

THE POLITICS OF MIND READING:  
CARTOGRAPHY AND BRAIN SCIENCE  
IN THE DISCOURSE OF MEDICINE

A Senior Honors Thesis

by

JOSHUA WILLIAM OSBUN

Submitted to the Office of Honors Programs  
& Academic Scholarships  
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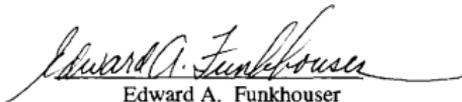
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## ABSTRACT

The Politics of Mind Reading  
Cartography and Brain Science  
In the Discourse of Medicine

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Medicine, like all other contemporary discourses, has a history. As such, medical discourse has been shaped by a wide range of ideologies in the long course of its development, and is open to criticism and analysis. In this sense, medicine may be perceived as an historical trajectory of texts which, like literary texts, demand a hermeneutic response. Philosopher Peter Machamer has observed that “the discovery and individuation of different entities and activities are important parts of scientific practice. In fact, much of the history of science has been written, albeit, unwittingly, by tracing the discoveries of new entities and activities that mark changes in the discipline.”<sup>1</sup> In this view, medicine can be studied by tracing the ideological changes that uncover its underlying rhetoric. I will follow this plan of action precisely in this thesis, for I will examine many of the prominent texts in the history of brain science in order to examine the ideological changes in its discourse, and to show how the contemporary perception of the brain relates to earlier discursive perceptions.

My reading of the trajectory of texts that make up the discourse of brain science uncovers an underlying notion of cartography in the writings. I am convinced that this discourse recycles itself in a continual effort to describe the physiological entity of the brain in a topographical fashion. This cartographical rhetoric, which begins as the dominating force of the discourse during the Renaissance, I would argue, arises out of the Western political ideology of the exploration and colonization of uncharted territories. If the body is perceived as an unexplored spatial region, then it is not unreasonable that science projects this political ideology on its examination of the brain. Since the discourse has not altered its fundamental rhetoric in 500 years, I would argue that there is no actual progress in the narrative of scientific evolution, but that there is rather a regression in the perception of metaphysical human identity.

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<sup>1</sup>Peter Machamer, Lindley Darden, and Carl F. Craver. "Thinking About Mechanisms." *Philosophy of Science*. (67 Mar. 2000: 1-25), p. 14.

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## I. Introduction

Medicine, like all other contemporary discourses, has a history. As such, medical discourse has been shaped by a wide range of ideologies in the long course of its development, and is open to criticism and analysis. In this sense, medicine may be perceived as an historical trajectory of texts which, like literary texts, demand a hermeneutic response. Philosopher Peter Machamer has observed that "the discovery and individuation of different entities and activities are important parts of scientific practice. In fact, much of the history of science has been written, albeit, unwittingly, by tracing the discoveries of new entities and activities that mark changes in the discipline."<sup>1</sup> In this view, medicine can be studied by tracing the ideological changes that uncover its underlying rhetoric. I will follow this plan of action precisely in this thesis, for I will examine many of the prominent texts in the history of brain science in order to examine the ideological changes in its discourse, and to show how the contemporary perception of the brain relates to earlier discursive perceptions.

The discourse of brain science has its own rhetoric, one that is masked by a thick technical language: rather than being a discourse that is immune to criticism and analysis, it is charged with many of the same thematic undertones as a literary text. By scrutinizing medical texts as such, I sense that they have significant connections to culture and society in their treatment of the human body and should be questioned about these characteristics. Michael Foucault, who has examined medical history from this standpoint, observes:

For me it was a matter of saying this: If, concerning a science like theoretical physics or organic chemistry, one poses the problem of its relations with the political and economic structures of society, isn't one posing an excessively complicated question? Doesn't this set the threshold of possible explanations impossibly high? But, on the other hand, if one takes a form of knowledge [*savoir*] like psychiatry, won't the question be much easier to resolve, since the epistemological profile of psychiatry is linked with a whole range of institutions, economic requirements and political issues of social regulation? Couldn't the interweaving of effects of power and knowledge be grasped with greater certainty in the case of a science as "dubious" as psychiatry?<sup>2</sup>

Here Foucault suggests that questioning the relationship of a pure science to social structure creates an impossible and complicated problem, but that imposing these questions on an applied practice such as psychiatry, or in my case brain science, creates an examination that is more easily grasped. In keeping with Foucault, I shall examine the epistemological profile of the brain in an attempt to demonstrate the level of power it exerts in the realm of medicine and culture by analyzing the rhetoric in which it is described.

In my understanding of the discourse, the narrative of medical history tells a story of progress in order to convince society of its validity as a healing institution. I would argue, however, that the rhetoric behind medicine and especially brain science

shows that the discourse has continued in a circular fashion by the manner in which it examines the body. Foucault supports this reading of progress when he writes that

It seems to me that in certain empirical forms of knowledge such as biology, political economy, psychiatry, medicine and so on, the rhythm of transformation doesn't follow the smooth, continuist schemas of development which are normally accepted. The great biological image of a progressive maturation of science still underpins a good many historical analyses: it does not seem to me to be pertinent to history.<sup>3</sup>

Here Foucault argues that disciplines that tell smooth narratives of continual evolution are inconsistent with his reading of them. For Foucault this narrative of progress undermines other perceptions of history. Thus he suggests that progress is not important in historical discourse but rather that working ideologies of different time spans should be examined. With this perspective Foucault substantiates the historical analysis offered earlier by Machamer. Foucault continues his argument against progress:

My problem was... to pose the question "How is it that at certain moments and in certain orders of knowledge, there are these sudden take-offs, these hastenings of evolution, these transformations which fail to correspond to the calm, continuist image that is normally accredited?" But the important thing here is not that such changes can be rapid and extensive or, rather, it is that this extent and rapidity are only the sign of something else- a modification in the rules of formation of statements which are accepted as scientifically true.<sup>4</sup>

What Foucault is relating here is that the popular view of science tells a narrative of progression and maturation. He counters this narrative of medical history and indicates that the important issue at hand is the examination of the changes in which the discourse is presented as "scientifically true." Expanding on Foucault's negation of progression in medicine, I would offer that there is a lack of advancement because the discourse of brain science throughout its history has relied on a rather fixed biological and spatial rhetoric.

My reading of the trajectory of texts that make up the discourse of brain science uncovers an underlying notion of cartography in the writings. I am convinced that this discourse recycles itself in a continual effort to describe the physiological entity of the brain in a topographical fashion. Even in the early writings of Greek physicians this ideology in the discourse is present. I notice in my reading that the method of cartography becomes markedly different in the Renaissance beginning with the theorist Andreas Vesalius, who detaches himself from a metaphysical awareness of the body and seeks to describe the body in corporeal terms based on the structures he observes before him. I've found in my analysis that the grounds of Vesalius' method of observation recycle themselves into the period of the scientific revolution and into the twentieth century. What is more, I've found in reading the texts of current neurological journals that I am able to locate this cartographic rhetoric in many of the abstracts I have read. While the language of the science presents itself in a way to convince the culture of its validity as a practice, I've discovered that beneath this exercise in public relations lies a reductionist notion of mapping the human brain.

Observing the political history during the work of Vesalius, I notice that his research is paralleled by the discovery, exploration, colonization, and discovery of the New World. I would argue that the cartographical rhetoric in medicine is a projection of political ideologies. Howard Marchitello suggests that,

The European discovery of the New World provoked the implementation of the systematic appropriation of the other on a virtually global scale- an act for which European states brought the full weight and power of their political, legal, and religious systems to bear, as all three worked first to make further encounter possible, and then to allow for the legal possessing of New World lands, people, and resources.<sup>5</sup>

Marchitello's view argues that the colonization of the New World consumed Western culture with its "full weight and power." If the body is perceived as one of the "others" that Marchitello writes of, then it would be subject to the same political rhetoric. As such, my reading of neurological literature is congruent with Marchitello's viewpoint in that the body was appropriated into sections, explored and colonized as an uncharted territory. Indeed, this is exactly what I have observed in discourses of brain science written since the Renaissance and therefore I intend to demonstrate this argument throughout this essay.

Since the rhetoric of cartography continues to dominate the discourse, I would argue that there can be no progress in medical ideology when the grounds of its perception have not been fundamentally altered in 500 years. It is my intention in this essay to show that the notion of cartography dominates the rhetoric of neurological texts

and that this dominance has caused the discourse to ignore its subject matter as something more than a physical object. As such, brain science in my opinion has abandoned those metaphysical tenets that have troubled human beings since they began to think about thinking. In this sense, I would argue that the history of the discourse has regressed in the treatment of the human essence in an effort to prove itself as a valid practice.

## II. Hippocrates

Through the course of medical history the name Hippocrates (460-361 BCE) has become synonymous with "Father of Medicine"<sup>6</sup> (see fig. 1). As the premier Greek physician, he wrote between 50 and 70 medical texts, laying the foundation of Western medicine. Hippocrates represents a major turning point in medical thought as to the origin of disease. Before him, medical theorists believed in a divine origin of disease where illness was brought on an individual who was impure in the eyes of the gods and could not be cured until he redeemed himself. Hippocrates believed rather in a natural causation of disease, thus taking the first physiological approach to medicine.

More over, Hippocrates was the first physician to make assertions on the structure and function of the brain. He was interested in its anatomy and physiology both in healthy and diseased states. He was the first to associate the function of the brain in relation to the rest of the body. In a work entitled *On the Sacred Disease* he writes,

Men ought to know that from nothing else but the brain come joys, delights, laughter and sports, and sorrows, griefs, despondency, and

lamentations. And by this, in an especial manner, we acquire wisdom and knowledge, and see and hear and know what are foul and what are fair, what are bad and what are good, what are sweet and what are unsavory... And by the same organ we become mad and delirious, and fears and terrors assail us.... All these things we endure from the brain, when it is not healthy.... In these ways I am of the opinion that the brain exercises the greatest power in the man. This is the interpreter to us of those things which emanate from the air, when the brain happens to be in a sound state.<sup>7</sup>

Taking the brain to be an organ of nature as such, Hippocrates diverges from his contemporaries, who believed that the heart was the organ of reason and that the brain served as a device to provide it with warmth. In the above passage, alternatively, Hippocrates clearly identifies abstract, intangible ideas such as “joys, delights...sorrows, and griefs” with a physical object- the brain. This assertion suggests that the emotional side of human nature resides within something physical and tangible, an idea very radical in a society dominated by such a great supernatural realm as that of Ancient Greece. As one of the first philosophers/ scientists to study the human body objectively, he carries over this new school of thought to the specific case of epilepsy, which according to Greek culture was a common sign of punishment from the gods. In the discourse of medicine, epilepsy had been the first and for many centuries the only disease studied affecting the brain, and so it becomes the focus of early attempts in describing brain science. In *On the Sacred Disease* Hippocrates challenges previous



Figure 1: "Hippocrates" from Magner, *History*, p. 67.

notions and superstitions of epilepsy as what he terms a "sacred disease," or one brought on by the gods. He makes the following argument for the natural cause of the ailment:

I do not believe that the 'sacred disease' is any more divine or sacred than any other disease but, on the contrary, has specific characteristics and a definite cause. Nevertheless, because it is completely different from other diseases, it has been regarded divine visitation by those who, being only human, view it with ignorance and astonishment. This theory of divine origin, though supported by the difficulty of understanding the malady, is weakened by the simplicity of the cure consisting merely of ritual practice and incantation. If remarkable features of the disease were evidence of divine visitation, there would be many 'sacred diseases:' .... It is my opinion that those who first called this disease 'sacred' were the sort of people we now call witch doctors, faith-healers, quacks, and charlatans. These are exactly the people who pretend to be pious and to be particularly wise, by invoking a divine element they were able to screen their own failure to give suitable treatment and so called this a 'sacred' malady to conceal their ignorance of its nature.<sup>8</sup>

Here his writing exemplifies the change of thought he provokes in the specific case of epilepsy. He attempts to negate the argument of divine origin by associating its supporters, whom he calls "witch-doctors, faith-healers, quacks and charlatans," with their own inability to prescribe an effective treatment. For Hippocrates, questions of failed treatments should be remedied with further investigation, not by an assumption

that the disease is out of the scope of human reason. By setting this precedence, Hippocrates marks a change in the medical discipline where physicians begin to look beyond the supernatural factors effecting the human body and see it as a state of nature that can be manipulated by human touch.

