paul Hirst and Penny Woolley and published in 1982, opens with a quote from the evolutionary biologist Theodosius Dobzhansky (Hirst and Woolley, 1982).²¹ Human society and culture, says Dobzhansky, are the product of the biological evolution of our species, but ‘human phenomena’ – Dobzhansky mentions intelligence, the capacity to use linguistic symbols and culture – ‘affect the biological evolution of man so profoundly that it cannot be understood without taking them into account... Human evolution is wholly intelligible only as an outcome of biological and social facts’ (Dobzhansky, 1955: 320, quoted in Hirst and Woolley, 1982: 1). This is the central theme of Hirst and Woolley’s argument. Human attributes are, as they put it, ‘directly conditional upon man’s animal past’. But even *physical* attributes, such as bipedalism, opposable fingers and thumb, and the size and capacities of the human brain, arise from selection pressures from emerging *human* forms of life. And as humans developed their distinctive cultural forms, their attributes have been socially shaped and hence vary greatly between cultures and across historical time.

We have many empirically rich examples, ranging from bodily comportment (styles of walking, marching, swimming), through the manifestation of distress (in physical or mental symptoms and syndromes), to a sense of personhood (as individual, unique, autonomous) (Mauss, 1979). Indeed, as we can see from the numerous examples of children brought up in the wild or confined away from human contact, some attributes that we think of as quintessentially human – speaking, sexuality, the sense of self – do not appear at all in the absence of social and cultural shaping. Referring to the work of many anthropologists, psychiatrists and doctors of the first half of the 20th century, Hirst and

Woolley point out that cultures not only shape, in fundamental ways, the forms of expression of mental distress (Yap, 1951) but also that one can be brought to death by one's genuine belief that one has been cursed (Cannon, 1942, 1957). The recognition that the habitus, bodily capacities and fundamental mental categories of humans require formation – that the envelope of the skin does not, by rights, delineate an enclosed, autonomous zone – is thus by no means new. The human body cannot be the province of the biologists alone: culture, symbolism and the imagination are also constitutive, even when it comes to the organization and properties of basic musculature, hormonal systems, sicknesses and their cure, its emotional economy and even its passage to death.

In the 30 years or so since Hirst and Woolley wrote their book, these arguments have become even more telling, not least because they mesh with the changing thought styles in the heartland of molecular biology itself. Starting, perhaps, in the 1930s, there was a shift from a molar image of life, of organs, flows of organs, of muscles, of blood, of tissue, as represented in the paintings and drawings in the anatomical atlases of the 18th and 19th centuries, to a gaze that envisions the body at the scale of the interactions between molecules (Kay, 1993). And the relations of the social and the biological – the selection pressures that human life exerted on human evolution, and the shaping of human attributes by their milieu – have been re-posed in molecular terms (Rose, 2001). Of course, much research over the subsequent 50 years was reductionist in its methods and indeed in its forms of conceptualization, seeking to explain the properties of organisms in terms of the additive properties of their simplest components. Major advances in our understanding of genetic mechanisms, cellular processes and neurobiology were achieved through these methods, but they were beset with problems when they sought to translate these insights to an understanding of the organism as a whole. And increasingly, as noted earlier, these approaches are being challenged by another (Woese, 2004). In these developing thought styles, the organism and its milieu are not construed as realms external to one another and merely interacting: rather, when it comes to the living organism, organism and milieu are having to be understood as in constant and multiple transaction at the molecular level. This opens some intriguing new possibilities for overcoming the stand-off between progressive thought in the human sciences and the truth discourses of biology.²²

Consider, for example, the style of thought in 'social neuroscience'. Researchers seek to account for the distinctively *social* form of human existence by identifying evolutionary processes that have selected for the *neural preconditions* of sociality, group formation, and even consciousness (Cacioppo and Berntson, 2004; Cacioppo et al., 2011). Humans, they argue, can become 'social' in the sense of forming cooperative relations with one another because they have the capacity to ascribe

meanings to the movements or visible features of others, to ascribe these to their internal mental states, and hence to recognize the intentions and the feelings of their con-specifics. In a key article in 1990, Leslie Brothers, who was trained in psychiatry and psychoanalysis, famously argued that:

While many non-primates (for example, ants) can interact in highly specific ways with others of their kind, it appears that primates, especially those most closely related to ourselves, have developed a unique capacity to perceive psychological facts (dispositions and intentions) about other individuals. This capacity [that she termed social cognition] appears to distinguish primate social behavior from that of other orders ... (Brothers, 1990: 27)

Many of those who have developed these ideas suggest that such capacities for social cognition have genomic conditions – that is to say, they are rooted in specific molecular sequences that code for the neurobiological processes that subservise such human sociality. For example, Klaus-Peter Lesch has suggested that a ‘polymorphism’ in one particular genetic sequence of the serotonin transporter gene (*5-HTT*), present only in humans and some primate species – which regulates the activity of one important neurotransmitter in certain regions of the human brain – has consequences for embryonic development and brain plasticity, in particular in brain areas related to cognitive and emotional processes, which transcend ‘the boundaries of behavioral genetics to embrace biosocial science and create a new social neuroscience of behavior’ (Lesch, 2007: S24–S28). Here is an argument from contemporary neuroscience that argues that humans are evolved to be ‘social’ and something of the specific form of human sociality has its conditions in human neurobiology.

