Muscularity and the Western Medical Tradition

David Shanks

To paint a proper portrait of a man, the Renaissance artist Leon Battista Alberti advised, "to first visualize their bony insides […], then attach tendons and muscles in their place and finally clothe the bones and muscles with flesh and skin."[1] In fact, so important was an understanding of the position of muscles, that Alberti compared a body without muscles to clothes without a person.[2] "If to paint dressed figures you must draw them nude, so to paint nudes you must first situate the bones and muscles before you cover them with flesh and skin in order to show clearly where the muscles are." Alberti was not alone in his concern with muscular anatomy. Western art abounds in paintings and sculptures of fantastically muscular figures. From the earliest surviving Greek art, such as Psiax's sixth century BCE depiction of Herakles strangling the Nemean lion, through to the works of Alberi and beyond.[3] The Western preoccupation with muscularity is perhaps best illustrated by a medical work of the Renaissance, the Muscle Man figures from Andreas Veslius' *De humani corporis fabrica*.[4]

Completed in 1542, the work is undoubtedly a watershed in Western medical history. It marks a turning point from the Galenic medical tradition, which had dominated European medicine throughout the Middle Ages, to the rise of modern scientific medicine.[5] As Nutton has pointed out, however, Vesalius was a "Galenist in the true sense."[6] Though he intended his work as a criticism and correction of Galenic anatomy, Vesalius followed many of Galen's precepts, not the least in the emphasis he placed on muscularity.[7] The 1542 portrait of the Vesalian Muscle Man would be easily recognized by ancient heal-

[1] Cited in A Hyatt Mayor, *Artist and Anatomists* (New York: Artists Limited Edition, 1984), 46.

[2] Mayor, 46.

[3] H. W. Janson, *History of Art*, ed. Anthony F. Janson, 4th ed. (Harry N. Abrams: New York, 1991) 157.

[4] Shigehisa Kuriyama, *The Expressiveness of the Body and the Divergence of Greek and Chinese Medicine* (New York: Zone Books, 1999) 11.

[5] Lawrence I. Conrad, Michael Neve, Vivian Nutton, Roy Porter, and Andrew Wear, *The Western Medical Tradition: 800 BC to AD 1800* (Cambridge: Cambridge UP, 1995) 273-5.

ers, particularly by Galen himself, one of the first to clearly and systematically discuss the anatomy and physiology of muscles. To the mind of Galen and his contemporaries, Vesalius' focus on muscularity would not have seemed at all unusual. Galen had in fact devoted an entire book to the subject, *De motu musculorum*, and continually discussed their significance in his other works.

Yet this focus on musculature is far from universal. In comparing the Western medical tradition to the Chinese, one of the salient differences is in fact this Western emphasis on muscles. Muscularity, it seems, was a particularly Western preoccupation.[8] There was no treatise dealing with muscles in the Chinese medical tradition, nor was there even a word for 'muscle' before contact with Western culture during the twentieth century.[9]

If muscularity is then a uniquely Western focus, how did this emphasis arise? The prominence of fantastically muscular figures in Western art suggests that muscularity was seen as essential to human identity. Yet this merely raises the question of how and why muscles became essential to the Western understanding of the body.[10] A fuller appreciation of the importance of musculature in Western society can be gleaned from an examination of its roots in the philosophy and science of the body in ancient times.

Systematic Dissection in Ancient Greece

The first prerequisite to a muscular view of the body is the presence of systematic dissection.[11] This is patent; the portrait of the Vesalian Muscle Man reveals a detailed knowledge of the muscular system only possible with dissection. Indeed, the first detailed account of muscle anatomy and physiology, *De motu musculorum*, was composed by Galen, an avid dissector. The second requirement is the development of the notion of the soul as the center of autonomous will.[12] Again, not coincidentally, muscle consciousness emerged as doctrines of the soul as the seat of conscious were first being proposed.

As the depiction of Herakles and the Nemean lion on an amphora of the sixth century BCE demonstrate, there was considerable interest in muscular physique before either the development of the notion

[6] Nutton, 273.
[7] Nutton, 274-5.
[8] Kuriyama, 8.
[9] Kuriyama, 9-12.
[10] Kuriyama, 116.
[11] Kuriyama, 116.
[12] Kuriyama, 144.
[12] Kuriyama, 144.

of soul as self or sustained efforts at dissection. In fact, the artist who painted the picture would likely not have described the figure as "muscular."[13] The Greek word for muscle, mys, appears relatively late in the sources. It is not used by Homer, writing in the eighth century BCE, nor by Herodotus, Thucycides, or any of the Greek dramatists of the period.[14] Hesiod, writing approximately the same time as Homer, also did not speak of muscles. In a telling passage, Hesiod described the parts of a sacrificial ox. The ox, he wrote, is composed of "flesh, entrails, bones, and fat."[15] Muscles are not mentioned. The term is used only sporadically in the Hippocratic Corpus.[16] Moreover, throughout the Corpus, muscles are not assigned any unique function. On the rare occasions when they are mentioned, they are described simply as a type of flesh.[17] The author of the treatise *On the Heart*, for instance, wrote that the heart was an exceedingly powerful muscle. He then proceeded to define what he meant by the term: "muscle in the sense […] of a compressed mass of flesh."[18] There is no indication that muscles were thought to have the capacity to contract, or to initiate movement in any movement in any way.[19] Indeed, most of the Hippocratic authors held that motion was the result of *pneuma* flowing through channels in the body.[20] The author of *The Sacred Disease*, for example, noted that a build up of phlegm could block the flow of *pneuma* through the channels, resulting in a loss of movement in the hands.[21]

Thus there is an apparent incongruity between the muscular figures portrayed in early Greek art and the absence of conception of muscularity.[22] It is appropriate, before turning to the main question of how muscle-consciousness arose, to briefly investigate how these seemingly muscular figures might have been understood.

The pseudo-Aristotelian work *Physiognomics*, which deals with determining character from physique, provides some insight. Large, sinewy, and well-articulated feet and ankles, the author contends, denote a strong and forceful character.[23] This association of articulation (literally jointedness) to strength is not confined to *Physiognomics*. In Sophocles' play *The Women of Trachis*, Herakles, on the point of death describes his limbs as "disjointed."[24] Here lack of articulation, or disjointedness, is a sign of weakness, even of impending death. The author of the Hippocratic treatise *Airs, Water, Places* also

[14] Kuriyama, 129.

