Organic Mechanism and
the Soul of Science

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Abstract. One of Donald Bates’s most striking claims was that the bio-medical sciences were central to the Scientific Revolution of the 17th century and that its innovators drew heavily on the “organic mechanism” of the ancients. The paper elaborates on and defends Bates’s proposal against a more conventional reading of the Scientific Revolution as driven by celestial and terrestrial mechanics and physics.

Keywords. mechanism, theology, organism, Scientific Revolution, teleology

Résumé. L’hypothèse que les sciences bio-médicales aient été au cœur de la Révolution scientifique du 17e siècle et que ses innovateurs aient puisé largement au « mécanisme organique » des anciens, est sans doute la proposition la plus marquante de l’œuvre de Don Bates. Cette article présente des arguments et défend cette hypothèse contre la lecture conventionnelle qui suppose que l’astronomie et la physique étaient les principaux moteurs de la Révolution scientifique.

Mots-clés. mécanisme, théologie, organisme, Révolution scientifique, téléologie

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"The New Mechanism of the 17th century," Don Bates argues, "was not a radical departure from Aristotelianism, but really Phase II of an intellectual tradition that started with the ancient Greek concept of instrument."¹ Medicine, in his view, not physics, set the pattern for modern science: "…[M]edicine is historically central to the development of science, and it is only through its history that the question of the uniqueness of scientific knowledge can be answered."²

Bates’s view contradicts a number of received assumptions, to wit, that the corpusculo-mechanical philosophy, not medicine, was the “soul of science” in its revolutionary period; that the bio-medical sciences experienced a “delayed” or “postponed” revolution on account of their overdependence on mechanical models of the body; and that there is a sharp discontinuity between the conceptual schemes of the ancients and those of the moderns. Bates sees antiquity and modernity as linked by an original and a revived commitment to experimentation on the living body and to the conceptualization of internal organs as intelligently created for a purpose and as employed by the human soul. However nous ceases to seem a plausible source of order in late modern thought. Whereas ancient mechanism depends on intentional and mentalistic concepts, modern mechanism does not. Mind, he says, became “so complex and contingently reactive that it was increasingly too leaky an explanatory sieve for any mechanical stability and consistency to be maintained…[T]he soul of mechanism shifted from mind to matter. The mind becomes a more capricious organ and loses its usefulness as a metaphor for the source of stability.” The term “law” is, Bates says, “the archaeological evidence for the shift of the soul of mechanism from mind to matter.”³ This paper will supply some material for consideration that supports Bates’s positive and original assessment of the role of the bio-medical sciences in the 17th century.

Bates develops his argument in part by a process of triangulation. Historians of science traditionally emphasized the divergence between ancient and modern scientific ontologies and explanatory schemata in the course of searching for clues to explain the difference between the social, economic, and educational systems of antiquity and those of modernity, differences to which the growth of empirical knowledge is supposed to have contributed.

Ancient science was said to be teleological, moralized, and anthropocentric. It was described as focused on the phenomena of vitality, on self-moving and self-developing entities in the sublunar world, and as recognizing perfect regularity only in the heavens. Except amongst the atomists, it was said to be wedded to a dualism of formative mental principles and passive material stuff, conceived on the model of a potter
and his clay. Early modern science, by contrast, was thought to reject anthropocentrism, powers and (for a time at least) forces, and formal, and final causes. The moderns were seen to be interested in the motion of nonliving things: in falling, rolling, hurled, impacted, swinging, circling, floating, and sinking bodies. They deanimated the stars and even deanimated the animals. They recognized that the heavenly bodies are imperfect and their motion subject to perturbation. In place of a distinction between “higher” objects (stars, forms, intelligences) and “lower” objects, they were seen as establishing a contrast between the idealization of a theory and the behaviour of observed objects and systems.

This way of making out the relations between ancients and moderns was once taken for granted. But, Bates argued, introduce a third fixed point into the picture, China, and the impression of discrete and opposed mentalities dissipates, even while new questions are raised. Chinese technology surpassed that of the West in our medieval period. Chinese philosophy and Chinese medicine were as subtle, ingenious, and complex as that of the West, if not more so. Why then the divergent development—a Scientific Revolution in Europe followed by an Industrial Revolution? The question has intrigued authorities from Joseph Needham to Geoffrey Lloyd to Nathan Sivin. It is commonplace to say that “Greece” is the answer to the question. But how can “Greece” be the comparative historian’s answer to the question of comparative development if the historian of Western philosophy has shown that it was precisely the rejection of Greek animism, teleology, and formative powers that characterized the Scientific Revolution?