Many from the social and human sciences react with horror to this suggestion that our specifically human social capacities have neurobiological bases.²³ At the least, they feel that their space is being colonized, their expertise displaced. But, more fundamentally, they suggest that the very nature of human beings is being misunderstood. That, instead of understanding humans as uniquely speaking subjects, with culture and history, this kind of analysis reduces them to puppets of their brains, implying that human sociality is a mere effect of neurobiology. These critics are concerned that, in claiming that the relations between our forms of life and those of our animal forebears may not be of fundamental difference but of continuity, we will forget that only humans can express these relations, communicate them with others, build systems of morality, law and civility upon them. They fear the consequence of placing humans among the animals in this way. I understand such arguments but find them unconvincing.

Of course, there are plenty of examples of simplistic reductionism – Leslie Brothers herself became very critical of the ways in which social neuroscience had developed (Brothers, 2001). There is much to criticize, in particular in the branch of social neuroscience that is enamoured of brain imaging, which is characterized by gross over-interpretation of results from imaging experiments in highly artificial laboratory situations, and espouses a kind of ‘blobology’ that claims that an area of the brain that shows activity in a brain scanner – one containing billions of synapses at current resolution – is the location for this or that human mental state.²⁴ Imaging technology, however marvellously sophisticated, cannot make up for the woefully simplistic conceptual apparatus of many imagers. Words like ‘subserve’ and phrases such as ‘neural correlates’ gesture to the explanatory gap that remains between brain processes and mental processes. Social scientists have given us excellent studies of the theories, premises, algorithms and assumptions that are built into the exquisite scanning machines that produce the images (Beaulieu, 2000; Dumit, 2003) – this is indeed Bachelardian phenomenotechnics in action. It is also a classic example of what Gerd Gigerenzer, a long time ago, termed ‘tools to theories’, a process in which a tool – here the functional MRI scanner that maps patterns of blood oxygenation in voxels in a three-dimensional space, that are then used to produce visual images implying activation in different locales – then becomes the basis for a theory about the activity of the brain itself that each image seems to confirm (Gigerenzer, 1991). And those from the social and human sciences rightly identify the impoverished sense in which, in these imaging experiments, ‘social relations’ are reduced to interactions between dyads that can be experimentally simulated in a laboratory and in a scanner (Cohn, 2004, 2008a, 2008b).

But critique is not enough, and nor are the familiar tropes of constructionism. There are opportunities for a more positive relation to these new understandings of what it is to be human. For example, John Cacioppo’s work has focused on the interplay between social interactions – at the level of dyads, through families, neighbourhoods to cities and civilizations – and the brain and nervous system of the individual:

through a continuous interplay of neural, neuroendocrine, metabolic and immune factors on brain and body, in which the brain is the central regulatory organ and also a malleable target of these factors . . . Social neuroscience is the interdisciplinary academic field devoted to understanding how biological systems implement social processes and behavior, and how these social structures and processes impact the brain and biology.²⁵

Further, Cacioppo argues, humans have an evolved human affinity for social life – hence the consequences of human isolation:

The social environment . . . is fundamentally involved in the sculpting and activation/inhibition of basic structures and processes in the human brain and biology . . . social isolation or perceived social isolation (loneliness) gets under the skin to affect social cognition and emotions, personality processes, brain, biology, and health.²⁶

A pre-eminently culturally shaped human experience – not just ‘actual’ but ‘perceived’ isolation – configures neural processes at the molecular level and vice versa. Humans can, indeed, be dying for company (Cacioppo and Patrick, 2008). If this is not an invitation to the social and human sciences for engagement in a genuinely transdisciplinary question, it is hard to see what would be. Indeed, perhaps this is an endeavour not that different in intention from Georg Simmel’s (1950 [1903]) classic study of mental life in the metropolis.