[15] Hesiod, *Theogony*, 329-30, *Classical Mythology: Images and Insights*, eds. Stephen L. Harris and Gloria Platzner (Sacramento: California Sate UP, 1998).

[16] E. Blastholm, *The History of Muscle Physiology: From the Natural Philosophers to Albrech Von Haller*, trans. W. E. Calvert (Copenhagen: Ejnar Munksgaard, 1950) 19.

[17] Blastholm, 23.

[18] "On the Heart," *Hippocratic Writings*, ed. G. E. R. Llyod, trans. J. Chadwick and W. N. Mann (New York: Penguin Books, 1978) 348.

[19] Bastholm, 19.

[20] Bastholm, 27.

[21] "The Scared Disease," *Hippocratic Writings*, 243.

[22] Bastholm, 32.

associated jointedness with strength. This work demonstrates how seasons, weather, waters and landscapes influence human health and constitution. While describing the various societies living along the coast of the Black Sea, the author turns his attentions to a particular Scythian tribe who inhabit the area next to the river Phasis. As a result, the sluggishness of the river, the author argued, their joints are "obscured by flesh."[25] Consequently, the Phasians are "have little stamina but become quickly tired."[26] Joints need not always have corresponded to our anatomical definition.

In the *Historia animalium*, Aristotle wrote that speech was "the articulation voice by means of the tongue."[27] Dolphins, who have both lungs and a windpipe and so can produce sound, but as their tongues are restricted, they cannot articulate their voice to produce speech.[28] In *De partibus animulium*, Aristotle noted that the articulations in the hearts are "more distinct in animals who sensations are keen."[29] In addition to signifying strength and power then, articulation is also indicative of certain abilities, such as speech or more acute sensation.

It is all but impossible to piece together what artists' thought when depicting what we think of as muscular bodies. Certainly, they would not have called their figures muscular, nor would they necessarily have associated the bulging contours with movement.[30] The discussion of articulation provides some hints as to how the muscular topography of the body might have been understood. What is certain is that at some point jointedness became insufficient in understanding the body. A new concept was needed in order to explain the motions of the body. Whereas in the Hippocratic Corpus muscles are only referred to rarely, and then in somewhat amorphous terms, by the time of Galen, some three hundred years later, a complete and fully articulated work on muscle anatomy and physiology was available.[31] Indeed not only did muscularity emerge as an important concept in Galen's time, but, as Vesalius' Muscle Man demonstrates, it became a salient feature of Western medicine for centuries to follow.

A unique set of intellectual circumstances allowed for the development of muscular consciousness. The first of these, I have already suggested, was the presence of systematic dissection, a distinctively Western practice. The discovery of muscles is inextricable intertwined with the emergence of systematic dissection.[32] As was discussed earlier, Greeks in the archaic period had no conception of muscles.

[23] Kuriyama, 134.

[24] Sophocles, *The Women of Trachis*, trans. Robert Torrance (Boston: Houghton Mifflin, 1961) 1103.

[25] "Airs, Waters, Places," *Hippocratic Writings* 162.

[26] "Airs, Waters, Places," *Hippocratic Writings* 162.

[27] Cited in Kuriyama, 136.

[28] Kuriyama, 136.

[29] Aristotle, *De Paribus Animation 667A*, in *Aristotle: Parts of Animals, Movement of Animals, and Progression of Animals* trans. A.L.Peck and E. S. Forester (Cambridge: Harvard UP, 1960) 243.

[30] Kuriyama, 129.

In fact the term for muscles, *mys*, is used very rarely, and significantly, only by medical writers who themselves regard it simply as a particular type of flesh.[33] The Hippocratic authors of these treatises, it is fairly certain, did not perform dissections.[34] Their descriptions of internal anatomy are, for the most part, speculative.[35] The author of *The Sacred Disease*, for instance, wrote that there were four main sources for the humours in the body: the heart, the head, the liver and the spleen. These are all connected, he contended, to the stomach through channels.[36] This account reflects a concern, not for accurate anatomical description, but for theoretical unity. References to dissection are all but non-existent in the Corpus. Those that do mention dissection, such as *On the Heart*, were composed at a much later date, approximately contemporary with the great anatomical undertakings of Herophilus of Chalcedon and Erasistratus of Cos during the mid-fourth century BCE.[37]

With the emergence of dissection in the fourth century, references to muscles in the sources increase dramatically.[38] While the term *mys* appears only 14 times throughout the whole of the Hippocratic Corpus; Galen used it over 460 times in his writings.[39] This is not to suggest that muscles were discovered simply because people began to cut up dead bodies. Anatomy does not proceed in this way. It is easy to fall into the trap of thinking of anatomy as merely a matter of recording what is observed while dissecting a body, particularly with our rich heritage of received learning on the subject. Anatomy is neither so obvious nor so straightforward as this. Cultures with a long tradition of animal sacrifices and of embalming their dead have notoriously inaccurate systems of anatomy. Ancient Egypt, for instances, where embalming was first extensively performed, had an anatomical tradition which consisted of the heart and fourty-four hypothetical vessels located throughout the body, which obviously bears little resemblance to the actual interior of the human body.[40] In fact animal sacrifices had long been a part of Greek religious practice by the time of most of the Hippocratic Corpus had been written. Turning again to Hesiod, we see that by the time he was writing in the eighth century BCE, animal sacrifice to the gods was, presumably, a well-established tradition, in need of mythological explanation.[41] So writers of the Hippocratic Corpus were heir to at least four centuries of animal sacrifice, which had little or no effect on their views of the body.[42]

[31] Kuriyama, 130-1.

[32] Kuriyama, 131.

[33] Kuriyama, 129.

[34] G. E. R. Lloyd, "Alcmaeon and the Early History of Dissection," *Sudhoffs Archives: Zeitschrift für Wissenschaftsgeschichte* 59 (1975) 130-1.

[35] Lloyd, 131.

[36] Lloyd, 133.

[37] Lloyd, 134.

[38] Bastholm, 19-26.

[39] Kuriyama, 130.