Hippocrates backs up his criticism of the origins of epilepsy by performing his own scientific research on the brain to propose his own theory of the disease's cause. He provides the following anatomical description of the brain:

The human brain, as in the case of all other animals, is double: a thin membrane runs down the middle and divides it. This is the reason why headache is not always located in the same site but may be on either side or, sometimes, affects the whole head. There are a large number of tenuous veins which extend to this structure from all parts of the body.<sup>9</sup>

Hippocrates uses this description of the brain to suggest that epileptic symptoms may be caused when these vessels become blocked, for he believes that through these vessels one respire and thus the brain would be deprived of air. In this manner he uses his own investigation to provide an objectified causation for a bodily disorder. He also initiates a trend of mapping the brain, a practice that would be taken to new heights in the sixteenth century. And so in this way Hippocrates makes early efforts to describe the human brain, bringing a kind of scientific objectivity to medicine that differed from the supernatural and spiritual theories of his predecessors. Hippocrates not only applies this logic to his study of the whole body, but also uses it to provide some more of his own insight into brain study.

Similarly, Hippocrates is also interested in the cause and origins of dreams, seeking to find scientific explanations for them. In his study of dreams he maps the brain, associating certain areas with specific function. About the mind-body interaction which cause dreams, he observes

Accurate knowledge about the signs which occur in dreams will be found very valuable for all purposes. While the body is awake, the psyche is not under its own control, but is split into various portions each being devoted to some special bodily function such as hearing, vision, touch, locomotion and all the various actions of the body. But when the body is at rest, the psyche is stirred and roused and becomes its own master; the mind itself performs all the functions of the body. When the body is sleeping it receives no sensations but the psyche being awake at that time perceives everything; it sees what is visible, it hears what is audible, it walks, it touches, it feels pain and thinks. In short, during sleep the psyche performs all the functions of both body and mind. A correct appreciation of these things implies considerable wisdom.<sup>10</sup>

Hippocrates thus sees dreams as an intersection between the body and mental health. Some dreams he believes to be healthy, as they are simply a transfection of a person's daily thoughts and actions into the nocturnal psyche. Other dreams are contrary to daytime activity and these he believes to be a sign of bodily disturbance. And so he develops a Proto-Freudian notion of "bad dreams" as a physical ailment relating to the brain. Hippocrates proposes that simply eating regularly and healthily and staying

hydrated could cure this ailment. Thus he found an early notion of brain science with the first treatment for the mental disease of nightmares. Further, he uses dreams as a means of proposing that certain areas of the brain are associated with certain functions, and writes that the brain is "split into various portions each being devoted to some special bodily function such as hearing, vision, touch, locomotion and all the various actions of the body." Here Hippocrates again diverges radically from his contemporaries when he makes an attempt to map the special areas of the brain. He continues on the subject of dreams to elucidate further observations and treatments:

The facts about dreams are as follows: those that merely consist of a transference to the night of a person's daytime actions and thoughts which continue to happen in normal fashion just as they were done and thought during the day, are good for they indicate a healthy state. This is because the psyche remains true to its daytime cogitations, and is overcome neither by excess nor by emptiness, nor by any extraneous circumstance. But when dreams take on a character contrary to daytime activity and involve conflict or victory over them, then they constitute a sign bodily disturbance. The seriousness of the conflict is an indication of the seriousness of the mischief. Now concerning this, I make no judgment whether or not to avert the consequence by appropriate rites or not. But I do advise treatment of the body, for an excretion resulting from some bodily superfluity has disturbed the psyche.<sup>11</sup>

Hippocrates' thinking here represents one of the first proposals of cause and treatment in brain science, and he asserts that "bad dreams," those eliciting images outside of ordinary daily activity, are a sure sign of bodily disease. Although Hippocrates attributes their source to the body, he still maintains that brain symptoms are linked to supernatural causes. In doing so his work suggests that even though he has provided a new way of examining the human body, he remains very connected to his cultural influences of religion. Having proposed a cause for the so-called bad dreams Hippocrates continues to propose a treatment,

If the opposing force be strong, it is a good thing to give an emetic and to administer a gradually increasing light diet for five days, to order frequently early morning walks gradually becoming more brisk, and gymnastics for those accustomed to this form of exercise, proportionate in severity to the increase of diet. If the opposing force be weaker, dispense with the emetic, reduce the diet by a third and restore the cut by a gradual measure over five days. Strenuous walks and the use of vocal exercises will put an end to the disturbance.<sup>12</sup>

This proposed treatment for the brain disease of nightmares is a simple remedy for those afflicted. The remarkable fact about his proposed treatment, however, is that it resembles the advice of modern physicians.

While the medicine of the body is slowly beginning to shift from the metaphysical to the physical during this period, the brain is still very much linked to mystical beliefs. Hippocrates shows this link in the treatment of bad dreams when he

emphasizes that while on the one hand he recommends treatment of the body, on the other he “makes no judgment whether or not you ought to avert the consequence by appropriates rites or not.”<sup>13</sup> Hence, he can alleviate the symptoms, but he does not believe he can redeem the patient with the gods. The fact that he makes “no judgment” on the religious issue shows a separation of religion and medicine, and marking an alteration in medical thought, implies a division between the priest and the medical practitioner.

### **III. Galen**

Galen (130-200 A.C.E.) was a Greco-Roman medical philosopher who first clarified notions of anatomy, physiology and therapeutics (see fig. 2). The hundreds of dissections he performed made him the authority on anatomical structure and circulatory physiology until the Renaissance. Like Hippocrates, Galen believed that disease was derived from nature but theorized that anatomy could answer larger philosophical questions such as the placement of the soul. In thinking so, Galen’s writings on the brain become a set of speculations on the mind-body-soul interaction rather than an objectified study of brain function and disease. While Galen’s theoretical approaches are more evolved than Hippocrates in terms of modern notions of science, his theories on the brain are somewhat less medical and more philosophical in nature.

Galen proposes that the “best doctor is also a philosopher,” and therefore “he must be practiced in logical theory in order to discover the nature of the body, the differences between diseases, and the indications as to treatment.... He must, therefore,

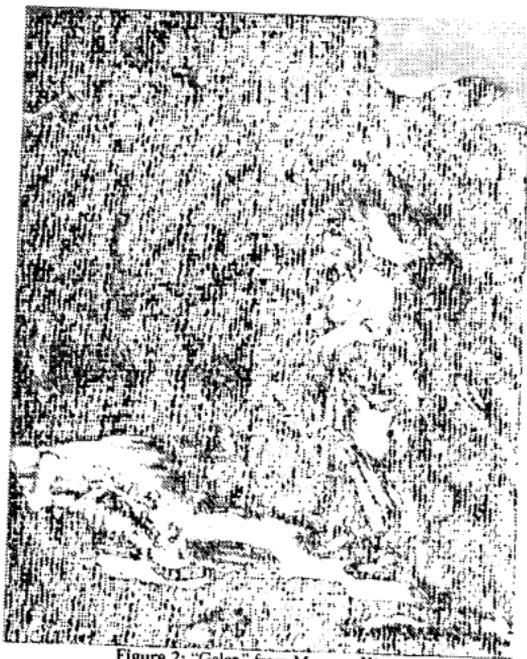


Figure 2: "Galen" from Magner, *History*, p. 87.

know all parts of the philosophy: the logical, the physical, and the ethical.”<sup>14</sup> Galen takes his “philosophy” of medicine to propose that health is a combination of harmony between the mind, the body and the soul. He continues to stress objectivity in describing the body and natural origin of disease, but extends it to include spiritual and mental health, wherein his ideas on brain science become prevalent. In this sense, he is different from Hippocrates, who rarely wrote of the spiritual nature of the body as combined with the physical. Galen believes that there are three forms of the soul, each housed in a certain organ. In this belief he offers a topography of spatial regions in the brain. The “rational soul” he identifies as being housed in the brain. Through his identification of the soul as residing in certain organs, Galen suggests a cartographical approach to the body as well. His writing on the brain tends to describe theories based on observation rather than anatomical or physiological research. In another manner of speaking, Galen is very similar to Hippocrates in that he spends much of his treatment of brain science on the subject of epilepsy. Galen and Hippocrates use epilepsy as the basis for the medical branch of brain science, largely because the disorder has such an observable nature. At this point in history, little could be done to determine the anatomical structure or physiological function of the brain, so Galen theorizes on the brain with what he can observe in the patient. Again, he tends to explain the brain in terms of a mind, body, soul relationship that is more spiritual than organic. Consequently, even 400 years after Hippocrates, brain science is still shaped by the stigma of a supernatural mystery.

Galen was one of the first medical philosophers to begin to map out brain structure. He considers imagination, cognition, and memory as the basic components of

intellect. He acknowledges they could be affected independently, but at least in his known writings he stops short of actually localizing these faculties in different parts of the brain. Galen asserts that certain nerves in the brain served specific functions. He illustrates this concept writing that,

In substance the encephalon is like the nerves, of which it was meant to be the source, except that it is softer, and this was proper for a part that was to receive all sensations, form all images, and apprehend all ideas. For a substance easily altered is most suitable for such actions and affections, and a softer substance is always more easily altered than one that is harder. This is the reason why the encephalon is softer than the nerves, but since there must be two kinds of nerves, as I have said before, the encephalon itself was also given a twofold nature, that is, the anterior part (the cerebrum) is softer than the remaining hard part (the cerebellum), which is called encranium and parencephalis by anatomists. Now... the posterior part had to be harder, being the source of the hard nerves distributed to the whole body.<sup>15</sup>

In this passage Galen asserts his belief that the placement and texture of nerves is related to their function. By tracing the nerve route, he is able to make claims on what he believes to be their purpose. He also describes the physical texture of the surface of that which he observes. By speaking of both nerves routes and textures, Galen portrays a map of the physical surface of the brain. Thus he begins to make his own map of brain structure during the course of his methods of observation.