Genomics beyond the Gene

The same is true of genomics. We need no reminder of the dispiriting and often murderous ways in which genetic explanations have entered human history. But things have changed. Genomics has moved away from a style of thought that looked for single genes for specific characteristics, the ‘gene-for’ paradigm so criticized by social scientists, especially when it claimed to have discovered ‘the gene for’ an aspect of the human condition, such as homosexuality or bipolar disorder. While the Human Genome Project was initially underpinned by the idea that the sequence of the genome would be ‘the code of codes’ or ‘the book of life’ – the digital instructions for making a human being – the real itself intervened to say no. The evidence from sequencing of humans and other organisms simply did not support the view that genes were distinct units, each of which coded for a single protein. Instead, it became clear that each sequence of bases could be ‘read’ in many different ways, thus enabling a small number of coding regions to generate a large number of different proteins. Further, it appeared that single nucleotide polymorphisms, or SNPs (multiple small molecular variations between species and between individuals), for example where a C is substituted by a G, or an A is substituted by a T in the string of bases that make up the genetic code, shape differences in the way an organism develops – leading to a plethora of genome-wide association studies seeking the algorithms of such variations that could explain why some individuals developed diseases and others did not (Manolio and Collins, 2007). This led to the first significant mutation in thought styles: a shift away from determinism towards a probabilistic way of thinking about the relationship between genetics, development, evolution, organism and life chances.

In a recent review of the impact of the sequencing of the human genome 10 years on, the eminent genome scientist Eric Lander pointed to our

growing realization of how much we now know that we do not know (Lander, 2011). While only about 1.5 percent of the genome contains protein coding sequences – the classical ‘genes’ – a further 6 percent is evolutionarily conserved, and hence biologically functional, but does not code for protein. This means that there are millions of conserved elements whose function we do not know: perhaps they are involved in the regulation of transcription in development, perhaps they do something completely different. There are thousands of other sequences that also have unknown roles in such processes as cell-cycle regulation, or immune response, or in brain processes. Genomic sequences – the ‘codes’ made up of G, C, A and T – are one-dimensional, but chromosomes in cells have a topography in three dimensions, and we know little about the implications of chromosomal configuration. We may be beginning to understand the role of the millions of polymorphisms in genes – places where a single nucleotide changes – but we know even less about the effects of copy number variation, where whole genetic segments are duplicated many times. We are moving away from the idea that each common disease will share the same genomic basis – even if a complex one – to a model where common diseases are the endpoints of many different, rare genomic variations. Even in conditions where we have a clear idea of heritability, such as certain forms of breast cancer, the proportion explained by what we know of genomics is small and the ‘missing heritability’ – which cannot be explained by genetics – is high, ranging from 50 percent for age-related macular degeneration, 20 percent in Crohn’s disease and around 95 percent in elevated lipid levels (Manolio et al., 2009). And so on. The more we know, the more we don’t know. And the more we find ourselves moving away from the idea that the genome is the prime mover, the uncaused cause, and towards a style of thought that sees the genome as much affected and shaped by all around it at the same time as it shapes it.

As it has become clear that variations in the genomic sequence itself, even at the SNP level, account for only a small percentage of differences between individuals in disease susceptibility, attention has turned to a process long known to developmental biologists who study cellular development and differentiation in organisms: epigenetics. This refers to the processes across the life of an individual in which transactions with its environment – with the cellular, organic, biographical, ecological milieu – modify the DNA itself, accounting for the fact that although every cell in a multi-cellular organism (in the liver, the heart, the brain...) contains the same DNA sequence, they develop radically different properties.²⁷ Of course, we should be wary of those who celebrate epigenetics as a new saviour – once more, there is much here that is simply not understood. Yet, at its best, the turn to epigenetics marks a recognition of the inseparability of vitality and milieu which could give a crucial role for the social and human sciences in accounting for the shaping of vitality at the molecular level.²⁸

Take, for example, the research undertaken by Michael Meaney and his group for over three decades on the effects of early experiences on rodent behaviour (Meaney and Stewart, 1979; Meaney et al., 1985). This work has focused on the effects of maternal behaviour on the developing brains of offspring – what is now termed epigenetic programming. The mother's behaviour towards her pup shapes the expression of genes through altering the methylation of the DNA, and this shapes neuronal development in the pup (Szyf et al., 2008) and in turn shapes the pup's own behaviour towards its own offspring. By 2009, this group was suggesting that these findings could be translated to humans: there were common effects of variations in maternal care on epigenetic regulation in stressed rodents and in suicide victims with a history of child abuse (McGowan et al., 2009). The brain, it seems, no less than the psyche before it, is open to environmental inputs, and – in yet another blow to ideas of a one-way traffic between genotype and phenotype – these work at the level of the genome, modulating gene expression with consequences that might flow down the generations (Meaney and Ferguson-Smith, 2010). Should the social and human sciences react with horror to such arguments? I don't think so. Is the argument that stressed rodents share something with stressed humans a threat to the conceptual and moral delineations of the human? I don't think so. Should we work with these researchers, help in trying to understand the strengths and weaknesses of animal models, seek to model more closely the effects of biography, sociality, culture and history, and guard against the rush to demand immediate impacts in social policies and practices? Yes. That would be a way of revitalizing sociology that would not threaten it but bring it, once more, into alignment with the positive knowledges of the creatures whose relations we seek to analyse.

