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Spirit sciences, memory motions

> . . . there must be in the brain and its *appendix* the *cerebellum*, far more of mechanism than is obvious to a vulgar eye, or even to that of a dissector. For though this seemingly rude lump of soft matter does for colour and consistence look almost like so much custard; yet there are strange things performed partly in it, and partly by the animal spirits that it produces . . .
>
> (Boyle, *The Christian Virtuoso* (1772/1965: vol. VI: 741))[1]

Ontologies of the invisible

Why should we believe in what we cannot see? Our innards pose epistemologically peculiar difficulties. In health, or 'life lived in the silence of the organs' (René Leriche, in Canguilhem 1966/1989: 91), body parts are phenomenologically absent, churning on in normal function 'below' or 'outside' conscious awareness (the hopeless metaphors are one reason to query common-sense notions of consciousness). We have quite false pictures of what a brain, for instance, looks like (Mundy and Gorman 1969). Organs come to notice only when something goes wrong, in what Drew Leder calls 'dys-appearance' (1990: 69–106): turbulence or stagnation is sensed, technologies invade or scan, and medical art conspires with folklore and imagination to produce vivid images of dysfunction, seeking to dispel helpless incomprehension by picturing the unseen.

But we are unused to *sensing* disruption in the nervous system, and the brain is for us pre-eminently insensible (Leder 1990: 111–14): even when its physical presence evokes powerful emotions, as Eliseo Subiela's film *Man Facing South-East* (1986), the poignancy arises from perceived distance between the lumpen wetware and the complexity of cognition and personality, not from direct recognition of a brain's sad particularity. Popular AI, cyberpunk, and virtual reality in different ways can function to reinforce hopes that neural matter could be substituted, detached, or dispensed with: in the 1995 film *Johnny Mnemonic*, 'synaptic seepage' is the interference of an artificial memory implant with the 'natural', nostalgic childhood memories it was meant to supplant. But memory and brain were once part of an odder phenomenology, a direct experience of neurophysiological process. Historical use of analogies from the natural world does not entail that only 'homely views were entertained of the

1 Thanks to Peter Anstey for this reference.

insides' (Porter 1995: 441). Our vestigial metaphors (minds in a whirl, memories being rummaged, brains scraped) barely hint at the baffling neural dramas which 'pre-' and early modern people seem to have sensed as spirits and fluids flowed, melded, clashed, and fought: historians have had to work hard to allow us even to glimpse more recent cultural brain-fears (Rousseau 1991; Oppenheim 1991).

In trudging through early modern texts, one can feel sudden jets of bewilderment about how people could have believed in the animal spirits. Was it not *obvious* that they were fantastical, theoretical wastrels which could not explain real complex functions? How can we relate to human sense the invisible exploits of warring spirits? Although there is no chance of reconstructing what it might have felt like to believe in animal spirits, and although I can offer only more skating among representations in lieu of historical phenomenology, it is possible indirectly to address some of the aura of alien inconceivability from these weirdly bodily mentalities.

Firstly, diverse 'histories of the invisible' reveal to us many forms of past trust in unseen causal powers and processes, supernatural, emotional, and scientific (Duden 1993: 8–10). Secondly, the imperative of visualisation, the demand that something be *seen* before it is believed in, had itself to be constructed, developing alongside new techniques for searching, sensing, and imaging the unseen in the cosmos and the body (Stafford 1991: 1–83, 401–63). Angels, ancestors, and attractions, saints, souls, and sympathies, ghosts, gods, and forces, provided cognitive frameworks for the possibility of coursing microfluids. What then was taken to be specifically at stake in including or excluding bodily spirits from an ontology? What criteria were deemed relevant? How strange, compared both to surrounding sciences and to social expectations, was the account of memory which spirits theory provided?