Galen is marked as the first physician to make observational, experimental, and clinical contributions to cerebral localization, the mapping out of the control areas of the brain's cerebral cortex. He learns from his dissection experiments that the nerves conveying voluntary and motor power to the parts below the neck originate from the spinal cord, to which sensation and voluntary movement are signaled from the brain. He makes the outstanding observation that the severing of the spinal cord results in loss of sensation and movement to all parts below the lesion. He also discovers that semisections would paralyze ipsilateral parts of the body below brain level. Galen seems fully aware that there exist two sets of nerves, sensory and motor. However, he cannot distinguish between the ventral and dorsal roots of the spinal cord and offers no explanation of their function. By tracing the location of certain nerve functions, however, Galen is able to propose that the brain controls sensation and voluntary motion. As such, he coins the term "apoplexy," which he defines as the simultaneous loss of both sensory and motor nerve function. Furthering his pathological definitions, Galen terms localized apoplexy as paralysis of the specified region of the body.<sup>16</sup>

Galen continues to identify neurological pathologies by recognizing three forms of epilepsy based on the movement of the body during a seizure. From this surveillance he attributes the nature of epilepsy solely to what he can observe and not to what he understands through experimentation, as he is able to with the rest of the body. He also describes mental health by monitoring emotional changes. He notices that melancholy and happiness may be brought on by stimuli affecting the body. These include such things as how hot or cold an individual is, how much alcohol he has consumed, how

moist or dry he is, or whether he has been having regular excretions. Thus, in this sense Galen parallels Hippocrates, linking the body to the mind and brain. However, he further connects these entities to the soul. Galen describes the relationship between body and soul writing that,

The soul, like the physiological nature, is a kind of breath or pneuma, the pneuma of the soul being moister and colder, and that of the physis being dryer and warmer. Hence the pneuma is also a kind of matter proper to the soul, while the form of that matter depends upon the proportionate mixing of the aerial and of the fiery substance. For it is not possible to say the soul is either air or fire alone, since an animal's body cannot become either absolutely cold or absolutely warm, or even dominated by one or the other in great excess: thus when the animal departs even to a small extent from symmetry, it becomes fevered if fire be in great excess, and chilled, livid and partly or entirely without feeling when air predominates: for this latter in itself is cold, but acquires a food temperament when mixed with the fiery element.<sup>17</sup>

In this passage Galen agrees with both Aristotle and Plato when he suggests that some disease and mental illness is an outward venting of a diseased soul. Yet he is very much concerned with the greater question of the brain's relationship to the soul man, what he believes to be the true essence of man outside of the physical body. Thus on the subject of the brain, Galen seems to take a step away from anatomical research. This action is to be expected due to his limited ability to study the brain for structure and function. Even

if he had been able to do such research, the mechanisms behind brain function would be beyond the scope of his intellect and primitive understanding of human physiology. Thus, Galen leaves brain science remaining in the supernatural realm, and the early attempts at brain science tend to be based on observation and postulation.

While Galen makes many early attempts to map structure and function in brain science, his view is still very clouded by religious sentiments. Medical historian Walther Riese describes Galen as "Aristotelian in his belief in a purposeful and wise organization of the living organism the description of which, in Galenic terms, almost equaled a religious service with the admiration for the creator of the human body and its marvelous structure as an ever re-current theme."<sup>18</sup> He is as much concerned with the "pneuma" and "spiritus" of the body and their location in the brain as he is with any anatomical or physiological entity he might discover. It was not until the Humanist movement that the medical ideologies become detached from religion.

#### **IV. The Move to Humanism**

In the period from 1450 to 1700, the Renaissance changed the arts, and the Scientific Revolution transformed ideas about the nature of the universe and the nature of man. The Greco-roman tradition was replaced by modern science and the seeds of this new mode of thought were planted by the work of the humanist scholars. The humanists were devoted to words and books and the difficult task of integrating experience and practice with classical learning. Their interests turned from heaven to earth. While humanist scholars were generally more concerned with art and literature than science,

their new perspective served the needs of the medical sciences as well. As staunch supporters of the newly purified Galenic texts, humanist scholars rejected corrupt medieval translations. However, their loyalty for ancient authorities made them skeptical of attempts to create a new medical science that would be independent of the ancient regime.<sup>19</sup> The humanists did not reject the ideas of the Greeks as Vesalius would, but they mark an important move in studying medical science from a spiritual standpoint to one that is strictly corporeal. They were concerned only with what they could see with an observant eye and did not care to make speculations on how their observations affected the nature of the human soul. This change in medical ideology marks an important shift in the underlying rhetoric of medicine that, I would argue, changes the shape of medical literature through the present day.

The critic C.D. O'Malley suggests that "mid-sixteenth century contests between Galenists, sworn supporters of Greek medical authority, and the anti-Galenist proponents of authority has sometimes been described as a kind of struggle between the forces of evil and good, between smug conservatives and valiant progressives."<sup>20</sup> Although such a characterization of opposing forces as this may be correct for the mid-sixteenth century, it by no means applies to the beginning of the century, when classical medicine was a progressive force seeking to enlighten the darkness of medievalism. "It was in consequence of that earlier conflict at the opening of the century," argues O'Malley, "that the seeds of modern medicine were planted, developed as roots, and have remained partly embedded in the medicine of classical Greece."<sup>21</sup> Henceforth some credit should be given to those physicians and humanists who were first responsible for that recovery

of classical medicine. Their endeavor represents an adjustment in medical thought from the Middle Ages, even though they were unaware that still further alteration in medical ideology was possible beyond the Greek contribution.

O'Malley describes the transition from the Middle Ages to the Renaissance in the study of Greek texts as follows,

The millennium and more from the fall of Rome to the dawn of modern times, during which Greek medical doctrine was known in the West partially, indirectly, and even erroneously by way of Moslem interpreters and their medieval commentators, was a period of some stagnation and even retrogression in medicine; and there is a degree of truth in the belief of those late fifteenth and early sixteenth century physicians who declared that direct access to Hippocratic and Galenic writings would constitute the greatest possible boon to the medical art... Greek doctrine was diluted by medieval interpretation and medieval belief; terminology was badly confused; spurious writings, notably those ascribed to Galen, falsified the Greek position, and, generally speaking, the rational, scientific spirit of the Greeks was sacrificed. In some instances only fragments of works had been known through the medieval Latin translations, hence out of context, and still other Greek writings remained completely unknown except by title until, beginning at the close of the fifteenth century, they were studied for the first time in the original Greek and translated directly from that language into Latin.<sup>22</sup>

Here O'Malley suggests how the Humanists brought back the ancient regime so that medicine could break out of the stagnation of criticism created by the Middle Ages, and physicians could reexamine the discipline from its last mark of notable transformation. Although the humanists refused to abandon the Greek tradition, they at least allowed medicine to regain its most advanced roots and to reevaluate its progress. Notable Medical Humanists such as Thomas Linacre and John Caius laid the foundation for such Renaissance medical theorists as Vesalius and Harvey to build on the Greek developments and revamp them into their own perception in ways that Middle Age physicians did not. Humanists also allowed for the radical notion of leaving behind the soul as it pertained to the body. This abandonment freed anatomists to delve into the body in an objectified sense. As cartographers they mapped only what they saw and did not have to sketch the path of the abstract as did their predecessors. Thus, while the humanists did not advance the Greek tradition, they revived it for criticism and provided an avenue by which Renaissance physicians could explore other realms of knowledge regarding the body.

## **V. Vesalius**

Andreas Vesalius was a Belgian anatomist and artist who lived from 1514 to 1564. Lois Magner describes Vesalius' achievement, observing that "Just as Copernicus and Galileo revolutionized ideas about the motions of the earth and the heavens, Andreas Vesalius transformed Western concepts of the structure of the human body."<sup>23</sup> Vesalius was a member of the first group of scholars able to utilize the complete works of Galen

since the humanists had just revived them and translated them into Latin for the first time. As such, Vesalius viewed his own work as the first real advance in anatomical research since Galen's time. It is not unreasonable to say that his ideas began precisely where Galen's ended, and he was one of the first scholars who was permitted to use his classical knowledge to both publicly criticize and denounce the work of Galen. He himself realized he was breaking from the Galenic tradition. In his 1543 book *Epitome*, Vesalius asserts his turn from the ancient regime:

In saying these things I admit the innumerable tenets of Galen contradict me: such as that the anterior ventricles are the olfactory organs; that these ventricles gradually increasing in softness, end by constriction into the visual nerves; yet more strangely that these front ventricles emit phlegm into the nose. These and many other things of the kind are, I am convinced, learned rather from copious discussion rather than dissection.<sup>24</sup>

Here it is clear that Vesalius is taking a different approach than did Hippocrates or Galen, thus setting forth a new tradition of medical discourse, one disassociated from religion and obsessed with mapping the structures seen by the eye.

What Vesalius comes to realize is that as Magner puts it, "human anatomy must be read from the 'Book of the Body,' not from the pages of Galen."<sup>25</sup> It is interesting to note Magner's reference to the "Book of the Body" as Vesalius is the first anatomist to have his study of the body published in a printed book as he wrote approximately a century after the advent of the printing press. Vesalius' superior studies are derived from

the fact that he has access to actual human bodies whereas Roman law prevented Galen from doing the same. In contrast to Galen, Vesalius has an agreement with a judge in which executions are arranged around his schedule of dissections according to his need for specimens. Moving away from the precedent that Galen had set in medical approach, Vesalius points out where Galen was wrong in applying structure in apes to humans. In one instance he holds a lecture, pointing out 200 differences between the human and primate skeletons. With such radical approaches Vesalius moves medical thought out of the period of medieval stagnation into a world of new ideologies brought on by the Renaissance.

Vesalius works on observation and dissection alone; he is completely uninterested in providing explanations for what he cannot directly witness and strives to be detached from any theological perceptions of the body. In this sense he becomes a true cartographer, tracing only the outline of the bodily landscape he can witness before him. In his *Fabrica*, for example, Vesalius negates the idea of a soul being located within the structures of the brain, writing

All our contemporaries, so far as I can understand them, deny to apes, dogs horses, sheep, cattle and other animals, the main powers of the Reigning Soul- not to speak of other (powers)- and attribute to man alone the faculty of reasoning; and ascribe this faculty in equal degree to all men. And yet we clearly see in dissecting that men do not excel those animals by (possessing) any special cavity (in the brain). Not only is the number (of ventricles) the same, but also all other things (in the brain) are

similar, except only in size and in the complete consonance (of the parts)  
for virtue.<sup>26</sup>

From this excerpt it is clear that Vesalius differs from earlier Greek thinkers in that he feels the human brain is simply more complex and capable than that of animals. He claims that since they are so similar in structure, animals by convention should possess a soul as well. Based on what he observes in the similarities between the animal and human brain, he deduces that if it is generally accepted that animals do not have a soul, then humans definitely do not have a soul housed in the brain. With such conclusions, Vesalius indicates that he is not concerned with the spiritual aspect of his work. Walther Riese comments on Vesalius' detachment from religious sentiments as well, noting the following observation by Vesalius:

Can such a description of the uses of the ventricles (as it concerns the powers of the Reigning Soul) produce in ignorant minds not yet confronted in our Most Holy Religion? Such (ignorant ones) will examine carefully (even though I myself were silent) the brains of quadrupeds. These closely resemble those of men in all their parts. Should we ascribe to these (beasts) every power of reason, and even a rational soul, in the basis of such doctrines of the theologians?<sup>27</sup>

In this passage, Vesalius' disinterest in religious sentiments is clear. He concerns himself only with that which he sees. If the theologians contend, "Blessed art those who hast not seen yet still believes," then Vesalius is the unblessed individual who wants, as Othello puts it, the ocular proof.