In all these areas of the life sciences, despite their differences, a style of thought is emerging of constant transactions across the apparent boundaries of the organism that constitute, shape and support vitality, at time scales from the millisecond to the decade, at levels from the molecular to the cellular, the organ and the organism itself. This is a form of argument that links to, but goes beyond, the important recognition that human capacities such as cognition and affect are 'distributed' – not the individuated property of singular organisms, but constitutively dependent on the webs of interactions among multiple organic processes within and between organisms and other entities in a locale. Of course this thought style operates in very different ways in different disciplinary domains, and there is no single way that the social and human sciences might make their links with them. But it is clear that such links will not be in terms of the relations of 'body' and 'society' – those enticing yet illusory totalities – but at a different scale. Not in terms of 'the body' or 'the brain' as coherent systems enclosed by a boundary of skin, but of bodies and brains as multiplicities, of the coexistence and symbiosis of multiple

entities from bacterial flora in the gut,²⁹ to the proliferation of neurons in the brain, each in multiple connections with milieu, internal and external, inorganic, organic, vital, historical, cultural, human. Distributed capacities in milieu which vital organisms themselves partly create and which in turn create them and their capacities.

Relationships between the social and cultural sciences and the life sciences are unlikely to be harmonious. There are many areas where the human sciences can and must challenge the simplicities of the life sciences when it comes to history and culture. Consider three examples from my own recent work on the relations between neuroscience and the criminal justice system. Neurobiological evidence about the specificity of 'the adolescent brain' (Casey et al., 2008) is being deployed in the United States in arguments seeking to mitigate the legal responsibility of young people. Such work cries out for an engagement from those who know how historically recent, and culturally specific, is the notion of adolescence itself. Many researchers are enthusiastically searching for neurobiological markers to ground psychiatric diagnoses – an endeavour which radically misunderstands not only the social role of classification but the very nature of human mental distress (Singh and Rose, 2009). In a related area, many seek to formulate neurobiological accounts of psychopathy, which they hope may give rise to strategies of prediction and pre-emption – but these look very different in the light of historical understanding of the category itself, and a social analysis of the historical conditions that have given rise to risk predictions of pathology, and an understanding of conceptual problems and socio-political consequences of the problematics of risk (Rose, 2010). These are just some small empirical examples of the places where dialogue across the divide, however difficult, is both conceptually significant and practically relevant.

These indicators of the difficulty of dialogue should not deter those from the social and human sciences, but incite them. Despite the warnings of those who fear the consequences of placing the human among the animals, this opportunity for engagement places a certain demand on us that is both conceptual and ethical. Not that we give up responsibility for that which is biological, or deny its pertinence for our own investigations, but rather that we take responsibility for the biological – for the social shaping of the bodies and brains that constitute us as specifically human animals, whose welfare, in some small way, we hope to foster.

Beyond Vitalism?

Some suggest that, with the emergence of a molecular vision of life, we no longer need any residual 'vitalism' to understand the processes in which life consists (Bedau, 2010). Who needs vitalism when the complexity of living systems can be broken down into describable interactions between specific kinds of parts, their living processes can be reverse engineered,

the parts and their properties can be freed from their origins in any specific organism, and reassembled, first in thought, then in reality, to produce whatever outcome you can dream up. We see these mechanistic principles in operation in some ways that animal models are used in biomedical research, for example where human genes are inserted into the animal in the hope that it will then be a more accurate model for the development of particular human pathologies or the testing of drugs. The implications of the many failures of translation from such animal work to humans, especially in relation to mental disorders, are the subject of much debate.³⁰ But perhaps the apotheosis of this way of thinking can be seen in certain approaches to synthetic biology, based on the explicit belief that vital processes can be construed as assemblies of parts specified by their gene sequences, and these parts can be fabricated and connected together to make something completely new... to create the organisms that evolution forgot (Baker et al., 2006; Endy, 2005; Royal Academy of Engineering, 2009). You take the genes for green fluorescence from one organism, the ability to live at 200 degrees from another, and to digest oil from a third, you insert them into a 'chassis' made from your organism of choice, and you have a green, heat-loving, oil-eater. Or so it is hoped. In this 'flat' ontology of life, the belief is that any element of a living system can, in principle, be freed from its origin in a particular organism or organ and mobilized, connected into relays, circuits, networks with other such elements and retain the properties that are somehow inherent within the 'part' itself (Rose, 2007).