Even cultures with a long tradition of viscerating animals for sacrifice never developed systematic dissection in any real sense. The Aztecs living in Central America, for instance, frequently practiced human sacrifice, yet a tradition of dissection never emerged. Consequently, their anatomy remained as speculative as both the early Greeks and Egyptians.[43] Indeed dissection has almost taken on an air of inevitably among many historians of medicine.[44] Charles Singer in his introduction to the history of anatomy, for instance, opened work by noting that "[t]here is, in a sense, an anatomical instinct."[45] His telescoped view of anatomy is one of an almost linear progression from animal depictions in prehistoric cave drawings to the rational investigations of men like Aristotle, Herophilus, Erasistratus, and Galen. Such views typify much of the scholarship on the history of anatomy.[46]

The Concept of Pneuma

Yet, as we have seen, dissection is the anomaly. Systematic dissection by Aristotle and his successors is a uniquely Western occurrence. More than simply cutting up bodies, dissection requires a particular mind-set that developed exclusively in the West.[47] Societies with long established traditions of animal sacrifice never dissected, it can be assumed, simply because they did not think that it would in any way improve their understanding of the body or disease. Such conceptions in fact appear frequently in early Greek medicine. The author of the Hippocratic treatise *On Ancient Medicine*, for example, laid down the methodology for new medical discoveries. Looking to the past for guidance, the author argued that medical advances should be made by carefully observing how the body responds to different dietary practices when sick, as compared to when well.[48] Even when he argued that knowledge of the internals organs of the body was important, the author simply wrote that "such things have to be deduced from a consideration of what clearly happens outside the body."[49] Analogy, therefore, to everyday objects, such as cupping glasses and sponges, was sufficient for gaining an understanding of internal structure.[50]

Sometime after this treatise was written in the fifth century BCE,[51] a new methodology for investigating the body emerged. The unique mind-set that allowed for the development of systematic dissection, and consequently muscle consciousness, was a picture of a divinely ordered world.[52] Greek

[40] Erwin, Ackernetch, *A Short History of Medicine* (New York: Ronald Press Co., 1955) 24-5.

[41] Hesiod, 329-330.

[42] Lloyd, 131.

[43] Ackerknetch, 29.

[44] Kuriyama, 117.

[45] Charles Singer, *A Short History of Anatomy and Physiology from the Greeks to Harvey* (New York: Dover Publications, 1957) 3.

[46] Kuriyama, 117-8.

[47] Lloyd, 131-2.

cosmogonies knew "nothing of a god who 'created Heaven and Earth' or who 'separated light from darkness.'"[53] Unlike Jewish and Christian traditions, the Greeks did not believe that the world was created out of nothing. Instead they held that the world was made by rearranging pre-existing material.[54] In the *Timaeus*, for instance, where Plato outlined his own account of the origin of the world, he wrote that the Demiurge, or God, "took over all the is visible – not at rest, but in discordant and the unordered motion – and brought it from disorder into order."[55]

The Platonic God, then was not a creator in any real sense; he did not make the material of the universe, but along the lines of a craftsman, he formed the world out of already existing material. The motivation behind this ordering, Plato noted, was as follows. The Demiurge is good, and wishing good for all things, he brought order to the universe, since he judged that order was in every superior to disorder.[56] Implicit in the account is the notion that the Demiurge, as a rational being, formed all things for a specific end or purpose.[57] The *Timaeus* abounds in of explanations of the parts of the body in terms of their particular goal, or teleos. Something as seemingly insignificant as eyelids, Plato noted, were the protection devised by the gods for vision." [58] Not only were all the parts created for a specific function, but, being good, the Demiurge devised that "all things should come as near as possible to being like himself."[59] Just as the shape of the head reflected the spherical nature of the cosmos, all other parts of the body were, as far as possible, created on the model of the Demiurge.[60]

Plato was certainly not the first to propose a teleological view of the cosmos. The idea goes back at least to the pre-Socratic philosopher Anaxagoras, who claimed the "Mind was what arranged everything and caused everything."[61] Plato's Socrates, after some initial enthusiasm, proceeded to berate Anaxagoras for not following up the idea. Instead he turned to such things as "air, ether, and other such absurdities" for explanation. Plato sought to eliminate many of Anaxogoras' deficiencies in his *Timaeus*.[62] In this work, Plato carried teleology to the extreme. The entire cosmos, down to even the most trivial structures of the human body, including the eyelids, were said to be organized and planned

[48] "Tradition in Medicine," *Hippocratic Writings* 70-3.

[49] "Tradition in Medicine," *Hippocratic Writings* 85.

[50] "Tradition in Medicine," *Hippocratic Writings* 85.

[51] Lloyd, Introduction, *Hippocratic Writings*.

[52] Kuriyama, 124-5.

[53] Friedrich Solmsen, "Nature as Craftsman in Greek Thought," *Journal of the History of Ideas* 24 (1963) 473.

[54] Solmsen, 473.

[55] Plato, *Timaeus* 30A, in *Plato's Cosmology: The Timaeus of Plato Translated with a Running Commentary*, ed. Francis MacDonald Cornford (New York: Liberal Arts Press, 1957) 33.

[56] Plato, *Timaeus* 30A-B, 33.

[57] Solmsen, 480.

[58] Plato, *Timaeus* 45D, 153.

by the Demiurge himself.

With Plato was born the proper mindset for dissection. The teleological view of the world provided the impetus for the study of anatomy and the emergence of systematic dissection. Rufus of Ephesus, the first to propose a specific function for muscle and an avid dissector, aptly summarized the connection between the teleological view of nature and dissection in his work *Anatomie des Parties du Corps*:

> L'homme, en effet, aux yeux des philosophes, […] est une representation du bel arrangement des chose céleste, manifestant un art varié dans la construction de ses parties et dans l'accomplissement de ses functions; en consequence, il imparte les subjets d'étude que fournissent l'anatomie aussi bien les autres branches de la medecine.[63]

Significantly, however, though he laid the groundwork for dissection, Plato performed none himself.[64] A telling passage from the *Timaeus* provides some insight. After carefully describing how the eye works, Plato noted that it was far more important to appreciate why the Demiurge had endowed humans with vision than it was to understand the workings of the eye.[65] Sight, Plato proposed, was given so that humans might observe the perfect order of the heavens. By studying the motions of the stars and planets, "we might reproduce the perfectly unerring revolutions of god and reduce to settled order the wandering motions in ourselves."[66] As his other writings attest to, it was the soul, and not the body, which was of primary concern to him.[67] Although the body reflected the divine order of the Demiurge, it was nevertheless a part of the transitory and imperfect sub-lunar world. It was the world of perfect Forms, which, to Plato's mind, contained all that was truly real and worthy of contemplation.[68] It was to this realm then, and not to the body's interior, that Plato turned his gaze.