Vesalius' work becomes the first real attempt to map the human body. While Hippocrates and Galen proposed efforts to provide a cartography of the body, he builds on their studies with extensive exploration and drawings. Moreover, his thorough dissection of the human brain provides what some critics argue is the first modern anatomical research in the field. Still further, he provides vivid descriptions to accompany the brain he draws. For instance in a top-view drawing of the brain he depicts the structures he exposes, noting

*In the third figure we have stripped off both membranes of the brain, that is, the thing and the dural, from the entire portions lying above this section (which we have made around the skull with a saw to display the brain). The process [falx cerebri] of the dural membrane separating the right portion of the brain from the left, which is still preserved in position in the second figure, we have divided from the osseous septum [crista galli] which intervenes between the sinuses of the olfactory organs. This process we have left spread out over the left side of the human brain so that its shape might be examined. The portions of the brain on the right and left have been separated from one another manually so that the superior aspect of the corpus callosum presents itself for inspection.*

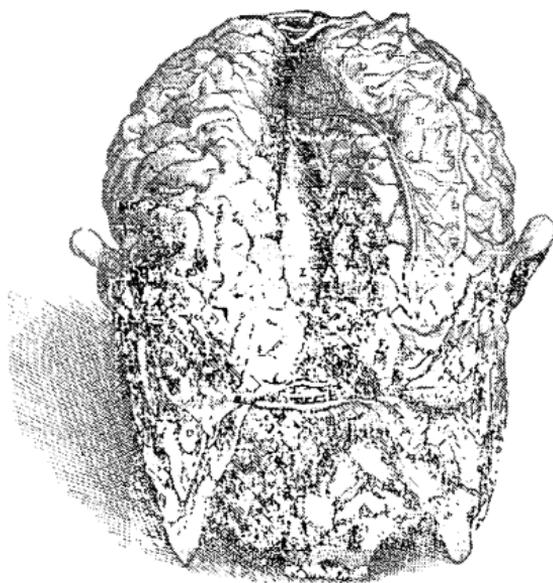
A and B indicate the left and right cerebral hemispheres; C the convolutions; D, the falx cerebri; E, the terminations of the severed cerebral veins; F,G, the inferior sagittal sinus; H, veins of the falx; I, K, internal

cerebral veins at the beginning of the strait sinus; L.M, the corpus callosum; N, the crista galli; O, pia-arachnoid; P, the dura (see fig. 3).<sup>28</sup>

In drawing and describing dissections as such, Vesalius offers a portrayal of structure to accompany the details of function that will eventually be theorized. Vesalius represents primitive ideas that can be associated with the thinking of the scientific revolution in the field of brain science with his anatomical studies. By providing a research-based structure of the human brain, he offers the notion of a brain science removed from religious foundations. Thus Vesalius signifies a very important departure from the field of brain science of his Greek contemporaries, for he views the body as nothing more than a physical form to be navigated and explored.

## **VI. The Scientific Revolution**

The Scientific Revolution is generally thought of as the great transformation of the physical sciences during the sixteenth and seventeenth centuries primarily brought about by such notaries as Copernicus, Galileo, and Newton. The popular view of medical history is that Harvey begins the scientific revolution in medicine with his work on the circulation of the blood, since continuing in the new ideologies of scientific thought he transforms medical research into an applied science that involves the discovery of mechanisms. I would argue however, that the scientific revolution was not what pushed medicine, and especially neuroscience, to evolve into its contemporary advancement, but rather the change of medical thought spurred by the humanists and fully developed by Vesalius, that of the cartography of the human body. It is true that the

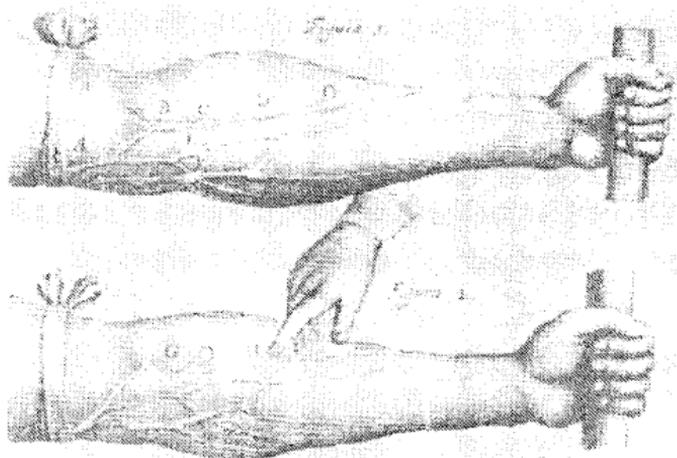


**Figure 3:** Vesalius' representation of the cerebral gyri, from Saunders, *Illustrations*, p. 189.

scientific revolution is more fitting with the reasoning required to work out the body's physiological mechanisms, but I hope to show that the desire to understand function is driven by the earlier discovering of the structures that create the function. Hence it is humanist cartographers such as Vesalius that drive the desire to map the body as an unexplored microcosm.

## **VII. Harvey**

William Harvey (1578-1657) served as a British Royal physician who also diverged from the Galenic mold to add a new perception to physiological thought through his work on the heart and the circulation of the blood (see fig. 4). Harvey is the first to disprove Galen's theories on the heart and movement of bodily fluids through his simple but effective experimentation. Using arguments based on dissection, vivisection, and the works of Aristotle and Galen, Harvey agrees that in the adult all the blood must go through the lungs to get from the right side to the left side of the heart. He theorizes that the heart is muscular and that its important movement is the contraction, rather than the dilation. His most radical idea, however, is that it is the beat of the heart that produces a continuous circular motion of blood. Moreover, he uses simple mathematics to estimate the amount of blood pumped by the heart in an hour's time. Harvey's theories are very unique when compared with the long-standing and generally accepted tenets of Galenic medical thought. Therefore, Harvey's model causes most Galenic theory to be reworked, representing yet another change in the discourse of physiology. This model was unacceptable to many scientists at the time, who had firm belief in the



**Figure 4:** Harvey's demonstration of the circulation of the blood, taken from Magner, *History*, p. 200.

Galenic tradition of medicine, and thus they question Harvey's accuracy. The real problem was that few others were able to understand Harvey's radical new theories let alone the implications and new questions that arose with them. And so they were hesitant to abandon the old system. For some thinkers, new ideas about the movement of the blood, the respiration, and the distribution of the spirits were so painful that they tried to force them backwards into ancient Greek works with what modern science would consider remarkably convoluted arguments. Harvey changed medical thought in a manner that is unsurpassed by anyone else of his time. He uses the language of the scientific revolution in medicine to provide what he believes is the concrete, quantitative data that proves his speculations and at the same time disproves previous perceptions. Even Harvey is aware of the radicalism of his ideas. In his famous work *De Motu Cordis* he writes

Thus much of the transfusion of the blood out of the veins into the arteries, and how it is disposed of and transmitted by the pulse of the heart, so some of which those perchance that were heretofore moved by the reasons of Galen, Columbus and others, will yield; now as concerning the abundance and increase of this blood, which doth pass through those things which remain to be spoken of, though they be very considerable, yet when I shall mention them, they are so new and unheard of, that not only I fear mischief which may arrive to me from the envy of some persons, but I likewise doubt that every man almost will be my enemy, so much does custome and doctrine once retrieved and deeply rooted (as it

were another nature) prevail with every one, and the venerable reverence of antiquity enforces: Howsoever, my resolution is now set down, my hope is in the candor of those which love truth, and learned spirits.<sup>29</sup>

In this excerpt Harvey recognizes that he contradicts Galenic theory and even feels that Galen and Columbus should “yield” to his ideas. In such an attitude, he portrays the movement of the time to abandon the old system for that of the new regime of scientific validity. In doing so, Harvey’s approach to medicine further severs it from its ties to the human spirit and the soul, and again the mapping of the physical body seems to be preferred over an effort to connect science to religious and philosophical sentiments of the body.

From a scientific standpoint, medicine would now become more practical and sound, and physicians would be able to further separate themselves as scientists, leaving their cultural perception as religious practitioners further behind. Magner suggests that medical progress was widely needed, arguing that Harvey creates the real revolution in medical practice:

Well aware of the revolutionary nature of his work, Harvey predicted that no one under 40 would understand it. His work constituted a revolution in science worthy of comparison to that launched by Isaac Newton. Although illness, age, and loss of precious materials and manuscripts during the English Civil War prevented Harvey from accomplishing all his goals, he did live to see his followers establish a new experimental physiology inspired by his ideas and methods. The

questions raised by Harvey's work provided the "Oxford physiologists" – men such as Robert Boyle, Robert Hooke, Richard Lower, John Mayow, and Christopher Wren- with a new research program for attaining a better understanding of the workings of the human body.<sup>30</sup>

Here Magner relates that Harvey's work laid the foundation for a better understanding of the human body. However, Harvey is still concerned very much with mapping, so perhaps he merely continues the trend of Vesalius rather than revolutionizing the world of medicine. While Magner contends that Harvey transforms medicine as a scientific practice, I would argue that he rather remains stagnate and repeats the Vesalian trend to map the body. Instead of offering a radical new method of perceiving the circulatory system, I suggest that Harvey enters into a circular thought process with in his own spatial study of the body.

With his routing of the circulatory system Harvey continues the trend of mapping the body that dominated the medical historic tradition. While Harvey does not address the brain, he suggests an approach that helps his successors research their own mappings of the mind. Harvey's rhetoric can be seen in his description of how he came to deduce the circular motion of the blood.

I began to bethink myself if it might not have a circular motion, which afterwards I found true, and that the blood was thrust forth and driven out of the heart by the arteries into the habite of the body and all parts of it, by the beating of the left ventricle of the heart, as it is driven to the lungs through the vena arteriosa by the beating of the right. and that it

does return through the little veins into the vena cava, and to the right ear of the heart, as likewise out of the lungs the aforesaid arteria venosa to the left ventricle, as we said before.<sup>31</sup>

Here Harvey traces the route of the blood from the heart to the lungs and back to the heart. His rhetoric seems to be more that of a topographer describing the pathway of a river rather than that of a scientist proving a complicated theory. Harvey continues his description,

Which motion we may call circular, after the same manner that Aristotle says that there in and the air do imitate the motion of the superior bodies. For the earth being wet, evaporates by the heat of the Sun, and the vapours being raised aloft are condensed and descend in the showers and wet the ground, and by this means here are generated, likewise, tempests, and the beginnings of meteors, form the circular motion of the Sun and his approach and removal.<sup>32</sup>

In this section, Harvey compares his map of the blood pathway to Aristotle's description of water evaporation, which is done in terms of physical, Earthly entities. With this comparison, Harvey makes his depiction of blood flow even more geophysical in nature. He goes on to write that,

So in all likelihood it comes to pass in the body, that all the parts are nourished, cherished, and quickened with blood, which is warm, perfect, vaporous, full of spirit, and, that I may so say, alimentative; in the parts the blood is refrigerated, coagulated, and made as it were barren,

from thence it returns to the heart, as fountain or dwelling-house of the body, to recover its perfection, and it is melted, and is dispensed again through the body from thence, being fraught with spirits, as with balsam. and that all the things do depend upon the motional pulsation of the heart...<sup>33</sup>

Here Harvey's portrayal is like a mother earth rejuvenating the life forms around her. With this underlying metaphor, Harvey again moves his description towards the earth, which has been so scrutinized by cartographers. Finally Harvey concludes his depiction of blood flow writing,