However, a closer examination of synthetic biology shows how misleading is this fantasy of biological control, and its foundational premise of life as pure mechanism. As Rob Carlson recently pointed out (Carlson, 2010), a Boeing 747 consists of about 50,000 kinds of parts – some 6 million total components – and the precise specification of each part is known and amenable to a quantitative description. A relatively simple cell, for example yeast, has millions of moving parts, most of which are unknown: approximately 6300 kinds of genetic parts, of which we can name about half, but for most we have no design specifications at all, not to mention all the other parts that are involved – the structure of sugars and lipids for example – that are not encoded in the genome, and for which we have only the vaguest ideas of how they are shaped and how they work. A human body has something around 10^{14} or 100 trillion cells, most of which are as complex as yeast – not to mention the microbes that inhabit us. The human brain contains about 100 billion neurons, each of which is different, with 100 trillion synapses connecting them. Social scientists must look beyond the hyperbolic forms in which some scientific activities are presented in the current climate: we must work closely with the actual researchers, and explore their operative philosophy. We will find this more hesitant, more modest – and more open to a genuine conceptual engagement.

Conclusion

Of course, there are crucial philosophical issues at stake here. But the best way to understand them, I suggest, is to proceed by means of what Michel Foucault, drawing on Bachelard, called ‘field work in philosophy’, that is to say, by empirical investigations of the operative philosophy of the biologists themselves. This is not a matter of subscribing to what the scientists themselves say about their activities when they reflect on them from their armchairs, in retirement or in their popular writings. To decipher their operative philosophy, we should ask them, as Bachelard did, to:

Tell us what you think, not when you quit the laboratory, but during the hours when you leave ordinary life behind you and enter scientific life. Instead of leaving us with your empiricism of the evening, show us your vigorous rationalism of the morning. (Bachelard, 1940: 11, quoted in Rheinberger, 2005: 318)

In one of his characteristically enigmatic statements, the French philosopher and historian of biological thought Georges Canguilhem remarked: ‘The thought of the living must take from the living the idea of the living’ (Canguilhem, 2008 [1965]: xx). That is to say, at every historical moment, the ways in which we *think about* how to think about vitality must be informed by, underpinned by, shaped by, premised on, the very way in which vitality itself is understood in the contemporary sciences of life. Our relationship to the forms of knowledge generated by the life sciences cannot – should not, in Canguilhem’s normative doctrine – be indifferent to that knowledge, cannot treat it as merely one set of claims among others.

Yes, we can identify the conditions of possibility of our regimes of truth about life. Those conditions not only define the structure of the rationality of the life sciences but, increasingly, shape our experience of ourselves and our present. They set a path for the development of biomedicine and biotechnology, and all the ways in which, today, vitality – in plants, animals and humans – has become a domain of intervention and the production of biovalue. In analysing the ways in which the life sciences are reshaping our experience of ourselves in our present, we can also identify what those truths about ourselves, our lives, our world, our reality, make possible or preclude. There is much to be critical of here, especially if one wishes to reshape those pathways in the service of life, and not just of reputation, grants or profit. But all truth claims have conditions, and elegant descriptions of the ways in which our current biological truths have been created do not suffice for a critical engagement between the social and the life sciences.³¹

To paraphrase another of Georges Canguilhem's suggestive phrases, we can say that every mode of biological reason is, in a certain way, also a philosophy of life.³² A philosophy of life because our way of living, our sense of how we should live as humans, why we should live as humans, of what we owe to ourselves and others, of what we can know, what we should do, what we can hope for: all these have become tangled up – maybe always were tangled up – in what we think we are as living creatures. Who can doubt that this is true of all the varieties of reasoning about vitality, intervening in vitality, and questioning vitality, that constitute contemporary biology?

As we know, there are some who claim that these developments have put the final stake in the heart of vitalism. Do we now inhabit a fully disenchanting world, in which we realize that vitality is merely the intelligible result of physical, chemical, mathematical, stochastic processes? Things are more complex. Of course, our powers to intervene in our bodies are remarkable: to replace body parts, modulate vital systems with drugs, tame cancers and much more (Hacking, 2007). As for our brains, we have a very long way to go (Price, 2011). But simple mechanical reductionism does not capture the operative philosophy of the sciences of life and the forms of biomedicine to which they are linked. Vitalism will remain as a constant reminder of the self-organizing, dynamic, self-regulating complexity of living systems, the fact that, unlike machines, they exist and develop in time and space, and of the inseparability of organism and milieu in life in the real world. The social and human sciences need to grasp these operative philosophies of biology and biomedicine, to explore the 'philosophies of life' which they embody and the potential forms of life to which they may be linked. But more than this, our own disciplines need to grasp the shaping – and the all too frequent cramping – of human vitality, to engage with the sciences and play our part in addressing the local, national and global inequities that devastate the vital lives of so many of our fellow biological citizens.