Because animal spirits were insensible, their ontological status was always open to question: critics could just deny their existence on the grounds that they could not be observed.[2] But it is historically naive to claim that 'as a scientific theory medical spirits have one obvious defect from a modern point of view: it would be very difficult to disprove them empirically, since they are invisible and dissipated at death' (Walker 1953/1985: 125). Excessive profligacy and unnecessary prudery in the postulation of hypothetical constructs are both dangers. But rather than entering relevant general disputes on realism (Hacking 1983: 21–52), I focus on actual historical debates about the existence of these particular delightfully mobile theoretical entities.

2 After long searching in vain for an early modern visual representation of animal spirits, I have finally seen them pictured in flow. In an animated account of Cartesian physiology which forms part of a CD-ROM presentation on Descartes (*René Descartes: vie, philosophie, et oeuvre* (1996)), the spirits are shown roaming up into the brain and spreading across its pores. They are blue and yellow, rather like worms or Miro creatures.

Historically, there were analogous disputes about early modern ontologies of the invisible across different parts of the spirit realm. The all but ubiquitous belief among natural philosophers in supernatural and supra-mechanical causes had considerable methodological importance, since observability could not be the sole criterion for reality. Remember that animal spirits functioned as analogue angels, ferrying messages between soul and body, brain and organs (chapter 2 above): the place of angelology as respectable philosophy (not just theology) was secure through to the early eighteenth century (West 1955; Heilbron 1982: 3). Even if Locke, as Catherine Wilson (1995: 239) argues, was 'edging away from the vision of a world in which angels and animalcula could occupy the same referential space, being merely invisible in different ways', invisible and subvisible spirits long remained associated. Angel-discourses, like talk of animal spirits, did not simply stop with the 'scientific revolution', or even become stuck among marginalised groups. Animal spirits were useful tools for thinking about memory, self, and body, just as talk of angels fulfilled a number of important functions beyond the basic issue of their existence, opening space for debates about impenetrability and individual boundaries, about the perfectibility of cognitive capacities, about psychology and purity (Sutton 1994a).

Matter, memory, morality

Many natural philosophers in the seventeenth century took it for granted that theories of cognitive functions like memory and perception would be constrained by, and part of, their wider picture of the physical world. Sciences of matter and of memory were mutually relevant. The explanatory and ontological connections across domains may now seem too swift: but for those concerned with relations between the psychology of memory, society, and neurobiology, the distaste of English Restoration philosophers for Descartes' model of memory exemplifies discourses in which later firm lines between the moral, the cognitive, and the physical are lacking. Critics of distributed memory display aggrieved reactions to a perceived 'transgression and confusion of boundaries that it is important to restore to their proper order' (Irigaray 1974/1985b: 106): their localist theories sought to guarantee memories an ordered immunity to melding, with the diffuse spirits eventually being dismissed from science.

Historians of distributed representation have extra cause for interest in early modern interdisciplinarity. Neural nets are promising potential models for human memory partly because they offer a bridge between the brain, which must somehow support the persistence of memory in a changing physical system, and other, more easily studied, dynamic systems. Holograms, Hopfield nets, and spin glasses offer different models for the distributed storage of many patterns (Pribram 1971: 152–66; Cowan and Sharp 1988;

Metcalfe 1989; Churchland and Sejnowski 1992: 82–96). Similarities between neuroanatomy, experimental psychology, image processing, and optics justify the use of the term 'distributed' for connectionist representations (van Gelder 1991b: 33–5). The concept of distributed representation, then, does not, as is sometimes alleged, depend on any one fashionable new technology, but describes a set of related dynamical systems. Whether implemented in animal spirits, in Newtonian vibrations, in brains, or in artificial nets, it provides a peculiar and fragile form of representational stability over time.