As a result, Platonic anatomy and, in particular, Platonic ideas of movement are as purely speculative as those of the Hippocratic writers.[69] The few examples of accurate anatomical descriptions of the interior of the body in the *Timaeus* are simply based on common anatomical knowledge of the time and in no way indicate the practice of even rudimentary dissection.[70]

[59] Plato, *Timaeus* 30A-B, 33.

[60] Plato, *Timaeus* 30A, 44D, 33, 150.

[61] Plato, *Phaedo* 97C, in *Plato's Phaedo*, ed. and trans. R.S. Bluck (Indianapolis: Bobbs-Merill Educationsl Publishing, 1985) 108.

[62] R. J. Hankinson, "Galen and the Best of All Possible Worlds," *Classical Quaterly* 39 (1989) 207-8.

[63] Rufus of Ephesus, *Anatomie des parties du corps, oeuvres de Rufus d'Éphèse, texte collationné sur les manuscrits, traduit pour la premième fois en français, avec introduction*, trans. and ed. Charles Daremberg and Charles Émile Ruelle (Paris: L'Imprimerie Nationale, 1879) 168.

[64] Andrew Cunningham, "The Ancients of Anatomy," *The Anatomical Renaissance* (Aldershot: Scholar Press, 1997) 13.

Plato did not distinguish muscles from flesh, either in terms of structure or function. Nor did he consider that the flesh was in any way involved in movement.[71] As to its function, Plato states that it was intended as insulation from both the burning heat of the summer and the wintry cold, and as protection against falls.[72] Motion was in fact not of great interest to Plato in the *Timaeus*. Physiologically, of central concern were the mechanics of respiration and how the body is nourished by the food it ingests.[73] The mechanics of motion, however, were not ignored. When describing the composition of the body, Plato wrote that the limbs were composed of "sinews contracting and relaxing about their sockets."[74] Though this does resemble modern conceptions of muscle to some extent, a careful reading indicates that Plato saw the sinews simply as sort of guy wires used to hold the limbs together and to move them around with respect to their joints. Sinews were not muscles in any sense in that they were not originators of movement, nor did they provide the force of movement.

In a later section, Plato noted that *pneuma*, originating from the heart, was the chief source of all movement.[75] This theory of motion was by no means original since, as mentioned earlier, many Hippocratic authors espoused similar theories of motion. The theory itself is generally thought to have originated with Alcmaeon of Croton in the late fifth century BCE.[76] Only fragments of his writings survive, but his theory of *pneuma* was adopted by many philosophers and physicians in antiquity to account for movement. Air entering through the mouth and veins, goes to the brain and cavities, where it provokes movement in the extremities.[77]

Aristotle, one of Plato's pupils at the Academy, was the first to carry his teacher's teleological views to their logical extreme and to perform systematic dissection. Though Aristotle did not himself write a cosmogony, teleology was as central to his view of the world as it had been to Plato.[78] As he noted in his work *De partibus animalium*, dissection was a joy, because, in doing so, "we are contemplating the painter's and carver's Art, which fashioned them."[79] Aristotle's teleology was, however, of a different type than Plato's. Whereas for Plato the cosmos was consciously designed by the Demiurge, Aristotle, despite his colourful metaphors, held that "Nature" was the force the shaped the universe.[80] The notable

[65] Plato, *Timaeus* 46E-47A, 157.
[66] Plato, *Timaeus* 47C, 158.
[67] Cunningham, 13.
[68] Cornford, 64.
[69] Bastholm, 39.
[70] Cunningham, 13.
[71] Bastholm, 39-40.
[72] Plato, *Timaeus* 74B-C, 296-7.
[73] Bastholm, 40.
[74] Plato, *Timaeus* 74B, 296.

difference is that for Aristotle the universe was not a "consciously directed result of rational agency," as it was for Plato.[81] "Aristotle's God is far too intellectually self-centered […] to waste his time worrying about anything else."[82]

While Plato extolled his readers to turn their gaze to the heavens and the perfect, unchanging realm of the Forms, Aristotle concentrated his attention on this transitory world. Like his teacher, Aristotle believed that the proper focus of the philosophy were the external Forms. Methodologically, however, Aristotle broke from the purely speculative approach of Plato. Instead, he turned to empirical investigation as a was to study the Forms.[83] His rationale, as set out in *De partibus animalium*, is as follows. Though the eternal realm of the Forms is of higher worth than this perishable world, the opportunities to study it are limited precisely because it is so far removed from this world.[84] The transitory world in which we live, however, offers abundant opportunities for study. "Anyone who will but take enough trouble can learn much concerning every one of their kind."[85] The perfect, external, and stable Forms could be perceived, albeit dimly, in this ephemeral realm.

Aristotle, true to his principles, performed innumerable dissections on a variety of different animals. In what serves as his mission statement in De partibus animalium, Aristotle goes as far as to say that he intended to dissect every animal he possibly could, even unsightly ones, "which have no attractiveness for the senses."[86] As a result of these investigations, several significant advances were made within Aristotle's school, the Lyceum.[87] One area where Aristotle's anatomy is far ahead of Plato's is the heart. In the *Timaeus*, Plato described the heart simply as "that knot of veins and fountain of blood."[88] Aristotle's description, on the other hand, reveals a detailed knowledge of the heart's structure. In his work *Historia Animalium* Aristotle wrote the following:

> The heart has three cavities. It lies above the lung at the point where the windpipe divides into two. It has a fat, thick membrane where it is attached to the Great Vein and the Aorta. It lies with its apex upon the Aorta.[89]

[75] Plato, *Timaeus* 43A-C, 147-9.
[76] Basthol,m 26-7.
[77] Bastholm, 28.
[78] Hankinson, "Galen and the Best of All Possible Worlds," 207.
[79] Aristotle, *De partibus animalium* 645A, 99.
[80] Solmsen, 47.
[81] Hankinson, "Galen and the Best of All Possible Worlds," 209.
[82] Hankinson, "Galen and the Best of All Possible Worlds," 213.
[83] Cunnigham, 13.
[84] Aristotle, *De partibus* 644B, 97.