There are good historical reasons why many in the social and human sciences have been so critical of attempts to build a positive relation with the life sciences. But their dread of determinism, reductionism, of the dire ethical and socio-political consequences of locating humans among the animals, is now misplaced. It is time for us to configure a new double relationship with biology. On the one hand, this requires us to subject the tendentious and exaggerated claims of enthusiasts, popularizers and their media representations to critical evaluation, and to argue for a sober evaluation of the current state of the life sciences, recognizing the limits of their explanatory capacities and the many weaknesses in their translational achievements. On the other, we must move beyond description, commentary and critique, beyond the study of downstream 'implications' of biology and biomedicine, to develop an affirmative relation to the new ways of understanding the dynamic relations between the vital

and its milieu – the vital in its milieu – the vital milieu – that are taking shape. This relationship cannot be one of wide-eyed embracing of every latest pronouncement, let alone the displacement of our own hard-won knowledge of the social shaping of human lives. An affirmative relationship is one that seeks to identify and work with those arguments that recognize, in whatever small way, the need for a new and non-reductionist biology of human beings and other organisms in their milieu, and which can thus be brought into conversation with the evidence, concepts and forms of analysis developed in the social and human sciences. This requires us to accept that the social and human sciences are also sciences of the living, of living bodies, of living matter, of matter that has been made to live. It is hard to know how such a relationship of critical friendship will turn out. But the project of creating that relationship is one of the most important to confront our disciplines today. It might also restore some of the capacity of those disciplines to help remake our human world for the better.

In a famous remark, Sigmund Freud encapsulated the blows that human narcissism has suffered at the hands of science – first when Copernicus showed that our planet was not at the centre of the universe but just a tiny fragment of a vast cosmic system, and second when Darwin showed us humans that we were not the privileged beings of creation and revealed our ‘ineradicable animal nature’. But, Freud continued:

human megalomania will have suffered its third and most wounding blow from the psychological research of the present time which seeks to prove to the ego that it is not even master in its own house, but must content itself with scanty information of what is going on unconsciously in its mind. We psychoanalysts were not the first ... to utter this call ... but it seems to be our fate to give it its most forcible expression and to support it with empirical material which affects every individual. (Freud, 1953–74 [1916]: vol. 15, 284–5)

Contemporary life sciences, in claiming that the historical, biographical, social and cultural are written into the interior of the individual in their biology and their neurobiology, offer a harder challenge to that human narcissism. But this challenge might be even more important in the ways it reconfigures the relations between humans and animals, humans and matter, humans and their milieu, in what it helps us to understand about our vital existence.

Some will also recall Michel Foucault’s words at the end of *The Order of Things* (Foucault, 1970: 386–7). The figure of ‘the human’ as the unique organizing principle of knowledge and morality was, he argued, held together by a certain ‘historical *a priori*’. In giving the uniqueness of

the human a privileged place as both the subject and the object of 'positive' knowledge, this a priori formed the unspoken premise of the human sciences. He suggested that structuralism would transform this framework, displacing the figure of 'man' from its throne. Almost half a century later, it is not philosophy but the life sciences that is leading an epistemic change in our relationship to the human. And if a new figure of the living is taking shape, effacing the old 'like a face drawn in sand at the edge of the sea', what part might the human and social sciences themselves play in the new figure of the human that is being born? That is the challenge for those who hope to revitalize our own disciplines for the 21st century.

Notes

1. An earlier version of this article was given as my inaugural lecture for the Martin White Professorship of Sociology at the London School of Economics and Political Science in March 2011. I dedicated that inaugural lecture – which as it turned out was also my valedictory lecture at the LSE – to the memory of two inspiring and generous transdisciplinary intellectuals who knew so much about the relations of the natural and social sciences, Paul Hirst and Roy Porter – they are much missed. A version was also given as a keynote address to the International Conference on Knowledge, Culture and Social Change, Centre for Cultural Research, University of Western Sydney, 9 November 2011, and published by them as a Working Paper (available at <http://www.uws.edu.au/ics/publications>). I am grateful to the comments from ten referees who read the paper for *Theory, Culture & Society*, especially those who wrote at length on the issues I discuss: their anonymity prevents a proper dialogue, but I have done my best to address some of their comments while maintaining the overall lecture form of my argument, which is intended as a statement of position drawing on a decade of my own empirical work in genomics, neuroscience and synthetic biology. In important ways, this ethos underpins my newly established department of Social Science, Health and Medicine at King's College, London.
2. We can note in passing the point made by one referee – that the centrality that the linguistic turn gave to signs did, in fact, have considerable resonances in the life sciences – Canguilhem famously remarking, in the wake of the work of Watson and Crick on the genetic code, that 'the science of life [now] resembles grammar, semantics and the theory of syntax. If we are to understand life, its message must be decoded before it can be read' (Canguilhem, 1994: 317). While few can doubt the importance of this moment in the history of the life sciences, perhaps now, while digitization remains crucial, the science of life itself resembles engineering more than informatics (cf. Rose, 2007: 44).
3. There are also many problems with animal models, and with translation from animals to humans, which illuminate precisely the differences between species: these are discussed in Rose and Abi-Rached (2012: ch. 3).
4. There is a long history of these 'holistic' and 'vitalist' forms of thought in biology, for example in the work of Kurt Goldstein; these issues are