Mechanism and magic

Ongoing concern with the mechanics of imaginary fluids does not, then, reveal pockets of traditional supernatural belief surviving even among leading mechanical philosophers, great but divided men who bridged the worlds of magic and science, religion and rationalism. Animal spirits were wholly compatible with the new corpuscularian philosophies of the seventeenth century, and in this section I show that early modern memory theories too were part of, and had to be compatible with, broader mechanical views. Mechanism, as historians of science have demonstrated, was neither a secularising nor a 'progressive' force in any obvious sense. The old spirits and the chaotic mix of transmitted theories were not just eliminated. To the extent that new naturalising explanations did gain ground, for instance as reference to medical causes displaced possession (Schwartz 1978; Macdonald 1981; Walker 1981), this is hard to interpret simply as new explanation of the unknown by reference to the known. Many active principles and invisible entities, occult qualities and sympathetic forces, were incorporated into the new mechanistic mainstream (Hutchison 1982, 1991: Henry 1986a, 1989a; Schaffer 1987; Brooke 1991: 117–51). Wilson (1995: 40–1) argues that, in the 'recalibration of human knowledge with respect to the very small', a 'materialization of hidden resident spirits' was more influential in the rise of mechanism than any intrinsic conceptual virtues. In England in particular, the spread of mechanism saw philosophers 'capture rather than discard the domain of spirits' (Brooke 1991: 135). This was necessary to preserve the supernatural and the idea of free will against naturalists, magicians, and Hobbist atheists who threatened to explain everything by the mere jumbling together, 'rumblement', and confused causal motions of matter (Gabbey 1982: 200, 1990: 26; Jacob 1978; Jacob and Jacob 1980; Hutchison 1983).

Specifically, the insensibility of animal spirits was no bar to their intelligibility within the new philosophy. Aristotelian scholastics, broadly, had assumed that what is unobservable must be either incorporeal or inaccessible to natural philosophy, in a realm of occult (as opposed to manifest) powers specific to particular natural agents. In the new philosophy, by contrast, the basic mechanisms cited to explain ordinary corporeal interactions were *micromechanisms*, and thus unobservable (Hutchison 1982). Further, entities and processes which *are* observable are not thereby guaranteed intelligibility: the multiple mediations involved in perception entail that perceptual 'data' must be interpreted, and do not simply offer up reality. Mechanists, far from eliminating occult qualities, rendered all properties of objects equally 'occult' or equally intelligible: accessibility to the senses was no longer a privileged criterion in ontology (Hutchison 1982; Wilson 1995: 51–7).

These historical accounts of mechanism chime well with the defence of a form of scientific realism offered by Paul Churchland (1985) in rejecting anti-realism about theoretical entities. Global excellence of theory is the best measure of ontology, and 'superempirical' virtues such as simplicity and reductive potential should be more powerful criteria than observability: understanding the idiosyncrasies of our perceptual and cognitive mechanisms will, Churchland argues, undermine the temptation to privilege perception and the middle-sized objects it prefers. Churchland focuses on criteria for the success of a theory which are 'internal' to the science of a time, although in recent work (1993, 1995) he is increasingly aware of the place of cultural and historical factors among the 'superempirical' influences on acceptance or rejection of theoretical entities.

No account of the 'real' criteria used in debates about hypothetical entities can bypass close attention to the specific locations in which such debates occurred. Simon Schaffer has undertaken just such a study of the sciences of spirits in English natural philosophy of the 1670s. Though he does not deal with animal spirits or physiology in particular, Schaffer's results provide a framework for my analysis of mechanism and English theories of memory in this chapter and the next. Through the stages of 'the experimental naturalization of spirit' (Schaffer 1987: 77) by Restoration natural philosophers, theorists retained an inherently ambivalent attitude to the mechanical principles with which they justified and defended their postulation of various active principles. Mainstream Royal Society scientists like Boyle, Hooke, and Mayow, as well as the increasingly marginalised Henry More (Gabbey 1982), were aware of the dangers of explaining too much, attributing powers too complex to confused matter.