Bates maintains that a key component of the explanation of the divergent scientific fortunes of China and the West is that certain biases present in ancient science either persisted continuously in European medical philosophy, or were recovered in the early modern period. The most important of these elements was not, as is commonly believed, atomism, or even, contrary to the opinion of Joseph Needham,⁴ the concept of a law of nature, though atomism has a role to play in Bates’s account. It was a tendency to interpret form—especially the parts of animals—as manifesting either intelligent design by an artisan or something strictly analogous to it. Behind or within this tendency, which Bates identifies as present in Plato, Aristotle, and Galen, were three convictions:

1. Benevolent Creator: Nous or some incorporeal principle manipulates insensate matter for higher purposes. The forms of nature are accordingly good.
2. Technism: The body is fashioned in such a way as to be usable and used by the soul.
3. Organicism: The body is constructed of organs with particular shapes and textures. Each organ is, as Galen says, “the cause of a complete action,” yet they all function to maintain the life of the whole.
Bates hypothesizes that these thoughts will not be found, or will not be seen to be systematically represented, commented upon, copied, integrated and reproduced in Chinese philosophy of nature, and that they will be seen in 17th-century science if we set aside our historiographical prejudices about the soul of modernity and the contrast between ancients and moderns.

Bates's explanatory proposal is historically testable and can be falsified on several grounds, to wit., if it can be shown that theodicy, technism, and organicism are peripheral themes in ancient Greek medical writing, or that they are markedly present in Chinese medical philosophy, or that they do not persist, or are not recovered in early modern science. With the question of China left to the experts of this symposium, and granting the premise concerning the character of ancient science, this leaves the task of evaluating the claim that theodicy, organicism, and technism are pertinent to the characterization of the Scientific Revolution.

II

Following Herbert Simon who characterizes learning as a change in an agent’s internal representation of a task or a domain which leads to improved performance,\(^5\) we might understand the Scientific Revolution as a period in which the participants in the revolution changed their internal representations of many things, and did so in ways that facilitated performance, with a speed and intensity that justify the term “revolution,” and with a profundity that justifies the term “scientific.” The conventional view against which Bates sets his own is that corpuscularianism and mathematical physics are the innovations of the West that were revolutionary and that were responsible for the face of modern science with works such as Galileo’s *Dialogue Concerning the Two Chief World Systems*; Descartes’s *Principles of Philosophy*; Boyle’s *Excellency and Grounds of the Mechanical Hypothesis*; and Newton’s *Mathematical Principles of Natural Philosophy* leading the way.

Richard Westfall, a major proponent of this view, insisted that “Two major themes...dominated the scientific revolution of the 17th century—the Platonic–Pythagorean tradition, which looked on nature in geometric terms, convinced that the cosmos was constructed according to the principles of mathematical order, and the mechanical philosophy, which conceived of nature as a huge machine and sought to explain the hidden mechanisms behind phenomena.”\(^6\) Much effort and imagination has gone into describing this alleged reconceptualization and the psychological and attitudinal changes associated with it. Thus E. S. Burtt: “The scholastic scientist looked out upon the world of nature and it appeared
to him a quite human and sociable world…. Now the world is an infinite and monotonous mathematical machine…All those things which were the very substance of the physical world to the scholastic—the things that made it alive and lovely and spiritual—are…crowded into the small fluctuating and temporary positions of extension which we call human nervous and circulatory systems…. It was simply an incalculable change in the viewpoint of the world held by intelligent opinion in Europe.”

Charles Gillespie claimed that the internal representation of time altered as a result of Galileo’s mathematicization of the law of falling bodies, changing from a narrative and phenomenological concept to a metrical one. Carolyn Merchant’s pioneering study of the origins of modernity forcefully suggested that Cartesianism caused nature to be represented as a corpse and as a resource for exploitation.