thoughtfully discussed by Georges Canguilhem in the essays gathered together in Canguilhem (2008 [1965]). The debate between these two styles of thought has an ambiguous political history; the debates in Germany are very well analysed by Anne Harrington (1996).

5. In 2011, the global biotech industry was estimated to have a value of \$305.7 billion, an increase of 41.3 percent since 2008, around 60 percent of which is based in the USA, but China, India, Japan and Brazil are rapidly developing their biotech sectors. (Data from 'Research and Markets': http://www.researchandmarkets.com/reports/41522/biotechnology_global_industry_guide, consulted 8 March 2011, who also provide the figure in the next paragraph.)
6. Data from Ernst and Young, *Beyond Borders: Global Biotechnology Report* (2011), available at: <http://www.ey.com/GL/en/Industries/Life-Sciences/Beyond-borders-global-biotechnology-report-2011> (accessed October 2012).
7. Jack Price (2011), a neuroscientist, has recently argued this eloquently in relation to his own specialism – brain reconstruction in the face of damage from stroke and neurodegenerative diseases.
8. As one of the anonymous reviewers of this article perceptively remarked, this focus on knowing and managing living matter, this fascination with the vital, raises some important issues about the ways that one might approach the non-vital, matter that is devoid of life, without, as that reviewer put it, 'compelling that matter to be "vital" in order to be of concern to social science'. Perhaps the current interest in 'the anthropocene' illustrates some of these tensions in the different ways of giving matter its due.
9. We could point to numerous examples of the intricate relations between biology and sociology across the 19th century – for example the relation between Claude Bernard's and Auguste Comte's notions of milieu, illuminatingly examined by Ed Cohen (2009).
10. The interplay of biology and sociology in the biographies of key figures across the first half of the 20th century are worthy of note. Geddes, who was a co-founder of the Sociological Society in 1903 with Victor Branford among others, was originally trained as a biologist, as were Carr-Saunders and Lancelot Hogben. Tom Harrisson, founder of Mass Observation, was an ornithologist, and Bulmer (1985: 11) describes Mass Observation as a kind of social bird-watching.
11. He was chair of the Population Investigation Committee from 1936, and chair of the statistics committee of the Royal Commission on Population from 1944 to 1949.
12. Keynes (in Blacker and Glass, 1967: 368) describes Carr-Saunders as being 'by common estimation to-day the most distinguished sociologist in the country'.
13. Of course, in this paragraph, I can give references to only a fraction of the books published on these topics!
14. As one of the anonymous referees of the paper put it, 'all the intricate attention to the ordering, compositional and translational work scientists do – along with the modicum of room to manoeuvre that other entities have been ceded – has somehow precluded science studies scholars from ever actually being greatly provoked or excited by the substantive findings of