Hence it is, seeing the veins are certain ways or vessels carrying the blood, there are two sorts of them, the Cava and the Aorta. Not by reason of the side, as Aristotle says, but by their function; and not, as it is commonly spoken, by their constitution, seeing in man Creature (as I have said) a vein differs not from an artery in the thickness of the Tunicle, but by their use and employment distinguishable, a vein and an artery, both of them not undeservedly called veins by the Ancients, as Galen has observed, because that this, viz. the artery, is a way of carrying the blood from the heart into the habit of the body back again into the heart. This is the way from the heart, the other the to the heart. This contains blood rawish, unprofitable, and now made unfit for nutrition, the other blood digested, perfect, and alimentative.<sup>34</sup>

Here Harvey displays his skills of deduction, combining the details of what he has observed through research to surmise a working model for the circulation of the blood. Instead of questioning the inconsistencies of his findings with the Galenic tradition, he runs with them to devise by his standards a more realistic system. He even entertains the idea that his discoveries may be false, but has enough confidence in his research to challenge precedence. Harvey seems to very much parallel Vesalius and the humanist tradition in his writings. He too is concerned purely with the physical aspect of the human body and rather than completely throwing out Greek theories, he tries to build on them. In doing so Harvey sets a precedent for himself, that of taking the humanist vision into the scientific revolution. If critics argue that he sets the medical scientific revolution into motion, then it seems to me that he merely grafts the humanist method onto it, rather than changing the discourse himself. By establishing the mechanism by which the body functions under normal physiological conditions, he adds to the change brought on by the Renaissance to allow physicians from here on out to be able to address the abnormalities in the mechanism resulting in a diseased body. He does this by mapping not only structures he sees, but also the physiology he deduces. Thus I would argue that Harvey takes his own view on a trend begun by Vesalius by applying it to his own research. In the end he offers a different kind of mapping to further alter the discourse, for he applies this ideology to the motion of fluids in the body. Even though Harvey in my opinion does not alter the method of thinking behind the notion of mapping the body as a spatial region, he alters the discourse of medicine by offering a new structure to map, those regions of the body that are dynamic rather than static.

## VIII. Thomas Willis

Thomas Willis (1621-1675), an Oxford physician and disciple of the distinguished anatomist Jacobinus Sylvius, can be seen as Harvey's shadow in the field of neurology (see fig. 5). Willis wrote the famous book *Cerebri anatome* in which he concerns himself cover to cover with brain function. In his book Willis proposes that the cerebral gyri controlled memory and the will. He believes that imagination is a cerebral function rather than an intangible process, and he attributes it to the corpus callosum, which he broadly defines as the white matter of the hemispheres. Willis also calculates that the corpus striatum plays an important role in his scheme of the brain since he believes it controls sensation and movement. With associations such as these Willis is dedicated to linking brain structures to what he can deduce they regulate. In this sense Willis too is a cartographer in that he attempts to identify the spatial location of brain structures with their function. In doing so he provides a more detailed model of brain regions.

Bernard Hollander observes that "Willis assigned to each particular part of the brain a special influence on the mind."<sup>35</sup> Willis connects voluntary motion with the cerebrum and involuntary motion with the cerebellum, and disagrees with both Galen and Descartes when he decides for himself that the pineal gland is not in fact the seat of the soul but rather a lymphatic gland that has no relation to the substance of the brain. What interestingly makes him the true parallel to Harvey is that he traces the pathway of cranial blood vessels, of which he terms their circular motion as the "Circle of Willis."



Figure 5: "Thomas Willis" from Finger, *Origins*, p. 23.

Thus Willis can be seen as perceiving the brain in the same manner that Harvey perceives the circulatory system.

Willis serves as an early exponent of an idea known as cortical localization, one that would become very prevalent in neurology in the nineteenth century. Cortical localization is the notion that the cerebral cortex of the brain is made up of functionally distinct areas that each controls specific thought processes and brain operations. Willis begins this type of observation 150 years before its boom. The idea of cortical localization extends Vesalius' notion of the brain chart, and it can be reduced to an effort to create a more detailed map of spatial surface that lies before the neurologist. Willis creates the notion of cerebral localization and hence he also can be seen, like Harvey, as extending the Vesalian rhetoric to the brain. Willis too, in my opinion, does not invent a new form of viewing the body and the brain, for he applies bodily cartography to his own region of the body. What he does provide is the first attempt to locate the centers of brain functions as topographical regions and herein lies his contribution to the narrative of the discourse.

## **IX. Rene Descartes**

Rene Descartes (1596-1650) was a very influential philosopher of the post-Renaissance period who also theorized on aspects of brain function. As a philosopher Descartes would naturally be concerned with more than just mere corporeal structure and function and thus he poses an interesting juxtaposition to thinkers of his day such as Harvey and Willis. Descartes believes that voluntary human behavior demands an

interaction of the rational soul with the automaton. He maintains that this interaction occurs through the pineal gland, which is a small body hanging between the anterior ventricles of the brain (see fig. 6). The pineal gland is a unique structure that has no bisymmetrical counterpart and for this reason Descartes ascribes it to be a likely seat for the soul. In doing so Descartes brings metaphysical entities back into the discussion of the physical regions of the brain.

Descartes distinguishes very sharply between matter and spirit, defining the former as extended substance and the latter as inextended thinking substance. Hollander explains that Descartes "held that the whole material world and all its processes were to be explained mechanically by means of the concepts of extension, divisibility and mobility."<sup>36</sup> Accordingly, Descartes insists that a purely mechanical explanation of the world must explain both the behavior of inorganic matter and the processes of organic bodies. He applies this argument to the body when he writes in *Passions animae* that

All functions of the body follow naturally from the sole disposition of its organs, just in the same way that the movements of a clock or other self-acting machine or automaton follow from the arrangement of its weights and wheels. So that there is no reason on account of its functions to conceive that there exists in the body any soul, whether vegetative or sensitive, or any principle of movement other than the blood and its animal spirits agitated by the heat of the fire which burns continually in the heart, and which does not differ in nature from any of the other fires which are met with inanimate bodies.<sup>37</sup>

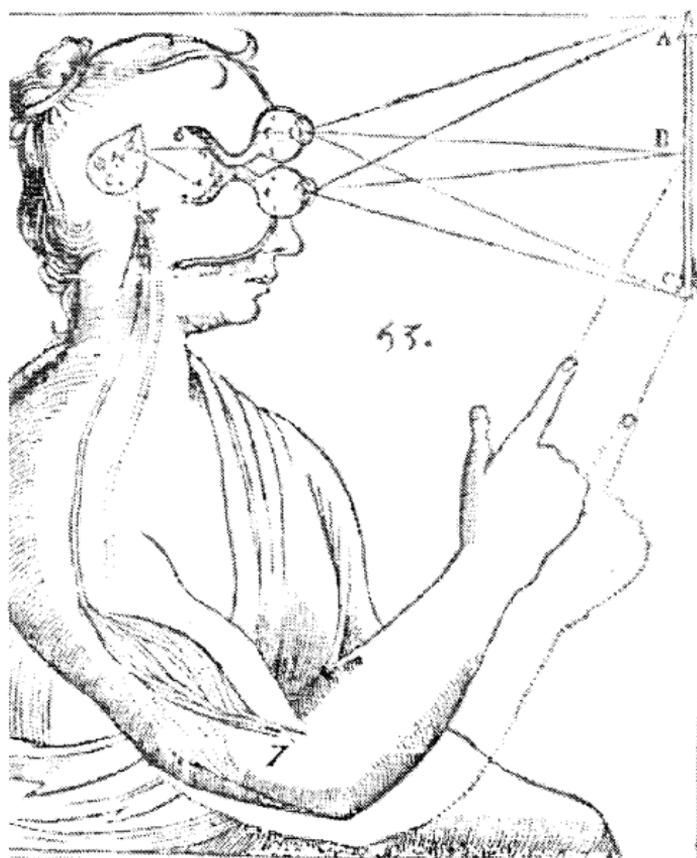


Figure 6: Descartes' representation of how light enters the eye and forms an image on the retina. Hollow nerves from the retina project the image to the ventricles. The pineal gland then releases the animal spirits into the motor nerves to produce motion. Taken from Finger, *Origins*, p. 26.

Here Descartes argues that the purely mechanical justification of nature portrays a human figure devoid of a soul. Thus he feels his explanation for the working of the brain is superior since with his rationalization of the soul he can account for intangible energies such as emotions and thoughts. With this method of examination Descartes can be more closely linked to the Greek tradition. However, he uses the current conventions of his time to arrive at his conclusions, using a map of the body as a means to discover the soul.

Descartes' model of brain function is strikingly different from his peers such as Willis. Rather than being purely mechanical and material, his hypothesis centers on the body containing the soul, which he believes to be the pineal gland. He elucidates his model, writing that,

This small gland (the pineal body), which is the principal seat of the soul, is suspended between the cavities containing these spirits in such a manner that it can be moved by them in as many different ways as there are sensible differences in objects; and at that same time, it can be moved in divers ways by the soul. Which is of such a nature that it receives as many different impressions within itself, or in other words, has as many different perceptions as there are different movements of the gland; and conversely, the bodily machine being moved in diverse ways by the soul or by any other cause, it impels the surrounding spirits towards the pores of the brain, through which they are conducted by the nerves into the muscles, by means of which the soul causes them to move our limbs.<sup>38</sup>

Descartes' model, therefore, is a combination of the spiritual and physical body. This perspective becomes the only counterpoint of its time to his peers, who consider the body as a purely tangible entity.

Where Harvey and Willis deal with the body in terms that can be objectified (movement, heartbeat, breathing), Descartes deals with the subjective products of the brain- the emotions. He defines six primary emotions which include wonder, love, joy, hatred, desire, and sadness. All other emotions he believes to be combinations of these six. Again in *Passions animae* Descartes observes

The ultimate, immediate cause of the passions is merely the disturbance by which the animal spirits set the small gland, which is in the middle of the brain, in motion. It is therefore an error to place the seat of the passions in the heart. No doubt the passions cause some disturbance to be felt in the heart, but this is through the medium of a small nerve which descends from the brain to the heart. Passion depends so much on the machinery of the organism, that a slight modification in the construction of the machine is enough to transform a passion. The same impression made on a gland by a terrifying object may arouse fear in some men, and excite courage and boldness in others; the reason of which is that all brains are not made alike, and that movement of the gland which excites fear in some, will in others cause the spirits to penetrate into the pores of the brain, whence they descend, some into the nerves through which move our hands in defense, and some into those

which stir the blood and drive it to the heart in the way required for the production of the spirits necessary to the continuance of this defense, and for the sustenance of will.<sup>39</sup>

From this passage we see a further illustration of Descartes' union of the mechanical body and the ethereal soul. Emotions to Descartes are part of the soul unified with the physical body. More a philosopher than a physician, Descartes is able to diverge from his peers in an approach that is unpopular by scientific conventions of the time.

Hollander observes that for Descartes "the human body is an automatic machine in which everything is explained by the laws of motion. To this machine a soul is joined, and what was mechanical in the body becomes passions in the soul."<sup>40</sup> From this elucidation it seems clear that Descartes is concerned with more than what he can see, and strives to discover that which he can feel with his own mind, a view very diverse from the remainder of seventeenth century medical literature.