The claim that the new physics led the Scientific Revolution by changing agents’ internal representations in this way is, however, problematic. Neither Burtt, nor Gillespie, nor Merchant were able to capture and convey a sense of the fascination with the motion, warmth, and breathing of animals, and the vitality and the reverence for the anatomical detail of the plant and animal kingdoms characteristic of the 17th century. At the same time, the branches of science that manifestly involved changed representations—matter theory, astronomy and terrestrial physics—did not lead to rapidly improved performance in a domain outside of the better and more precise stating of theories, and rapid improvements in performance were not associated with radically changed theoretical representations.

This was noticed by Kuhn, who then went on seemingly to deny his own insight. In a famous paper, Kuhn distinguished between the Classical and the Baconian sciences. The Classical sciences, astronomy, geometrical optics, statics and hydrostatics, music and mathematics, on Kuhn’s view, are distinguished by the following features: First, they are essentially non-experimental, depending upon a few relatively accessible and mostly qualitative observations of shadows, mirrors, levers and the motions of stars and planets. Second, as “mixed” or mathematized sciences, they are not easily accessible to amateurs, requiring a flair for mathematics and hard concentration. Third, the sense of progress and direction in them is clear. Older problems are solved; theories are extended, new relationships become mathematically expressible.

On this characterization, the Classical Sciences could not have been revolutionary. They are cumulative, and they are understood and practiced by a small elite. They move in the direction of greater precision, accuracy, and comprehensiveness, not by shaking up existing worldviews. Galileo, for example, boasts in the Preface to his book on the Two New Sciences that the trajectory of a projectile was known by everyone to be a curve, but that it was he who discovered it to be a parabola; that
bodies were known to accelerate on falling, but not according to the square of the time fallen. The Baconian sciences, by contrast, evolved from the lower crafts and the servile occupations, from agriculture, mining and ore-preparation, medicine, jewellery-making, lens-grinding, dyeing, ceramics, weather-watching, and animal breeding. From the crafts came chemistry, the theories of magnetism, electricity, and the theory of heat, pharmacology, and surgery. Just as the classical sciences possess certain built-in inhibitions to revolution, the Baconian sciences have a tendency to improve rapidly when certain conditions are met. These conditions include critical mass, the free flow of information, and the provision of incentives.

The impression of dynamism in the 17th century is more easily ascribed to the flowering of the Baconian than to that of the Classical sciences. According to Charles Webster, there was a “spectacular increase in scientific book production in medicine and agriculture as well as mathematics after 1650.¹¹ Enhanced performance in a number of domains is evident as technicians, mechanics, and artisans were able to make improvements to weapons, fortifications, optical instruments, and clocks, and as the nobility took ever more interest in crops, gardening, and the breeding of livestock. And post-1650, Westerners were assuredly better at science; at measuring and observing, at designing experiments and apparatus. In short, the Copernican system, Kepler’s dynamics, and Newtonian mechanics would have constituted merely formal improvements in the classical sciences of little consequence; had they not been brought under a common heading with experimental and observational practices and records and brought within a common discourse of improvement and utility. Kuhn nevertheless turned aside from concluding that the Classical sciences were not revolutionary. Insofar, he said, as the Scientific Revolution is “a revolution in ideas, it is the changes in these traditional, quasi-mathematical fields which one must seek to understand.” And the mid-20th century theorists of the Scientific Revolution insisted (perhaps because outward signs of impact were lacking) on the inward, psychological transformations of the scientific revolution in mechanics and astronomy: vertigo, strange new views of time, cosmic loneliness.

Meanwhile, medicine and its ally, chemistry, have been considered the laggards of the Scientific Revolution. Richard Westfall, writing in 1970, entitled his bio-medical chapter “Biology and the Mechanical Philosophy.” He took up four main topics: classification (Ray, Tournefort); the circulation of the blood (Harvey); iatromechanism (Borelli and Descartes); and microscopy and the theory of generation (Descartes, Leeuwenhoek, Grew, Malpighi). While he commended each of these individuals, the conclusion of Westfall’s chapter was that the science of life, to the extent that it sought depth and was not merely taxonomic,
had ineffectually extrapolated from physics to the realm of the living. Westfall insisted that iatromechanism was “crudity itself”\(^\text{12}\) and that “it is difficult to read the embryologists of the late 17th century without a sense of bewilderment”\(^\text{13}\) and that the mechanical philosophy “obstructed comprehension of the new discoveries.”