Restoration *pneuma* theory, then, had to simultaneously produce and control knowledge of spirits, both extending and limiting their domains (Schaffer 1987: 55–8). Seeking a political psychology of the incorporeal, Schaffer identifies collective methods for ensuring the safety of pneumatological inquiry. Safe laboratory spaces, sites of discipline and technology, were created and claimed as necessary for producing secure testimony from reliable witnesses, as Boyle and Hooke distanced themselves from wonder-mongering stories about spirits and apparitions collected by More and Glanvill from around the country (Easlea 1980: 201–7; Jobe 1981; Shapin and Schaffer 1985:

314–17; Sutton 1994a). Enthusiastic anecdotes were to be controlled by attention to the status of the teller, and nature's activity was to be controlled within the experimental space. The ultimate derivation from God of all activity in nature was supplemented by a range of intermediate 'supra-mechanical' active principles and subtle fluids which were neither part of the realm of blockish inert matter nor challenges to the authority of the supernatural (Henry 1986a). The explanatory utility of any candidate entity was partly judged by its politico-juridical and theological standing. Boundaries between natural and supernatural realms in various research programmes were increasingly policed, with active spirits and agile invisible fluids both necessary to and dangerous for the natural philosophers' enterprise.

It is important not to overestimate the success of the mechanists' supernaturalism (Hutchison 1983), or of the more general Christianising of European culture in the seventeenth century (Gaukroger 1995: 24–8). Repeated and conflicting attempts to tidy and reinforce boundaries between matter, spirits, and the supernatural may just as easily have blurred as clarified them, and certainly did not necessarily enforce acceptance and obedience to any particular way of drawing the lines. But there was at least pressure, in every domain of natural philosophy, to align the account of theoretical entities in that domain with a complex and shifting set of constraints ranging from the need to be consistent with other sciences to the necessity of distancing reliable knowledge from (what were perceived as) dangerous claims made by others.

Memory and action at a distance

The mechanical philosophers in particular needed a good theory of memory. Their commitment to contact action as the means of change in the natural world,[3] and their rejection of allegedly occult action at a distance, encouraged them to posit specific mechanisms by which to bridge the temporal gulf between experience and remembering.[4] If past events in some sense 'become present' in remembering, the apparent action at a temporal distance called for mechanical explanation just as much as did stranger phenomena like

3 'The next thing to be consider'd, is how *Bodies* produce *Ideas* in us, and that is manifestly *by impulse*, the only way which we can conceive Bodies operate in' (Locke *Essay* II.8.11). For Henry More, matter communicates not at a distance but 'by jogging or crouding the parts interjacent' (IS preface, p. 6). Compare the list of overlapping principles under the umbrella of 'mechanism' in McGuire 1972: 523, n. 2.

4 In the more familiar context of perceptual theory, it is well known that many early modern philosophers accepted a principle of 'no cognition at a distance' (Yolton 1984a: 12–13, 1996: 84–100). I know of no extension of this point in the secondary literature to the case of memory. Yolton is sceptical about the plausibility of the requirement of no cognition at a distance, since he argues that we have a form of direct acquaintance with distant objects. But the principle seems even more plausible in the case of remembering: only a feeling that there is something mysterious about the existence of causal processes connecting past and present could encourage its rejection.

magnetism, ship-stopping fish, and the marine torpedo which 'suddenly benumbs the hand that touches it, even at a distance through a rod'.[5] Tales of prodigious memory were often repeated in the place-memory tradition from Pliny's *Natural History* (1962: 86–7). Early mechanists found them as unpalatable as they did the other occult happenings dear to Renaissance natural magicians, and sought reductive explanations of how physical continuity is in fact maintained between experience and remembering.[6]

This is a general motivation in the sciences of memory: causal processes in physical media, it is argued, preserve some trace of an experience or event (Warnock 1987: 43–52). It is by way of this trace that the original experience may be operative in partly causing (not determining) an episode of remembering (Martin and Deutscher 1966). Historically, it is clear that this need was at work in early modern theories.