Admittedly, Aristotle paid particular attention to the heart, because that was where the soul resided in his philosophy. For Plato, the heart was merely the home of the spirited soul, of secondary importance to the rational soul lodged in the head. As opposed to Plato's off hand and speculative description, however, Aristotle's indicates a sincere desire for anatomical accuracy. His account touches on many of the most defining features of the heart's structure. He described the location of the heart in the thoracic cavity, the presence of both the aorta and the vena cava, and the pericardium membrane with accuracy. Aristotle also described the different chambers of the heart, though he counted only three of the four chambers of the mammalian heart. The likely explanation for this error can be found in a well-noted passage in the *Historia animalium*.[90] Aristotle observed the difficulty of distinguishing the chambers of the heart of very small animals.[91]

Aristotle, as this passage indicates, did not perform dissections on humans.[92] In another well-known passage in Historia animalium, Aristotle noted that the internal parts of the body, "are unknown, especially those of man; consequently one must refer to the parts of other animals which have a nature similar to that of humans, and examine them."[93] This would in fact be the method used by all ancient anatomists, save for a brief period in Alexandria when human dissection and vivisection were performed.[94] In spite of this deficiency, Aristotle's anatomy was far and away superior to those of his predecessors. Not only the hearth, but in the other internal organs are also described with greater detail and sophistication, only possible with the practice of systematic dissection.

Though his anatomy differed quite significantly from that of his former teacher, Aristotle's theory of motion was in many respects the same. For Aristotle, as for Plato, sinews functioned as guy wires for movement. The heart, the seat of the soul in Aristotle's philosophy, was though to be the director of all motion. It is described as having an " abundance of sinews," which, Aristotle aptly noted " is reasonable enough, as the motions of the body have their origin there."[95] The sinews are used by the heart to move the limbs of the body. The heart, Aristotle went on to note was "like a living creature inside the body that contains it."[96] The heart is even described along the lines of a puppet-master, using the sinews as strings to control the body.[97] The sinews are, therefore, not of themselves involved in any

[85] Aristotle, *De partibus* 644B, 97.

[86] Aristotle, *De partibus* 645A, 99.

[87] James Longrigg, "Post-Hippocratic Medicine II: Medicine from Lyceum to Museum, " *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians* (London: Routledge, 1993) 161.

[88] Plato, *Timaeus* 70A-B, 283.

[89] Aristotle, *Historia animalium* 496A, in *Aristotle: History of Animals* trans. A.L. Peck and E.S. Forester (Cambridge: Harvard UP, 1959) 344.

[90] Aristotle, *Historia animalium* 513A, 378.

[91] Longrigg, 168.

[92] Longrigg, 168-9.

way initiating movement.

Like Plato, Aristotle also thought that the final cause of movement was *pneuma*.[98] Closely following the teachings of Alcaemon of Croton, both cited the *pneuma* as a dynamic driving force of all motion.[99] Aristotle departs markedly from the theories of both Plato and Alcaemon in one significant detail. Whereas Alcaemon and Plato held that the *pneuma* was issued from the brain.[100] Aristotle argued, as the heart was the seat of the soul in his view, the *pneuma* emanated from there to the rest of the body, where it provides the force for the movement. In general, though, the final cause of the motion, *pneuma*, was essentially the same.[101]

Sinews for both Plato and Aristotle likely correspond to the structures we now call tendons, cords of strong connective tissues that attach muscles to the bone.[102] These long, thick, and fibrous structures are far more conspicuous to the untrained eye than are muscles. Muscles are in fact notoriously easy to miss when performing dissections. Aristotle, despite his close attention to detail, did not refer to muscles at all.[103] He carefully described the structural differences between sinew, or tendons, and flesh. Flesh, Aristotle noted, is characterised by the fact that it can be cut in all directions, whereas sinew can only be divided lengthwise.[104] In addition, Aristotle certainly went further than Plato in assigning more than simply a protective function to the flesh. Flesh, he argued, in addition to providing insulation, was also both the organ and medium of touch, or sensation.[105] Yet despite his investigation of flesh, Aristotle did not hit upon muscles. It would in fact be nearly four hundred years before muscles are mentioned as distinct structures involved in motion by the Greek physician Rufus of Ephesus during the reign of the emperor Trajan.[106]

After Aristotle's initial efforts at dissection, several others followed. If not commonplace, dissection at least became an accepted method of investigating and understanding the human body. Though some medical sects, most notably the Empirics, objected to the practice, claiming that such inquiries were of no value, dissections continued to be performed throughout antiquity, right up until the time of Galen at the end of the second century CE. The great Alexandrian anatomists of the early third century,

[93] Aristotle, *Historia animalium* 494B, 338.

[94] Longrigg, 161-2.

[95] Aristotle, *De partibus* 666B, 241.

[96] Aristotle, *De partibus* 666B, 241.

[97] Aristotle, *De motu animalium* 701B, in *Aristotle's On the Movement and Progression of Animals* trans. Anthony Preus (New York: Georg Olms Hildesheim, 1981) 36-7.

[98] Aristotle, *De motu animalium* 703A, 36.

[99] Bastholm, 47.

[100] Bastholm, 52.

[101] Bastholm, 52.

[102] Bastholm, 19-20.

Herophilus of Chalcedon and Erasistratus of Cos, likely went as far as to performed human dissections and perhaps even vivisection on condemned criminals.[107] A full account of their investigations and those of others subsequent to Aristotle is beyond the scope of this paper, but it is enough to note that dissection was certainly carried out after Aristotle.

And yet none of these discovered muscles, at least not as structures with any definite function. This was certainly not the result of sloppiness or carelessness on the part of the anatomists. Though Galen suggested that muscles went undiscovered as a result of the dissectors who were "shrinking detailed dissection and content with plausible ideas."[108] Anatomists after Aristotle continued to make discoveries of the body's inside indicating their care and attention to detail. Erasistratus, for instance, is credited with discovering the difference between motor and sensory nerves, a distinction that would presumably have required meticulous observation and considerable attention to detail.[109] Muscularity is by no means obvious. Chinese traditional medicine did not need muscles to account for movement, nor did the Western medical tradition for quite some time. Even after the advent of dissection, muscles remained hidden from the eyes of even the most astute of observers.[110]

It would be wrong to discount the role of dissection altogether. Certainly dissection contributed significantly to the eventual discovery of muscles. Those to first discuss muscles as separate structures with a unique function in movement were enthusiastic dissectors. Rufus of Ephesus, whose justification for dissection was quoted above, undoubtedly saw dissection as a crucial element in the understanding of the human body.[111] Galen, as well, frequently extolled all who would be doctors, or who sought to understand the world, to perform dissections:

> If anyone wishes to observe the works of Nature, he should put his trust not in books on anatomy but in his own eyes and either come to me, or consult one of my associates, or alone by himself industriously practice exercises in dissection.[112]

In point of fact, Galen's detailed description of muscles in his work, particularly in *De motu musculorum*, would have been impossible without sustained efforts at systematic dissection.