The accounts of living things of the 17th century are often characterized as natural history or taxonomy rather than as theory; biology according to Gillespie did not exist as a science until the 19th century. Those curious inquirers, haunting fields and ditches, or armed with their microscopes, or assembling their catalogues, are thought to have lacked both deeper accounts of processes, diachronic or synchronic, as well as the precision of the physical sciences. Theological frames of reference, no longer needed in physics, still surrounded the study of insects and of generation; an implausible mechanical theory of epigenesis vied with the myth of preformation. Harvey’s praiseworthy approach to measurement and his heart-pump analogy are, on this view, good science, but his quasi-Aristotelian embryology and his conviction that the blood is a spiritual substance, bad science. The recourse to entities and processes such as interior moulds, vital principles, nitroaerial spirits, nerve juice, vibrations in the cerebro-spinal fluid, and spontaneous generation, is considered to have held the investigation of life sciences back in a prescientific state.

Bates invites us to write a chapter on biology and the mechanical philosophy very differently. On his view, Harvey is not applying a new mechanical science—hydraulics—in a realm formerly dominated by powers and spirits. Harvey’s representation of the world is still unapologetically dominated by powers and spirits, as one can see from his writings on the blood and the egg. Rather, in his heart-pump analogy, he is availing himself of an existing trope in bio-medical thinking that united ancient philosophers of a range of ontological commitments\(^\text{14}\) and that differentiated them from the Chinese: the comparison of a part of the body to an instrument.\(^\text{15}\) In Harvey’s embryology, the soul builds a body to suit her purposes, beginning with the all-important heart, and, as Malpighi realizes, the organs that successively make their appearances are related to one another and function as an ensemble. It is the continuity in this line of thinking that Bates advances as central to modern science under our current understanding of what makes up a scientific worldview. The Royal Society reintroduced such lost Alexandrian practices as vivisection and, in doing so, set aside, somewhat self-consciously, old taboos on contact with bodily fluids including blood and semen and on the cool and deliberate infliction of pain on living creatures.
Suppose we agree that there was a Scientific Revolution, a period of accelerated learning, and we agree further that it cannot be regarded, as was traditionally done, as involving changed representations, pertaining to the quantification of space, time, matter and motion. Given the status of physiology and natural history between 1650 and 1750, is it plausible to maintain that the revitalization of Greek ideas concerning the body and its place in the world in the medical sciences were important in the shift to modernity? Is there a recollection, or revitalization, or development of the features identified by Bates—theodicy, organicism, and technism—that might support this claim? Here there is room both to endorse Bates’s conception and to adduce some cautions.

First, theodicy. If Bates is right, teachings concerning the goodness and well-orderedness of the world as a result of its creation by a benevolent and intelligent force were not well represented, either in ancient atomism or in Chinese philosophy in the 17th century. The atomists either downplay the extent to which the world is characterized by regularity and beauty, or refer it to chance, or call on specific nonintentional principles such as the “boundary-mark” or “limit.” The good world theory is conspicuously revived in the early modern period by Descartes, Malebranche, and Leibniz, who emphasize the simplicity, fecundity, and universality of the laws of nature, and the usefulness of the human sensory system, and by physico-theologists like Henry More, Robert Boyle, and John Ray, who are impressed by the evident purposiveness of living forms, and the adaptations of animals to their environments. The conviction that human anatomical features, and the shape of the universe as a whole were products of intelligent design was a fixture of Greek thought, present in the Timaeus, in neo-Platonic theology, Stoicism, and most importantly, perhaps in Galen, who, in his treatise, On the Use of Parts, berated the atomists for their failure to appreciate that every anatomical structure was beautifully designed for a purpose, beginning with the hand, whose purpose it is to enable the soul to perform works of intelligence.16

Galen’s references to faculties, and indeed to the wisdom and powers of Nature, were treated with derision by mechanical philosophers. However, they did not dispute the phenomena of order and harmony Galen was describing, or their significance; they merely insisted that, conceptually, Nature should be identified with God, and “faculties” should be re-analyzed in mechanical terms. Even the defenders of one or another version of the “corpusculo-mechanical philosophy” place mechanism within a creationist framework, in which the benevolence and wisdom of the creator are seen to be as important, or in some cases more important, than his power. The reassertion of this essentially pagan sentiment
shifted the theological focus away from the corrupted soul of man, his efforts at personal redemption, and his fate in the life to come, to the corporeal world. The signs of order and purpose in the world that the scientific inquirer was in a unique position to detect helped to legitimize scientific activity which was otherwise subject to criticism as vain and useless. From Thomas Browne’s *Religio Medici* to Robert Boyle’s *Christian Virtuoso*, there is constant reference to the harmony between the motive of curiosity or utilitarian ambitions and a pious disposition.