We have returned, by a different path, to the point at which part I ended. The mechanists' need for causal processes as mechanisms of continuity imposed one of the two possible views deriving from the medical philosophies sketched in chapter 2. Memory is either a body or a motion, either an atom or a pattern. Either actual bits of matter are transferred from object to brain and kept there, or (patterns of) motion are transmitted through different material media from object to brain[7] and are somehow later recreated. The general requirement of causal continuity was shared by Cartesians and scholastics: information somehow transmitted from object to brain has then to be stored. I showed in chapter 3 that Descartes made the medium of storage the motions of animal spirits through the pores of the brain, rather than things (whether dedicated in the brain or arriving from the object). Chapters 5 and 6 address historical and conceptual implications of this approach: but first I demonstrate that neighbouring domains in natural philosophy provided rich sources of comparison in decisions between these differing theories of memory.

5 Ficino, *De vita coelitus comparanda* (1489), quoted in Copenhaver 1990: 275. On action at a distance and magical explanation see also Henry 1988, 1990. Mary Hesse (1961/1970: 112–21) shows how the commitment to contact action in seventeenth-century mechanism was shared by both corpuscularian and medium theorists.

6 For the hostility of early mechanical philosophers to Renaissance naturalism see Heilbron 1982: 11–22; Hine 1984; Gaukroger 1995: 146–52. Copenhaver (1990, 1991) gives a wonderful account of the history of explanations (through to Gassendi, Boyle, and Borelli) of the torpedo (the electric ray) and the 'ship-holder' or *echeneis* fish. The torpedo/ray was 'disenchanted' only when John Walsh in 1773 showed conclusively that its effects were electrical. Copenhaver comments (1990: 279) that this 'ended the ray's career as a magical object . . . except insofar as eighteenth-century conceptions of "electrical fluid" resembled the *spiritus* and *pneumata* long counted among the arcana of the magus'.

7 Most historians of these theories have discussed perception. The importance of changes in optical theory for early modern theories of cognition as a whole has often been noted: recent work includes Hatfield and Epstein 1979; MacIntosh 1983; Straker 1985: 264ff.; Meyering 1989: chs. 2, 5, 6. Only MacIntosh makes the link with theories of memory.

Superposition and interference: optics and memory

Because the mechanists' memory theory required the internal preservation of motions, it was inevitably caught up with continuing developments in matter theory. Superposition, the key mechanism for 'storing' many traces in the same region of the brain, was a physical principle, clarified by Galileo, which describes situations 'in which one motion is a result of combining two different components' (Prudovsky 1989: 455). The desirability of superposition became a controversial topic in early modern disputes about light and sound, which inevitably became entangled with the neighbouring sciences of memory and brain. This analogy between memory and light explains how mechanists, who believed all material bodies to be composed only of atoms or corpuscles in motion, could still accept that two memories could, in a sense, overlap or be in the same place without violating principles of impenetrability. In the case of light, I suggest, most believed that 'interference is a direct consequence of the principle of superposition' (Kassler 1995: 112), that the motions overlaid would not be re-separable, and that this was good reason for resisting the application of superposition to key physical or cognitive domains.

In the Cartesian plenum, light is a motion or a tendency to motion, and is the transmission of energy not of a body: Descartes hoped that there would be no interference between light rays if they are only lines of tendency rather than actual motions (Sabra 1967/1981: 11, 59). Before the success of Newton's optics (Hakfoort 1988), many were attracted to continuum ('wave') theories over emission ('corpuscular') theories (Shapiro 1973: 136, n. 5): Robert Hooke, whose memory theory I examine in chapter 5, worked closely on the different continuum theories of Descartes and Hobbes (Shapiro 1973: 134–43, 189–202; Sabra 1967/1981: 186–95, 251–64; Westfall 1971: 206–13).[8] At a gross conceptual level, interference is not a pressing concern if light (or sound, or memory) is a body, for the identity of the individual atoms which are the ingredients in any compound is never in doubt: in principle the component bodies can always be re-separated. But if light (or sound, or memory) is thought of as a compound of motions (or of dispositions to motion), questions about interference and confusion between the motions immediately arise. It becomes much harder to see how the elements of the composite can retain their own identity: ingredients seem irretrievably altered in the process of mixture (compare Shapiro 1973: 188, 1994 on colour mixing).