[103] Kuriyama, 147.

[104] Bastholm, 42.

[105] Aristotle, *De partibus animalium* 653B-654A, 157-159.

[106] Bastholm, 71.

[107] Cunningham, 22-3.

[108] Galen, *De anatomicis administrationibus, Galen On Anatomical Procedures, Translation of the Surviving Books with Introduction and Notes*, trans. Charles Singer (London: Oxford UP, 1956) 7.

[109] Batholm, 61.

If, as we have seen, dissection is not manifest, but requires a particular mind-set to develop, so too do the anatomical discoveries. As Lloyd pointed out, dissection is always guided by theory.[113] Things that appear obvious to someone who knows of their existence are often not seen by those who are unaware of their presence. One might, for instance, feel terribly self-conscious about a stain on one's shirt that would be largely unnoticed by others. Not until it is pointed out does the stain become plainly visible. So it is with anatomy. With a long tradition of muscular consciousness, muscles seem a reasonable, and even necessary, part of any body. Yet, as the history of medicine proves, this simply is not the case. Movement can indeed be accounted for in many different ways, and muscles are not the prominent structures we have come to see them as. The eighteenth century artist Charles-Antoine Jombert touched on this when he asserted that "a beginner sees almost no muscle in a nude body."[114] Observing muscles is an acquired skill.[115]

Why did muscles, after centuries of dissection, become theoretically necessary for explaining motion? Form the time of Alcaemon of Croton in the late fifth century BCE, *pneuma*, in various different forms, had provided a suitable answer to the question of how bodies are moved.[116] Even with his thorough knowledge of internal anatomy, Aristotle still relied on *pneuma* to account for movement.[117] In an excellent example of how theory can colour anatomical investigation, Aristotle assigned to the structures that he observed functions in line with this theory of motion. The abundance of sinews, for example, emanating for the hearth that were used to account for the movement of the limbs.[118] The answer to why muscularity eventually emerged lies in the unique functioned assigned to muscles.

The Idea of Voluntary Motion

Muscle physiology began with Rufus of Ephesus during Trajan's reign in the second century CE. Little is known of the man himself, though several of his works are extant. He is the first to clearly describe muscles as an organ in and of themselves, and not simply class them as "flesh", as other anatomists had done.[119] He described muscles simply as firmly compressed and densely compact organ.[120] His description of their function is equally terse, though of tremendous influence to the Western medical tradition.

[110] Kuriyama, 143-4.

[111] Rufus of Ephesus, *Anatomie des parties du corps*, 168.

[112] Galen, *De usu partium* II-3, in *Galen on the Usefulness of the Parts of the Body, Translated from Greek with an Introduction and Commentary,* trans. Margret Tallmadge Ma (Ithaca: Cornell UP, 1968) 119.

[113] Lloyd, 140-1.

[114] Cited in Kuriyama, 112.

[115] Kuriyama, 112.

Muscle, he wrote "est l'organe du mouvement volontaire."[121] This is in fact the only time in all of his existing works where muscles are referred to. Immediately after this statement, Rufus went on to discuss other organs of the body, almost unaware of the significance of his statement. Galen, writing shortly after Rufus, however, fully appreciated the importance of the statement. Whereas Rufus had spent only two or three lines on the subject, Galen devoted an entire treatise to it.

Galen opened his *De motu musculorum* with Rufus' statement on the function of muscle as organs of voluntary motion.[122] He proceeded to describe, with incredible detail, the structure, location and function of (so Galen claimed) virtually every muscle in the body.[123] Though the work contains a number of errors, particularly with regard to their source and sites of attachment, Galen's description of muscles and muscle groups agree for the most part with modern muscular anatomy.[124] The work is the first fully articulated account of the anatomy and physiology of muscles in medical history.[125] It marks the beginning of muscle-consciousness and the Western preoccupation with muscularity.[126]

Rufus', and later Galen's, description of muscular function is of great relevance to the emergence of this preoccupation. Their choice of words is telling; "voluntary action" denotes the presence of free will.[127] As opposed to certain processes in the body, such as heart rate or digestion, over which an individual exercises no control, there are those which are clearly under the individual's direction.[128] Altering one's pace when walking, for instance, or even choosing not to relieve oneself are actions of free will.[129] Muscles, as "organs of voluntary action," Galen maintained, allow the individual to control the movements of his or her own body. The rise of muscle-consciousness is inextricably linked to the development of the idea of free will and the notion of the soul as the autonomous agent of the body.[130]

The conception of the soul as an autonomous agent within the body emerged only gradually. In the archaic period, the notion of the soul as a self-direction, individual force that constituted the true self had not yet evolved.[131] By the fourth century BCE, the picture began to change substantially. Socrates, in *Alcibiades*, argued that the soul did in fact constitute one's real self.[132] In the *Gorgias*, a somewhat later dialogue, as opposed to the Homeric soul, the Socratic soul in the afterlife was endowed with all

[116] Bastholm, 39.

[117] Aristotle, *De motu animalium* 703A, 36.

[118] Aristotle, *De partibus animalium* 666B, 241.

[119] Bastholm, 72.

[120] Rufus of Ephesus, *Anatomie des parties du corps*, 184.

[121] Rufus of Ephesus, *Anatomie des parties du corps*, 184.

[122] Galen, *De motu musculorum* I.1, in *On the Movement of Muscles by Galen of Pergamon*, trans. Charles Mayo Goss, American Journal of Anatomy 123 (1989) 1.