Second, what about technism—the doctrine that the body is fashioned so as to be used by the soul for her purposes? One might be surprised to find this doctrine cited as a modern one especially, for it was evidently not the view of Descartes, who believed that the animal body was a machine, formed by chance and necessity, that needed no soul to operate it. The only purpose of the soul, according to standard views of Cartesianism, is to think, and the best thinking is about incorporeal objects and abstract relations, such as triangles, mathematical physics, and God. It was moreover the foes of Descartes, especially the Cambridge Platonists, who identified themselves more closely with organism and with Aristotelian notions of life as capability.

Yet Descartes also describes the animal body as a machine constructed by God and therefore as incomparably better than (though still basically similar to) the machines constructed by human artisans. Even the *Meditations on First Philosophy* can be read as leading up to the Sixth Meditation’s presentation of the human body as an innervated fleshy system that mediates experience for the good of the organism. As Annie-Bitbol-Hesperies has pointed out, it was Cartesian physiological anthropology (and not his metaphysics) that was taken to be his most important contribution by Descartes’s immediate successors, and, according to Bates, the Cartesian conception of the human body is Platonic and Galenic, or Alexandrian, removed as well from the abstractions of the atomists. The Cartesian “self,” insofar as it ought to be studied and can be known by philosophy, turns out not to be the bloodless and rather generic thinking substance of *Meditation Two*, but the body-machine:

There is no more fruitful exercise than attempting to know ourselves...I believe that we would have been able to find many very reliable rules, both for curing illness and for preventing it, and even for slowing down the aging process, if only we had spent enough effort getting to know the nature of our body, instead of attributing to the soul functions which depend solely on the body and on the disposition of its organs.

Finally, amongst the carryovers from antiquity into the modern period, there is organicism, the doctrine that the body is a federation of organs, as Théophile Bordeu will put it a century later, working for a common end. This view is expressed in Leibniz, (and even in Gassendi)
who maintains that a living creature is composed of machines within machines to infinity. Rather than considering organs and fluids as related to planets and herbs, and medicine as directed to the exploitation of these cosmological and environmental relations; medical theory moves decisively inside, to try to understand the co-operative functioning of the organs to produce the manifestations of life and their pathologies. An especially dramatic example of the revival on an ancient Greek concern was the search for integrated theory to explain the relations between the beating of the heart, the expansion and collapse of the lungs, the colour of the blood, and the warmth of the body. This “pneumatic system” had been admired and explored by Galen. Its true nature remained inexplicable until the process of oxidation in both burning and animal metabolism was grasped late in the 18th century, but the investigations of Boyle and John Mayow, the latter an inspired experimentalist rather than, pace Westfall, a confused occult philosopher, were characteristic of the reawakened interest in bio-medical systems of the modern period.