Descartes' ideology on the perception of the brain can be examined as a trend following the Vesalian idea, but adding an age-old question for further analysis.

Descartes too is a cartographer seeking discovery, but his quest differs vastly from other theorists. Because Descartes concerns himself with the ethereal essence of man as well as the corporeal, he suffers much criticism from his scientific peers and successors.

According to Riese, Descartes became the last to attempt to define the doctrine of the seat of the soul.<sup>41</sup> It is important to note that Descartes is renowned in the philosophical world but criticized in the scientific realm. The detachment of religious sentiment is still very pronounced in brain science methodology, and while Descartes in my opinion takes

the same approach to cartography, his critics are skeptical of its validity because of the nature of what he tries to accomplish. In this sense, the Humanist association with the Greeks seems to have been evacuated of philosophical notions.

## X. Phrenology

Phrenology is a nineteenth century philosophy founded by Josef Gall in which knowledge of different portions of the brain is used to compare the physical forms and magnitudes of the skull on different individuals with the propensities and intellectual powers that these individuals are found to actually possess (see fig. 7). Little is known of Gall's motives for constructing his science, but his scientific and anecdotal evidence flowed from his philosophical-social interests. Even before commencing his anatomical investigations he had set down his views on *mind and matter*, body, and soul. in his first publication on the philosophy of medicine in 1791. Gall says of his motives:

Although I had no preliminary knowledge, I was seized with the idea that the eyes thus formed were the mark of an excellent memory. It was later only later on....that I said to myself; if memory shows itself by a physical characteristic, why not the other faculties? And this gave me the first incentive for all my researches, and was the occasion for all my discoveries.<sup>42</sup>

It is apparent that Gall too concerns himself with the spatial arrangement of the brain and skull. As a cranial explorer, he even views it as a quest for what he terms "discoveries." Hence his work suggests that the Vesalian trend is still prevalent in the early nineteenth

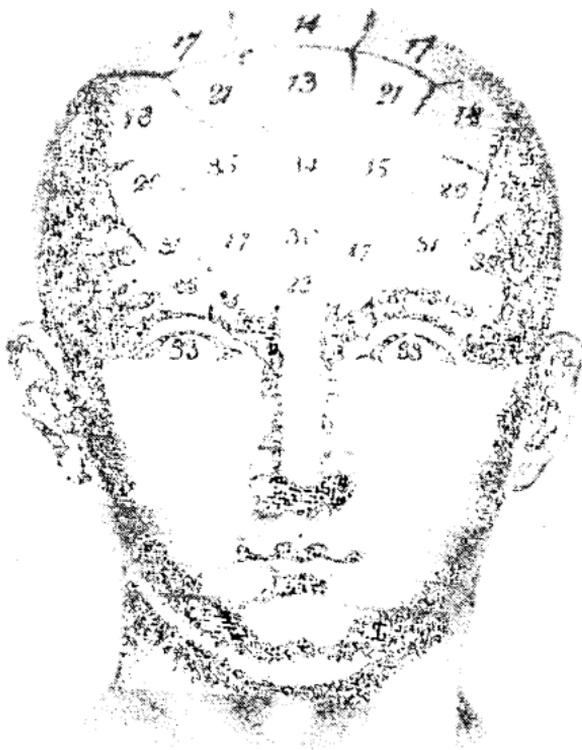


Figure 7: A phrenological diagram produced by Johann Spurzheim. Taken from Finger, *Origins*, p. 33.

century. On the one hand Gall rejects theories of the mind as independent from the brain; on the other, he asserts that experience is the only source for the contents of the mind and organization of thought; that is, he was both anti-idealist and anti-sensationalist. According to James John Garth Wilkinson,

Gall came out of the cerebral well, and looking upon the surface found that it was a landscape, inhabited by human natures and in a thousand tents, all dwelling according to passions, faculties and powers. So much was gained by the first man who came to the surface, where nature speaks by representation: but it is lost again at the point where cerebral anatomy begins.<sup>43</sup>

Wilkinson's description of Gall's work suggests that Gall is at once concerned with the spatial landscape of the brain and with its relationship to the philosophical rhetoric of the soul. In this sense, Gall can be seen as more closely associated with the Greek discourse. Nevertheless, he still combines the Greek question of the mind-soul relationship with the more recent idea of brain cartography.

From this perspective, phrenology takes a step backwards in the popular view of the evolution of scientific deduction while taking a step forward in unveiling the mysteries of the brain. Phrenology speculates on subjective data of behavior associated with the objective measurements of the skull to come to physical conclusions as to the state of an individual's mental health. According to the narrative of most critics of history, this methodology causes the revolutionary discourse of the Renaissance to be abandoned for a return to speculation. Phrenology does, however, change brain science

in that it is the first significant attempt to map brain function to location, perhaps gesturing at the mechanisms of mental thought process. For the first time since the early attempts by Galen, phrenology seeks to understand the relevance of structure. So instead of creating stagnation in the field, I would argue that phrenology poses the idea of associating the working map of spatial location with the mysteries of brain function. It also revives an ancient idea of the place of the soul within the discourse, a question that had been forgotten for several centuries.

Many medical historians take the view that phrenology failed as a bunk science but at the same time taught scientists to stick with research-based and quantified data when making valid assertions. Herein they believe lays the value of phrenology. Roger Cooter explains that,

Phrenology is a readily accessible example of knowledge patently flawed by extrascientific factors and, therefore, able to be contrasted with real science. Circularly, by referring to correct science, an explanation is thought to be had for incorrect science. But in fact, dogmatically explaining phrenology as incorrect science or pseudoscience renders not an explanation of past belief in it, but rather an accumulation of scientific capital to be expended in furthering the image of modern science and its practitioners as divested of social and ideological interests.<sup>44</sup>

Portraying the narrative of scientific advancement, Cooter argues for an inaccuracy in phrenology according to the modern scientific standard of validity. Nevertheless, he too

fails to see phrenology's connections to both the Greek and humanist perspectives. In a similar fashion, Foucault suggests that there is much value in an historical error,

Truth is undoubtedly the sort of error that cannot be refuted because it was hardened into an unalterable form in the long baking process of history. Moreover, the question of truth, the right it appropriates to refute error and oppose itself to appearance, the manner in which it developed ... does this not form a history, the history of an error we call truth?<sup>45</sup>

What Cooter and Foucault suggest is that in the errors of phrenology, science found a truth in objectified research. It reaffirmed the ineffectiveness of medical speculation and gave further support to the science of medicine. With results based on that which could be quantified, patients were more likely to trust the methodology of the physician. Even though they write phrenology off as a pseudo-scientific failure, historians contend it posed the medical questions in brain science that, unexplained by speculation, would begin to be answered and mapped out by subsequent 20<sup>th</sup> century research.

Conversely, I would assert that the birth of phrenology is rather the product of a change in the discourse with another underlying agenda, one that has its roots in the Greco-Roman era, when physicians sought to answer spiritual questions about the mind and body while treating disease. If phrenology sought to question the purpose of structure as an attempt to understand the total being, then I suggest it makes an attempt to examine the nature of the body in a manner unpopular to science at its time. Specifically, phrenology is in my opinion a significant attempt to create a map of the

brain and this in my view links phrenology to Vesalius as well. So rather than existing as a bunk science, phrenology marks a new way of examining the brain that combines both classical and humanist ideas. What is more, Gall's ideas come at the birth of a period of cortical localization. While many argue that Gall's work resulted in a failed science, he is still considered to have sparked the idea that certain regions of the brain are associated with specific functions. It is Gall's method of mapping the regions of the mind, I would argue, that becomes the protocol for cortical localization in the nineteenth century.

## XI. 19<sup>th</sup> Century Cortical Localization

As defined earlier, cortical localization is the notion that the cerebral cortex is composed of functionally distinct areas, which consequently demands of neurologists an effort to seek out these areas and identify them. Nineteenth century English philosopher Herbert Spencer (1820-1903) represents a shift in neurological thought from that of phrenology to a more corporeal study of the brain where localization of function is emphasized over metaphysical production of shape. Spencer himself begins his career as an avid phrenologist and then later denounces phrenology in order to examine the brain from the perspective of physical psychology. Hollander describes Spencer's work as "the first psychology without a soul,"<sup>46</sup> suggesting Spencer's move away from the metaphysical investigations of the brain. Spencer is a strong advocate for cortical localization and comments,

No physiologist.... Can long resist the conviction that different parts of the cerebrum subserve different kinds of mental action.

Localization of function is the law of all organization whatever: separateness of duty is universally accompanied with separateness of structure and it would be marvelous were an exception to exist in the cerebral hemispheres.<sup>47</sup>

In Spencer's account, different entities perform different duties and for this reason it is only natural in the manners of organization to dissect the brain in this fashion. And this is exactly what the nineteenth century did to the brain. Many famous neurologists of this period still leave their mark as great explorers behind as the names of structures neuroscientists use today.

One of the first discoveries performed in the century was the locating of the speech articulation area in the frontal lobe of the brain. The nineteenth century neurologist Paul Broca will be forever remembered as marking "Broca's area" as the site of language production in the frontal lobe. His study of frontal lobe aphasia was what allowed him to make the discovery. The entitling of functional structures with the names of their respective discoverers becomes a new trend in the nineteenth century (see fig. 8). In this sense, the brain scientists of this period are like explorers who discover and colonize areas of unexplored land and name what they find after themselves. Looking at the trends of political colonization during this period, I would argue that neurology follows the same thought process on the brain as governments do on territory. Cases such as that of Phineas Gage, the man whose skull was pierced by a tamping iron being projected through his frontal lobe by a blast, serve as accidental phenomena to support Broca's effort to localize this function. The effects of Gage's injury provide



**Figure 8:** Brodmann's drawing of the brain with different cortexes labeled. Taken from Finger, *Origins*, p. 42.

evidence to validate Broca's discovery and allow him to further stake his claim to the area of the brain he identifies.

The German neuroscientists Edward Hitzig and Gustav Fritsch are generally credited with their discovery of the motor cortex in the brain. The two experimented on the brains of dogs to come to their conclusions. Collaborating on their research they conclude:

A part of the convexity of the hemisphere of the brain is motor, another part is not motor. The motor part, in general is more in front, the non-motor part more behind. By electrical stimulation of the motor part, one obtains combined muscular contractions of the opposite side of the body. These muscle contractions can be localized on certain very narrow delimited groups by using very weak currents.... The possibility to stimulate narrowly delimited groups of muscles is restricted to very small foci which we shall call centers.<sup>48</sup>

The language of Hitzig and Fritsch is very cartographic in nature. They identify some areas as effecting motor function and some as effecting sensory function. The two neurologists use terms such as "foci" and "centers" to pinpoint the exact location of regions they describe. This diction is congruent with the theme of exploration and discovery in the texts of the period. Hitzig and Fritsch localize areas and discover new ones by affecting the familiar ones. In doing so they reduce Vesalius' dissection of the whole body to a small scale, providing perhaps a more detailed map of a specific organ.

The trend of cortical localization continues through the century where the underlying rhetoric of a master brain map remains possible to uncover. The neurologists Jan Purkinje and Theodor Schwann explore the electrical network of the brain and the body in an effort to map it. These two scientists also leave their names on the structures they discovered, for in neuro-anatomy the terms “Schwann cell” and “Purkinje fiber” appear. By the twentieth century any remnants of Descartes’ question of the philosophical mind are completely ignored for the discovery of new areas performing new functions. The modern map of the brain is rapidly being traced. Stepping out of the body to examine the world, the latter part of the nineteenth century sees extensive European colonization and exploration both in India and Africa. At the same time, the American West is at its peak of exploration, discovery, and division as land is divided up into smaller settlements named after their founders. Connecting these observations in both brain science and politics, I would argue that the same rhetoric governs both discourses. Hence, the driving rhetoric behind medicine becomes cartography and exploration rather than progress.