In early 1672, Hooke considered but rejected (as 'unnecessary') the idea of

8 Shapiro argues (1973: 136–7) that 'study of the dynamics of wave propagation' did not begin until the end of the seventeenth century and so is really part of eighteenth-century rational mechanics. Although quantitative and experimental approaches to dynamics did take some time, it is clear that the entirely qualitative animal spirits physiology had an intuitively dynamic tinge. Psychophysiology here was out of reach of the mathematical and physical concepts on which it was meant officially to be based.

the original heterogeneity of light, by which in white light various vibrations coalesce and destroy each other, just as many vibrations are 'dormant' as a 'coalition' in a musical string: Sabra sees Hooke here as 'the first to conceive of the principle of the superposition of waves as applied to light' (1967/1981: 259–60, 295). Newton responded to Hooke in part by developing this discarded suggestion, but continued to state his own conviction that white light was originally heterogeneous (Shapiro 1973: 189). He thought that a condition of success for a continuum theory, in which the waves composing white light might cross one another, was that they must not 'combine, or alter one another; they must exist as differentiated elements of a *heterogeneous* mixture' (Sabra 1967/1981: 279). Newton could not see the possibility of the pulse motion suggested by Hooke in which the components have lost their identity:

> though I can easily imagin [*sic*] how unlike motions may crosse one another, yet I cannot well conceive how they should coalesce into one *uniforme* motion [the pulse], & then part again [by refraction] & recover their former unlikenesse; notwithstanding that I conjecture the ways by wch Mr Hook may endeavour to explain it.[9]

So Newton takes the impossibility of re-separating out individual components from a coalescence or superposition of waves to be evidence against the wave theory of light. For a wave theory to work, superposed rays would have to preserve 'their separate existence and identity unaltered within the compound' (Whittaker 1951: 17, in Sabra 1967/1981: 282). But, for Newton, this is not possible: there can be no mixture, he thinks, without confusion. By late 1675, Newton claimed that Hooke had abandoned his own view and adopted Newton's idea of 'colours, like sounds, being various, according to the various bignesse of the Pulses' (Sabra 1967/1981: 327–8; Shapiro 1973: 201–2; 'bignesse' is related to the later concept of 'wavelength'). Hooke's position, however, remained in flux: in the early 1680s he wrote favourably of Descartes' theory of light as motion (Hooke LL 4.3: 113).

In these considerations about superposition in optics and acoustics, then, the decisive issue is confusion. By 1675, it seemed that light could not be motion, since if it was, motions would cross and destroy each other in a manner inconsistent with the observed results of prismatic refraction: it would be impossible for individual motions to be extracted or re-separated, for they would have blended irretrievably into the mix of motions. Seven years later, when Hooke lectured to the Royal Society on memory, he was all too well aware

9 Newton's *Correspondence*, in Sabra 1967/1981: 281. Sabra comments that Newton's objection 'derives its apparent plausibility only from interpreting the change produced by refraction as a disturbance (or confusion) rather than a regularization'. Newton had been impressed by More's argument (chapter 5 below) that we could not determine our own recollections if remembering was merely matter in motion (Iliffe 1995: 442).

of the parallel problems about confusion and mixture in the theory of light. So he knew well the difficulties likely to arise from thinking of memory as motion. If memories were just motions of animal spirits in the folds of the brain, we would never be able to isolate any past event, to re-separate one memory trace from all the other trace motions superpositionally stored, as dispositions or tendencies, with it. The problem with all sorts of spirits is that, as Milton's Raphael confessed, 'if Spirits embrace / Total they mix'. Only confusion and inadvertent productivity could result, and disorder is as dangerous in the cognitive as in the political realm.