IV

In what ways might the revival of Platonic theology and Alexandrian physiology be considered a change of representation leading to improved performance at a task? To what extent can we see it as two faced, as both a genuine retrieval of a past tradition and as playing a central role in modernization? The possibility that a particular brand of teleological mechanism was an unrecognized feature of ancient philosophy has been explored by scholars who argue that the contrast between Aristotelianism and atomistic mechanism has often been wrongly stated. Sylvia Berryman argues that ancient mechanism ought to be characterized as a separate school, independent of atomism. Galen, its best representative, compares the design of the development of the foetus to a process initiated by acting as engineers do with respect to a stage device. “[T]hey provide a first impetus of motion and then depart, so that the devices continue to move—by design—for a short space of time.” Aristotle had offered a corresponding view, and while he avers to the differences between living creatures and automata or puppets, he does not altogether deny the analogy. Mechanism is thus a third force, distinct from Epicurean atomism and to some degree consistent with Aristotelianism. This view is consistent with Bates’s suggestion that atomic mechanism, the view that simpler unseen motions and characteristics of the small parts of matter give rise to the manifest world without the action of any spiritual agents, can be contrasted with organic mechanism, the view that living entities consist of interrelated parts whose workings are directed by an agent with motives and purposes, different from a material cause.
In retrospect, we can see just how misleading the failure to distinguish these two varieties of the “mechanical philosophy” has been. The revival of Epicurean-Lucretian atomism with its reduction of sensory qualities to quasi-illusions and its denial that beauty and utility were goals in the mind of a creator fascinated historians like Burtt. We tend to think of the true scientific spirit as associated with the cool neutrality of a Hobbes or a Spinoza, who insist that all value is subjective and related to human interest. Bates’s proposals enable us to see why this radical position, however creditable we might find it, did not install these two as central figures of the Scientific Revolution. Atomic mechanism, without theodicy, technism, and organismism lacked proper connections with theology on one hand and experimentation on the other. Unlike organic mechanism, it lacked philosophical-theological legitimation and a programme of technique and practice. Unlike their more pious colleagues who insisted that divine benevolence was manifested in the creation and who asserted their commitment to human welfare, using microscopes, scalpels, and air pumps to prove it, Hobbes and Spinoza, however modern and mechanical in respect of their fundamental ontologies, did not contribute to broad acceptance of the mechanical philosophy, and are considered political and ethical theorists rather than natural philosophers.

To hold a scientific worldview in the West in modern times is to subscribe to the following theses.

**Emergence:** The manifest image present to the senses is the effect of an underlying material reality. Precise correlations can be established between the properties and dispositions of macroscopic substances and the latent, atomic reality underlying them.

**Determinateness:** Macroscopic phenomena are only semi-orderly and are not fully predictable. Yet the motions of body as such can be precisely described, as can the interactions of certain classes of bodies.

**Accessibility:** The hidden order, though invisible, can be visualized and represented by means of experimental techniques and instruments, and can be manipulated by humans.

**Permissibility and Utility:** These manipulations are permissible; i.e., they are sanctioned by God and are not demonic. They can contribute to human welfare, reducing toil, pain, and suffering.

We have perhaps underestimated the significance of the biomedical sciences of the 17th century because they did not seem to exemplify the determinateness and utility we expect from science. Seventeenth-century investigations into the nature of organisms did not result in the articulation of precise laws and relationships of the sort to be found in
mathematical physics. There was little progress in understanding con-
tagion, the realm in which clinical and socio-economic results were the
most striking, until the work of the medical heroes of immunology and
antisepsis of the 19th century. Yet shifting the historical gaze from deter-
minateness and utility to such features of modern science as accessibility
and permissibility reinstalls the living creature at the centre of scientific
endeavour. The Cartesian animal machine, the investigations into the
mystery of animal warmth and breathing with the help of the air-pump,
the microscopic study of the spermatozoa and other animalcules, the
study of the anatomy of the optical system, the brain, and the repro-
ductive organs of women, and of the development of the chicken from
the egg and the butterfly from the caterpillar might have a central place
in a rewritten narrative. Bates’s insistence that medicine is the soul of
science offers a novel and indeed daring and visionary perspective on
eyearly modern science.

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ence,” and to ponder the many important historiographical and philo-
sophical issues it raises.

NOTES

1 Donald Bates, “Medicine and the Soul of Science,” §44.
5 See for example, Herbert Simon, Reason in Human Affairs (Stanford: Stanford
University Press, 1983).
7 Edwin A. Burtt, Metaphysical Foundations of Modern Science (London: Routledge and
Mode: E. A. Burtt’s Metaphysical Foundations of Modern Physical Science
8 Charles Coulton Gillespie, The Edge of Objectivity (Princeton: Princeton University
10 Thomas Kuhn, “Mathematical and Experimental Traditions,” The Journal of
Interdisciplinary History, 7 (1976): 1-31; repr. in The Essential Tension: Selected Studies
11 Charles Webster, The Great Instauration: Science, Medicine and Reform, 1626-1660,
12 Westfall, Construction, p. 103.
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15 Shigesha Kuriyama’s recent presentation of Greek vs. Chinese medical concepts introduced a new set of concepts into the discussion of this redoubtable problem. Kuriyama suggests that in Chinese medicine the viscera are conceptualized as repositories for forces, not as instruments of the soul: *The Expressiveness of the Body and the Divergence of Greek and Chinese Medicine* (New York: Zone Books, 1999), p. 266.