The twentieth century in neurology is a conglomeration of hundreds of neuroscientists working in the same manners as the scientists of the nineteenth century. There are far too many figures with minor discoveries to thoroughly analyze their individual writings. Up to the present day, the brain continues to be divided into smaller spatial arrangements with more specific functions. Each area has been explored, catalogued, and placed on the map in the most detailed description possible. A culmination of such ideological treatment of the brain has produced the current

working model. I suspect that the twentieth century has not changed its perception of the brain and that I can uncover a similar rhetoric to what I have found in texts through the nineteenth century. In the remainder of this essay, I intend to argue that the current state of the art in the discourse of brain science is strongly linked to its past in both ideology and rhetoric.

## XII. Mechanisms

The current status of *neurology* is a field consumed by providing thoroughly researched mechanisms for the brain's most minute functions. In providing such mechanisms, scientists refine the working map of the brain, reducing it to smaller and smaller areas each with its own precise purpose. Indeed the contemporary state of the field strives to further define the structures it has discovered since the Renaissance in such a way that each intricacy of neurological structure and function is located to the smallest and most precisely accurate unit of space. By examining the discourse as such, we can assess the imbedded rhetoric of the current discourse. The writings of critics such as Peter Machamer, who suggests that mechanisms can be broken down into ontic, descriptive, and epistemic characteristics, demonstrate the modern equivalent of the Vesalian ideology of brain cartography. Characterizing mechanisms in this manner answers the question of "why" scientists have pursued such approaches. After mechanisms have been examined for their philosophical rhetoric, they can be placed back into the historical trajectory of brain science.

In a recent essay entitled "Thinking About Mechanisms," Peter Machamer, Lindley Darden, and Carl Craver discuss the rhetoric behind scientific mechanisms. I want to examine their method briefly as a means of demonstrating how to give evidence for my argument of current efforts to explore the brain as an uncharted territory. According to these theorists, mechanisms can be broken down into ontic, descriptive, and epistemic qualities. Linking these processes back into a historical trajectory, they comment that "The discovery and individuation of different entities and activities are important parts of scientific practice. In fact, much of the history of science has been well written, albeit unwittingly, by tracing the discoveries of new entities and activities that mark the changes in a discipline."<sup>49</sup> For Machamer et al, science generates its historical discourse from linking the state of the art to key changes in its past ideologies. Using this method the underlying rhetoric of modern brain science can be shown as recycling itself in historical change.

The argument of Machamer, Darden, and Craver is that a mechanism can be analyzed as having a rhetoric that uses certain features to validate its model. However, this rhetoric can be broken down to uncover certain other thematic elements in the discourse, and as previously elucidated, can show how these elements relate to the historical trajectory. Their argument portrays the reductionist theory behind science and how science divides its subject matter into smaller and smaller units of scrutiny. I intend to argue that through a reading based on the ideas of Machamer et al, I can weed through the epistemology of the discourse and demonstrate the cartographic rhetoric in current journal articles.

At this point I want to pause in my narration of mechanisms to define some terms relating to the philosophical examination of scientific rhetoric. A “mechanism” can be defined as a proposed model for the way in which an organic process occurs. A basic mechanism is composed of “entities” and “activities.” An “entity” can be thought of as any physical structure that has been recognized as existing as a concrete object. Conversely, an “activity” is an action or process carried out by an entity. We can define mechanisms by their ontic, descriptive, and epistemic characters. The ontic character of a mechanism is what defines its state of being or existence, namely the entities that comprise the mechanism. The descriptive character of a mechanism, its descriptive adequacy, is the manner in which the mechanism is represented, perhaps by textual analysis or a diagram exhibiting spatial relations and structural features. The descriptive character is the method by which the scientific rhetoric elucidates the relationship between entities and activities. In my argument, this characteristic is the cartographic depiction of scientific process. Finally, the epistemic adequacy of a mechanism is the basis of its knowledge, how it is presented as a scientific truth. The epistemic character of a mechanism is the manner in which it is portrayed as intelligible as the actual way a process occurs. First I will discuss the method by which these characteristics can be employed to study the rhetoric of a mechanism.

The first quality of mechanisms is derived from its ontic character, what defines its state of being as existing. By attributing mechanisms with an ontic adequacy, we are attempting to capture the healthy philosophical intuitions underlying both substantialist and process ontologies. Substantialists, those who emphasize the independent nature of

a mechanism, confine their attention to entities and properties, believing that it is possible to reduce talk of activities to talk of properties and their transitions. In contrast, process ontologists, those who view a mechanism as dependent on other processes, reify activities and attempt to reduce entities to processes. By combining the two arguments a mechanism can become ontically adequate by endowing it with both entities and activities. As Machamer et al put it, "The organization of these entities and activities determines the ways in which they produce the phenomenon. Entities often must be appropriately located, structured, and oriented, and the activities in which they engage must have a temporal order, rate and duration."<sup>50</sup> In other words, a mechanism is the series of activities of entities that brings about the completion or termination of a condition in a regular way. Hence mechanisms portray the way in which a bodily function occurs from its start to its finish. Machamer et al conclude "No philosophical work is done by positing some further thing, a law, that underwrites the productivity of activities," and adds that "In sum, we are dualists: both entities and activities constitute mechanisms."<sup>51</sup> Machamer's reference to a "law" governing the workings of a mechanism echoes Spencer's notion of the law or legality that drives localization and his argument here suggests that no single underlying rule can explain the rhetoric behind mechanisms and that one must examine the elements of the process to determine its rhetoric. Therefore, both defining and examining the entities and activities comprising a mechanism can provide an ontic state provided for any scientific function.

A descriptive adequacy can be attributed to mechanisms as well. Since mechanisms are very abstract in nature, a means of depicting them as concrete is necessary. Machamer et al elucidate,

Descriptions of mechanisms begin with idealized descriptions of the start or set-up conditions. These conditions may be the result of prior processes, but scientists typically idealize them into static time slices taken as the beginning of the mechanism. The start or set up conditions include the *relevant entities and their properties*. Structural properties, special relations, and orientations are often crucial for showing how the entities will be able to carry out the activities comprising the first stage of the mechanism.<sup>52</sup>

In their view scientists fix the game of mechanisms; they “idealize” them in description so as to work according to theory. Breaking the description of mechanisms into “time slices” parallels the notion of changing ideologies in the historical trajectory. Thus, in the current state of the art historical thought processes repeat themselves.

Although the intermediate activities may be divided into stages in the operation of a mechanism, they are more accurately viewed as continuous processes. Mechanisms occur in nested hierarchies and the descriptions of mechanisms in brain science are frequently multi-level. Machamer et al argue that “nested hierarchical descriptions of mechanisms typically bottom out in lowest level mechanisms. These are the components that are accepted as relatively fundamental or taken to be unproblematic for the purposes of a given scientist, research group, or field.”<sup>53</sup> Hence, bottoming out is relative; different

types of entities and activities are where a given field stops when constructing mechanisms. Documenting such new entities and activities allows us to map out the changes that become the substance of the history of science. Machamer et al once again provide the connection of modern mechanisms to their history when they conclude their explanation of descriptive adequacy by writing

The history of these changes implies that what count as acceptable types of entities, activities, and mechanism change with time. At different historical moments, in different fields, different mechanisms, entities, and activities have been discovered and accepted. The set of types of entities and activities so far discovered is likely not yet complete. Further developments in science will lead the discovery of additional ones.<sup>54</sup>

Finally, mechanisms are provided with an epistemic adequacy, their ability to make logical sense. The contemporary mechanical worldview, among other things, is a conviction about how phenomena are to be understood. Activities are essential for rendering phenomena intelligible. The intelligibility consists in the mechanisms being portrayed in terms of a field's bottom out entities and activities. Machamer et al once again elaborate on this point giving the example of protein synthesis:

The understanding provided by a mechanistic explanation may be correct or incorrect. Either way, the explanation renders a phenomenon intelligible. Mechanism descriptions show how possibly, how plausibly, or how actually things work. Intelligibility arises not from an explanation's correctness, but rather from an elucidative relation between

the explanans (the set up conditions and intermediate entities and activities) and the explanandum (the termination condition or the phenomenon to be explained). Protein synthesis can be elucidated by reference to Gamow holes. The ability of nerves to conduct signals can be rendered intelligible by reference to their internal vibrations. Neither of these explanations is correct; yet each provides intelligibility by showing how the phenomena might possibly be produced.<sup>55</sup>

In this view, descriptions of mechanisms render the end-stage intelligible by showing how it is produced by bottom out entities and activities. Making mechanisms logical allows them to be more likely to be accepted as concrete scientific processes and not just idle suggestions.

Machamer et al also relate epistemic adequacy to history, observing that

There is no logical story to be told about how these bottom out activities, these kinds of production, come to inhabit a privileged explanatory position. What is taken to be intelligible (and the different ways of making things intelligible) changes over time as different fields within science bottom out their descriptions of mechanisms in different entities and activities that are taken as, or have come to be, unproblematic. This suggests quite plausibly that intelligibility is historically constituted and disciplinarily relative (which is nonetheless consistent with there being universal general characteristics of intelligibility).<sup>56</sup>

As they write here, Machamer et al take the viewpoint that scientists tend to break things down to their most reduced state so as to present its subject matter in a logical sense. The theorists suggest that the manner in which they do this changes through the historical trajectory of a discourse and thus their manner of representing their subject requires some further examination. Following with the trend of reduction Machamer et al speak of, I would argue that the brain map is the underlying rhetoric that drives brain science to reduce its representation of the brain to its most localized spatial portrayals. By viewing the modern literature in this manner, I hope to demonstrate how a similar examination can uncover the cartographic project in the current state of the discourse

### XIII. Contemporary Maps of the Brain

In this section of the thesis I examine several examples of current medical journal articles relating to the field of neurology in order to assess the extent to which they rely on rhetorics of cartography. These articles, which have been pulled from the most respected journals in the field of neurology, continue to show a number of the ideological perceptions of Vesalius.

In a recent issue of the neurological journal *Brain* (2000), an article entitled “Accelerated Forgetting in Patients with Epilepsy: Evidence for an impairment in Memory Consolidation” contains a summary that reads

Patients with epilepsy frequently complain of memory difficulties yet perform normally on standard neuropsychological tests of memory. It has been suggested that this may be due to an impairment of very long-

term memory consolidation processes, beyond those normally assessed in the neuropsychological clinic.