[123] Galen, *De motu* I.1, 2.

the characteristics of the living person, except materiality.[133]

Plato continued his teacher's speculations on the soul to yet higher levels. Plato's dialogues contain the first truly fully articulated works on the nature of the soul – body relationship in Western literature.[134] The theme of the soul's relation to the body held Plato's interest throughout his life. In virtually every dialogue, he dealt with this theme. The theories he proposed were often contradictory, yet certain of his ideas remained constant for the most part, like his theory of the origin of motion. Plato spent a good deal of this work establishing the nature of the body – soul relationship. The rational and immortal human soul, Plato contended, was lodge in the head and was the seat of consciousness.[135] As elsewhere in his accounts, the soul is described as a kind of immaterial, inner being, distinct from the body, yet relating to it and trying to gain mastery over it.[136] The soul is of course the center of intelligence, and directs, or at least strives to direct, the body's movement.[137]

Motion, though directed by the soul, does not originate within the body by any means. All motion is ultimately the result of the self-moving soul.[138] Plato's account of the making of the World Soul and the rational human soul, while quite complex, serves to highlight the supernatural origin of motion. The ingredients are: divisible and indivisible Difference.[139] The Demiurge formed blended versions of these, yielding Intermediate Existence, Intermediate Sameness, and Intermediate Difference. Then mixing these three intermediaries together, he created a unity, which is the dough, so to speak, from which the souls are created.[140] The unity is rolled up into a strip and divided into portions.[141] In the end, every portion has a length that is the result of a rational arithmetical principle, which corresponds to the intervals of a musical scale. The Demiurge then cuts the strip lengthwise into two strips, and by joining their ends together, created two rings. One ring is placed inside the other and a right angle. The outer ring is given the movement of the Same, the inner ring, movement of the Different.[142] This is obviously

[124] Bastholm, 76.

[125] Bastholm, 76.

[126] Kuriyama, 144.

[127] Kuriyama, 144.

[128] Kuriyama, 144.

[129] Galen, *De motu* II.8, 22.

[130] Kuriyama, 144-5.

[131] Jean-Pierre Vernant, "Dim Body, Dazzling Body," *Fragments for a History of the Human Body, Part One*, ed. Michel Feher (New York: Zone, 1989) 21.

[132] Plato, *Alcibiades* I 130C, *Plato with an English Translation* trans. W. R. M. Lamb (Camberidge: Harvard UP, 1964) 201.

[133] T. M. Robinson, "Mind-Body Dualism in Plato," *Psyche and Soma* 40.

[134] Robinson, 37.

intended to be an astronomical picture. The movement of the outer ring corresponds to the orbit of the heaven and the fixed starts; the inner ring (which is further divided into seven smaller rings) corresponds to the motion of the sun, moon, and the five other planets.[143] Though Plato was rather unclear as to the exact manner in which these motions were involved in bodily movement, they were, in some way, intended as the source of motion.[144] Whatever their precise relation, they serve to emphasize the divine origins of motion within Plato's philosophy.

Aristotle was no less concerned with theories of movement than Plato had been. Aristotle developed a rather involved metaphysical theory of motion. Of central importance was distinguishing between that which moves, and that which is at rest, for a moving object always requires the presence of an unmoved object.[145] The origin of all motion, Aristotle claimed, required the presence of an "unmoved mover." He used the analogy of a man standing outside a boat, who can easily push the boat forward with a pole, but, if he were standing inside the boat (and was therefore no longer an unmoved mover), push as he might, he will not move the boat.[146] In *De motu animalium*, Aristotle sought to apply this metaphysical view of motion to animals.[147] Because of his extensive dissections, Aristotle's work was necessarily more anatomical than Plato's purely speculative accounts. As noted earlier, Aristotle described the heart as the puppet master of the body, the headquarters of the body, from which all movement commenced.[148] The heart functioned as the unmoved mover of the body.[149] The sinews, or tendons, function as the puppet's strings, connecting the limbs to the hearth, thereby allowing the heart to move the limbs. The bones were compared to the solid wooden and iron parts of the puppet, which are manipulated by the puppeteer.[150]

In addition to being more anatomical, Aristotle's theory of animal motion further differed from Plato's account (and resembled Galen's), in its distinction between voluntary and involuntary motion.[151] By involuntary, Aristotle wrote, "I mean those movements, for example, of the heart or penis; for they often move at some appearance, and not at the bidding of the mind."[152] Aristotle's definition bears an astonishing resemblance to Galen's distinction between those activities performed by muscles and those that occur naturally. In fact Galen maintained that the heart was not a muscle, precisely because, as Aristotle

[135] Plato, *Timaeus* 42E-44D, 147-9.
[136] Robinson, 42.
[137] Plato, *Timaeus* 42E-44D, 147-150.
[138] Cornford, 57.
[139] Conford, 59-61.
[140] Cornford, 60.
[141] Cornford, 67.
[142] Cornford, 72-3.
[143] Cornford, 67-74.
[144] Cornford, 93.

noticed, it was not under voluntary control.[153]

If both men were observant dissectors, and both shared a similar view as to the distinction between voluntary and involuntary motion, why did one of them resort to muscularity to account for motion, while the other did not?[154]

The chief difference between Galen and Aristotle, and the reason why one resorted to muscularity and the other did not, lay in their understanding of the causes of motion. In *De motu animalium* Aristotle wrote, "Now that which is moved but does not naturally cause motion can be acted upon by some other power; a mover must have some power and force."[155] All animals, therefore, have *pneuma*, which serves as the driving force and power for all motion.[156] Motion, for Aristotle as well as for Plato, was fundamentally an external and supernatural matter. Even voluntary motion relied not on a conscious desire, but on externally obtained *pneuma*.[157] As Canguilhem notes, in Aristotle's philosophy:

> tous le mouvement dans la nature est suspendu, par aspiration et par imitation, à l'acte sunaturel. Chez l'animal terrestre le plus parfait, l'homme, il y a une âme qui est venue à l'embryon du dehors, qui apparentée à l'éther divin, à l'âme des étoiles.[158]

With Galen, on the other hand, arises the notion of the soul as final cause and driving force of all voluntary bodily movement.[159] Galen did not resort to *pneuma* as a cause of movement. In his view, all voluntary motion was an act of internal spontaneity, not as a result of divine breath.[160] This theory of the soul was what permitted, in fact necessitated, the discovery of the muscles through dissection. As Hankinson makes clear, Galen took it as axiomatic that the transmission of any power must be a physical process mediated by a particular organ.[161] For Galen to maintain that voluntary action was gen-

[145] Aristotle, *De motu* 698A, 27.

[146] Aristotle, *De motu* 698B, 28.

[147] Georges Canguihem, *La formation du concept de réflexe aux XVIIe at XVIIIe siècles* (Paris: Librarie Philosophique J. Vrin, 1975) 9-10.