- these sciences'. I am particularly grateful to this referee for his or her incisive and generous comments on my draft.
15. Another notable figure in Australian 'corporeal feminism' is Vicki Kirby (see, for example, Kirby, 1997).
 16. The point, says Massumi, is 'to borrow from science in order to make a difference to the humanities' (Massumi, 2002: 21).
 17. In the remarks that follow, I have drawn on Ruth Leys' excellent analysis of the political claims that those such as Massumi and Thrift make for their approach to affect (Leys, 2011). Leys takes exception to the apparent denigration of meaning and intentionality in this work, which she traces back to Tomkins and others who see affects as comprising a set of fixed autonomic patterns, each triggered by various external stimuli, but which are prior to any attribution of meaning to those stimuli. She rightly criticizes the evidential base for the argument that that meaning comes later, if at all, as the subject seeks to give a plausible interpretation to him or herself of their affective state. While this is not the place to discuss her alternatives, it is clear that the claim that cognition and emotion form distinct faculties is neither conceptually nor neurobiologically supportable, and that there is no reason to accept the suggestion that the mental is identical to the cognitive, and the cognitive is formed of language-like propositions. For another excellent critique of affect theory, on which I have drawn, see also the detailed account of the selective use of Antonio Damasio, Joseph LeDoux and Daniel Stern provided by Papoulias and Callard (2010). Thanks to Lisa Blackman for thoughtful advice on the current state of affect theory, which forms the topic of her forthcoming book *Immaterial Bodies*.
 18. A critical analysis of Libet's claims can be found in Rose and Abi-Rached (2012).
 19. He cites the work of Stephen Turner and Christine Battersby in support here; this passage is also quoted by both Papoulias and Callard and by Leys, in the papers cited above.
 20. This is reminiscent of an older debate, in which Claude Bernard rejected Comte and argued for a distinction between the 'internal' milieu of the organism and the *milieu extérieur* which it inhabited (Bernard, 1878) – an argument which many suggest was the condition of possibility for modern experimental medicine, but which is now hard to sustain (see especially Canguilhem, 2008).
 21. Paul Hirst wrote several insightful books on the relations – and differences – between biological and social theory (Hirst, 1975, 1976).
 22. Of course, this is not a new development within the sciences of the living – see, for example, the work of Kurt Goldstein (1939). Some of these debates in the 1920s and 1930s – which had a very ambiguous relation to ideals of National Socialism – are well discussed by Anne Harrington (1996). One could also think here about the phenomenon of 'placebo', which was the topic of a series of seminars at LSE's BIOS research centre in 2004 organized by Anne Harrington; see also Harrington (1999, 2008) and Wahlberg (2008).
 23. As do some philosophers, for example Raymond Tallis (2011) and the Wittgenstein-inspired collaboration between the neuroscientist MR Bennett and the philosopher Peter Hacker (Bennett and Hacker, 2003).

24. For one really bad example, see Eisenberger et al. (2003). Hauke Heekeren has suggested that this is like trying to work out how an automobile engine works on the basis of an image gained from a thermal detection device mounted on a geostationary satellite (he made this comparison at a 'neuro-school' held by the European Neuroscience and Society Network in Vienna in 2009). Of course, as Heekeren pointed out at the same event, it is not at all clear what scale would be appropriate – it makes no sense to read a newspaper with a microscope, but neither is it sensible to read a book from a photograph of the bookshelf.
25. See: <http://s4sn.org/drupal/> (consulted November 2010).
26. From his website: <http://psychology.uchicago.edu/people/faculty/cacioppo/index.shtml> (consulted November 2010).
27. There are many different definitions of epigenetics and epigenesis. In the current context, the term refers to the ways in which an organism's genome does not merely 'express itself' during development, but is modified from conception onwards as a result of its interaction with extra-genomic factors. The recent book by Nessa Carey (2012) gives an excellent introduction to the field.
28. For an excellent review of work on epigenetics and human disease, see Portela and Esteller (2010).
29. For a brief introduction to the microbiome, see Gravitz (2012).
30. On the one hand, at the genomic level, researchers are finding many quite remarkable continuities between even simple animals and humans (Amsterdam et al., 2004; Rock et al., 1998). Yet the very wise genomic scientist Jacques Monod was very wrong when he famously claimed that what was true for *E. Coli* – a single-celled bacterium – was also true for the elephant (Jacob, 1995: 290). Research using model animals is constantly confirming the comment made by Georges Canguilhem many years ago: 'no experimentally acquired fact (whether it deals with structures, functions, or compartments) can be generalized either from one variety to another within a single species, or from one species to another, or from animal to man without express reservations' (Canguilhem, 2008 [1965]: 12). Gradually, the attention of life scientists is moving from the genome and the cell to the organism itself – the whole living organism, as a vital entity in constant transaction with its milieu from the moment of conception. The challenge is to understand that organized, dynamic vitality if we are to have a real 'feeling for the organism'. These issues are discussed at length in the book cited in note 3 above.
31. Of course, my argument here is not new: almost a quarter of a century ago, Donna Haraway was making a similar point:

Feminists have stakes in a successor science project that offers a more adequate, richer, better account of a world, in order to live in it well . . . In traditional philosophical categories, the issue is ethics and politics perhaps more than epistemology . . . So, I think my problem and 'our' problem is how to have simultaneously an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognizing our own 'semiotic technologies' for making meanings, and a

no-nonsense commitment to faithful accounts of a 'real' world... (Haraway, 1988: 579)

Thanks to one of my reviewers for suggesting that I make this confluence of arguments explicit.

32. Actually, Canguilhem wrote: 'Contemporary biology, read in a certain way, is somehow a philosophy of life' – the last phrase of 'Le concept et la vie' (1968).

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