[148] Aristotle, *De motu* 701B, 34.

[149] Canguilhem, 10.

[150] Aristotle, *De motu* 701B, 34.

[151] Aristotle, *De motu* 703B, 38-9.

[152] Aristotle, *De motu* 703B, 38.

[153] Galen, *De motu* I.3, 4.

[154] Kuriyama, 146-7.

uinely a spontaneous act originating from the soul and not some exterior force, like *pneuma*, he had to find a corresponding organ to carry out the function. Galen, therefore, needed muscles, as visible and tangible structures, to account for the purely voluntary actions of the soul. Pneumatic conceptions of motion relied too much on the supernatural to be truly voluntary acts. The discovery of muscles was then as influenced by theory as Aristotle's sinews ushering motion from the heart.

Galen's theory of muscularity and many of his other doctrines were taken up by subsequent healers and held a axiomatic for centuries. Muscularity by the time of Vesalius had become so central to the Western conceptions of the body, that, while trying to correct Galen's shortcomings, he served merely to highlight Galen's own preoccupation with muscularity. Muscularity is indeed a uniquely Western preoccupation. It was the result of a unique confluence of ideas and practices in Classical antiquity. Its emergence illustrates the innate dichotomy that characterised Western thought: the split between the emotional and the rational elements of the human soul. Galen's muscle conscious served not to decide the primacy of reason over emotion, but merely to demonstrate the existence of both within the same body.[162]

[155] Aristotle, *De motu animalium* 703A, 37.
[156] Aristotle, *De motu animalium* 703A, 37.
[157] Kuriyama, 147-8.
[158] Canguilhem, 16.
[159] Kuriyama, 144.
[160] Canguilhem, 17.
[161] R. J. Hankinson, "Galen's Anatomy of the Soul," *Phronesis* 36 (1991) 213.

Works Cited

Ancient Works

Aristotle, *On the Motion and Progression of Animals,* trans. Anthony Prues (New York: Georg Olms Hidesheim, 1981).

Aristotle, *Parts of Animals*, trans. A. L. Peck and E. S. Forester (Cambridge: Harvard UP, 1960).

Cronford, Francis MacDonald, *Plato's Cosmology: the Timaeus of Plato Translated with a Running Commentary* (New York: Liberal Arts Press, 1957).

Galen, *On Anatomical Procedures. Translation of the Surviving Books with Introduction and Notes*, trans. Charles Singer (London: Oxford UP, 1956).

Galen, "On the Movement of Muscles by Galen of Pergamon" trans. Charles Mayo Goss, *American Journal of Anatomy* 123 (1989) 1-26.

Galen, *On the Usefulness of the Part of the Body, Translated form Greek with an Introduction and Commentary* (Trans. Margret Tallmadge May. Ithaca: Cornell UP, 1968).

Hesiod, "Theogon." *Classical Mythology: Images and Insights*. Eds. Stephen L. Harris and Gloria Plazner (Sacramento: California State UP, 1998).

Hippocratic Writings, ed. G. E. R. Lloyd, trans. J. Chadwick and W. N. Mann (New York: Penguin Books, 1978).

Homer, *The Odyssey*, trans. Richard Lattimore (New York: Perennial Classic, reprint 1999).

Homer, *The Iliad*, trans. Robert Fagles (New York: Penguin Books, 1990).

Plato. "Alcibiades" *Plato with an English Translation*, trans. W. R. M. Lamb (Cambridge: Harvard UP, 1964).

[162] Kuriyama 151.

Plato, *Pheado*, ed. and trans. R. S. Bluck (Indianapolis: Bobbs-Merill Educational Publishing, 1985).

Rufus of Ephesus, *Oeuvres de Rufus D'Éphèse, texte collationné sur les manuscrits, traduit pour la première fois en français, avec introduction*, trans. and ed. Charles Daremberg and Charles Émile Ruelle (Paris: L'Imprimerie Nationale, 1879).

Sophocles, *The Women of Trachis*, trans. Robert Torrance (Boston: Houghton Mifflin, 1961).

Modern Works

Ackerknetch, Erwin, *A Short History of Medicine* (New York: Ronald Press, 1955).

Bastholm, E., *The History of Muscle Physiology: From the Natural Philosophers to Albercht von Haller*, trans. W. E. Calvert (Copenhagen: Ejnar Munksgaard, 1950).

Canguihem, Georges, *La Formation du Concept de Reflexe aux XVIIe et XVIIIe Siècles* (Paris: Librarie Philosophique J. Vrin, 1975).

Conrad, Lawrence I., Michael Neve, Vivian Nutton, Roy Potter and Andrew Wear, *The Western Medical Tradition: 800 BE to AD 1800* (Cambridge: Cambridge UP, 1995).

Cunningham, Andrew, "The Ancients of Anatomy" *The Anatomical Renaissance* (Aldershot: Scholar Press, 1997).

Gundert, Beat, "Soma and Psyche in Hippocratic Medicine" *Psyche and Soma: Physicians and Metaphysicians on the Mind-Body Problem from Antiquity to Enlightenment,* eds. John P. Wright and Paul Potter (Oxford: Clarendon Press, 2000).

Hankinson, R. J., "Galen's Anatomy of the Soul" *Phronesis* 36 (1991) 197-233.

Hankinson, R. J., "Galen and the Best of All Possible Worlds" *Classical Quarterly* 39 (1989) 207-26.

Kuriyama, Shigehisa, *The Expressiveness of the Body and the Divergence of Greek and Chinese Medicine* (New York: Zone Books, 1999).

Lloyd, G. E. R., "Alcmaeon and the Early History of Dissection" *Sudhoffs Archives: Zeistchrift Fur Wissenschaftsgeschichte* 59 (1975) 128-44.

Longrigg, James, "Post-Hippocratic Medicine from the Lyceum to Museum" *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians* (London: Routledge, 1993).

Singer, Charles, *A Short History of Anatomy and Physiology from the Greeks to Harvey* (New York: Dover Publications, 1957).

Solmsen, Friedrich, "Nature as Craftsman in Greek Thought" *Journal of the History of Ideas* 24 (1963) 473-96.

Vernant, Jean-Pierre, "Dim Body, Dazzling Body" F*ragments for a History of the Human Body, Part One* ed. Michel Feher (New York: Zone, 1989).