From the opening lines the summary of this article explains that insight into the disorder of memory loss in epilepsy patients will begin with the discovery of sites of memory consolidation. Hence, memory sites will be located based on impairment. The method of studying epilepsy is thus based in mapping out locations of memory. The authors continue the summary to discuss their method of research:

We carried out a prospective study of verbal memory over a long term retention interval of eight weeks in patients with epilepsy and in controls. Results were compared with performance on conventional tests of memory. Despite normal learning retention over 30 minutes, patients with epileptic foci in the left temporal lobe performed disproportionately poorly on the long-term test compared with patients with epileptic foci in the right temporal lobe and controls. Our findings provide evidence for an extended period of memory consolidation and point to the critical region for this process, at least for verbal material, in the left temporal lobe. The implications of our findings for clinical assessment and therapeutic management of patients with epilepsy are discussed.<sup>57</sup>

This summary describes the results of a group of scientists who performed memory tests on patients with known areas of epileptic foci in so that they can correlate areas of epilepsy in the brain with areas of memory storage. While the article appears to be the report of findings for memory loss in epilepsy patients, it can be examined for an

underlying rhetoric of brain cartography. Uses of terms such as “foci” and “consolidation” imply a localization of the entities they are discussing. The researchers have already discovered areas of epilepsy on their map of the patients’ brain and now they are using this discovery to explore more areas where they hope to locate memory storage. Thus while the summary seems to be about the side effects of a neurological disease, it also becomes an attempt to locate further sites of memory in the brain. Again the narrative of progress is seen here, for the article appears to be about the advancement of knowledge regarding epilepsy. However, the rhetoric I have unveiled shows that the method of research for this advancement is based on a cartography of memory, and the Vesalian perspective can still be observed in a contemporary medical finding.

Cartographic notions can also be observed in a recent issue of the journal *Brain and Language*. One particular article, entitled “Interhemispheric Effects of Simulated Lesions in a Neural Model of Single-Word Reading,” concerns itself with the neural structure involved in language processing. The abstract of this article reads

A neural model consisting of paired cerebral hemispheric regions interacting via homotopic callosal connections was trained to generate pronunciations for 50 monosyllabic words. Lateralization of this task occurred readily when different underlying cortical asymmetries were present. Following simulated cortical lesions of systematically varied sizes, acute changes in the distribution of cortical activation were found to be most consistent with experimental data when interhemispheric interactions were assumed to be excitatory. During subsequent recovery,

the contribution of the unlesioned hemispheric region to performance improvement was a function of both the amount of preexisting lateralization and the side and size of the lesion. These results are discussed in the context of unresolved issues concerning the mechanisms underlying language lateralization, the nature of interhemispheric interactions, and the role of the non-dominant hemisphere in recovery from adult aphasia.<sup>58</sup>

This abstract deals with language production resulting from the various interactions of different areas of the brain. The author explains that experiments were performed to study the effect of language production when these areas of interaction were subjected to lesions. Notions of spatial identification are very present in the abstract. The researchers speak of “lateralization” and “cortical asymmetries,” which again portray an image of the spatial construction of the brain. Since the article discusses the interaction of the region in the mechanism of language production, another image of roads, pathways, and arrows showing the network of locations is also depicted beneath the scientific jargon. In the images produced by the article’s descriptive adequacy arises the image of a map of all these entities connected by their functional activities. Thus the same rhetoric is at work here, that of depicting a map in order to portray a scientific process.

This kind of cartographical imagery is once more observed in a February 2001 issue of *Neurology* in an article by the title “The Functional Anatomy of Gaze-Evoked Tinnitus and Sustained Lateral Gaze.” I would like to break the abstract into sections for analysis. The first section reads:

*Objective:* To identify neural sites associated with gaze-evoked tinnitus (GET), an unusual condition that may follow cerebellar-pontine angle surgery. *Methods:* The authors examined eight patients with GET and used PET to map the neural sites activated by lateral gaze in them and seven age- and sex-matched control subjects.

The objective and methods of this article are concerned with “sites” of GET, which the authors intend “to map.” While the article is concerned with a neurological condition, the rhetoric immediately reveals that it is unconsciously concerned with a cartography of locations. The abstract continues, providing the experimental results:

*Results:* In patients with Get, tinnitus loudness and pitch increased with lateral gaze and, to a lesser extent, up and down gaze. Evidence for neural activity related to GET was seen in the auditory lateral pontine tegmentum or auditory cortex. GET-associated nystagmus appears to activate the cuneus and cerebellar vermis. These sites were found in addition to an extensive network that included frontal eye fields and other sites in frontal, parietal, and temporal cortex that were activated by lateral gaze in seven control subjects and the patients. The unilateral deafness in patients with GET was associated with expansion of auditory cortical areas responsive to tones delivered to the good ear. In addition to GET, unilateral deafness, end-gaze nystagmus, and facial nerve dysfunction were common.

Here the authors observe GET “sites” among certain structures of the brain. They describe location with diction such as “frontal,” “temporal,” and “parietal,” which orient us on the map of the brain, so that we may perceive the location of the condition. The abstract of the study concludes:

*Conclusions:* Patients with GET have plastic changes in multiple neural systems that allow neural activity associated with eye movement, including those associated with the neural integrator, to stimulate the auditory system. Anomalous auditory activation is enhanced by the failure of cross-modal inhibition to suppress auditory cortical activity. The time course for the development of GET suggests that it may be due to multiple mechanisms.<sup>59</sup>

In this abstract, neurologists study the effects a condition known as GET on hearing after a certain brain surgery was performed. The entire abstract is consumed with pin pointing the “neural sites” that are affected in a region of the brain known as the auditory cortex. So once again while the article appears to be engulfed in scientific discussion on an unusual disorder, the cartographic elements of the disorder’s components are still witnessed.

#### **XIV. Conclusions**

Throughout the course of my readings of texts in the historical trajectory of brain science I have uncovered an underlying rhetoric of cartography behind the mask of the thick scientific style. While the obvious rhetoric of the discourse is one that attempts to

validate the practice of physicians, I would argue that the driving rhetoric is rather one of recycling an effort to reduce the working map of the brain as a spatial region. When countering the narrative of progress that the palpable rhetoric suggests, the question of where the unconscious rhetoric is derived from arises. I would contend that, based on where I find the physical, cartographical rhetoric to originate, I can argue historical and cultural influences that drive the underlying rhetoric. Since I begin to observe the rhetoric as detached from metaphysical sentiments commencing with Vesalius, I would offer that it is driven by the start of colonization in the West at the time of Vesalius' research on the human body. If nations sought to explore and map out the new regions of land that they discovered, then it is not unreasonable that medicine would treat the body in the same fashion. Because of this parallel in discovery, brain science seeks to manage the brain as an unexplored spatial region as well and thus continually strives to refine the map of its subject matter to the most reduced detail.

The age of exploration, both in regards to the universe and to the body, continues in the present day. The regions of space beyond Earth remain yet to be fully explored and fully understood and therefore humans persist in their attempts to obtain a greater knowledge of location. In the same sense, science still has not explained the full function of the brain and much is yet to be understood. Indeed, the brain is capable of vast operations for which modern science has still not provided a map of the functional network. Until a satisfactory map of the brain is traced, the discourse will continue to present its work as a progression in the understanding of the body's most physically and metaphysically complex organ.

Since I have contended that the cartographical rhetoric of the discourse has resulted in the recycling of perceptions and the negation of progress, I would suggest that the discourse can progress through a new rhetoric, perhaps one that incorporates the metaphysical. When viewing the brain in its dual role as the human mind, it can be perceived in several more contexts than a complex network of structures and control mechanisms for the body. Contemporary neurophilosopher Thomas Szasz suggests the power of those who throughout history claimed to understand the mind from a metaphysical standpoint.

Before long, the tendency toward role-specialization, inherent in the social nature of human life, led to certain persons becoming accredited as experts in understanding Man (psyche, soul, mind). The first authorities, called "priests," were soon followed by philosophers and playwrights. From antiquity until the end of eighteenth century, the members of these three groups were the acknowledged experts on human nature. Attributed to divine sources, the authority of the priesthood was unquestioned and unquestionable and was inseparable from the authority of the "state" (as the executive arm of the "church").<sup>60</sup>

Here Szasz suggests that the authoritative power in the understanding of the essence of man resided within those who could understand the human psyche, soul, and mind. They were the "experts on human nature" who had "unquestionable" authority and insight into the individual person. Szasz continues to show the shift of power regarding human nature, contending that

Today, the familiar psychoanalytic psychobabble, parading as psychological science, is being refurbished with so called neurophilosophical accounts of mind-as-brain. As a result, the study of man as a moral agent became “unscientific” and unfashionable and was replaced by the “scientific” study of man as (mental) patient whose behavior is determined by the chemicals in his brain and the genes in his body. The moral-philosopher thus ceded his mandate to the expert in neuro-science; respect, justice, and the rule of law were replaced by compassion, tort litigation, and medical ethics; and the Welfare state was absorbed into the Therapeutic State.<sup>61</sup>

Szasz narrates that there was a shift from the philosophical perception of the brain to one that was dominated by scientific practice. No longer was the brain described in “moral” terms as its perception became consumed by the rhetoric of valid medical practice. Szasz agrees that this shift results in regression and does not support the abandonment of the metaphysical discernment of the brain. He argues that

Not surprisingly, the results still fall short of Utopia. It is one thing to understand the structure of DNA or control a dog in a kennel. It is a very different thing to understand human behavior, much less control a person possessing the rights in a society ostensibly committed to respecting “human rights.” As I show, the modern expert’s inability or unwillingness to concede this difference is regularly accompanied by his inability or unwillingness to acknowledge the conceptual primacy of the

person as a moral agent (that is, the cognitive absurdity and moral impropriety of reducing a person to his body or mind or soul).<sup>62</sup>

Here Szasz concludes his argument by criticizing the neuroscientist as unwilling to recognize the individual, and his brain, as having a metaphysical character. For Szasz, this “inability” to consider the person as having a “moral agent” leads to an inability to understand human nature. Thus, because the modern scientist rejects the philosophical view of the brain, his rhetoric of validity fails in that it is unable to consider the non-corporeal side of the body. I would offer, in accordance with Szasz, that what the discourse of brain science cannot explain about its subject resides in the metaphysical character of the mind.

While critics such as Szasz suggest that the modern rhetoric of science fails to progress because of the manner in which it ignores the supernatural aspects of the body, other critics comment on the relationship of the image of the disease in society. Along with locating the structures of the brain, the medical discourse also identifies disease of the brain. The diagnosis and description of brain disease poses yet another set of questions to be addressed in culture. Those individuals afflicted with such disorders play a complicated role because of the manner in which they are perceived in society. In one sense, the cultural image of the mentally diseased can be viewed as yet another depiction of the brain map, for it is an image of malformed structure. The image of brain disease is a map that steps out of the body and away from reduction to view the overall form of the body. The critic Sander Gilman observes that

Thus the relationship between images of disease and the representation of internalized feelings of disorder is very close. In this matrix the references to collapse (or to the needed sense of control) draw upon the historical pattern of the images found within aesthetic traditions. A free play exists between the uses of these images- whether they are altered and reproduced as visual images, incorporated as descriptive devices or metaphors in texts, or whether their presence haunts the presuppositions of "scientific" nosologies used in medical classification.<sup>63</sup>

Here Gilman suggests that the image of a disorder in society is closely linked to the internal emotions of the afflicted (see fig. 9). Thus, the aesthetics of disease depiction have incorporated themselves into many components of culture- art, literary metaphors, and of course scientific classification. Hence the outer map of the diseased body creates several complications that science tends to ignore when it reduces the whole picture of the brain into minute locations. Gilman observes these social complications in the imaging of brain disease:

Yet each presentation reflects the social constraints and implications of the medium selected. We can turn to those paradigmatic shifts in the history of imaging disease- to the Renaissance rediscovering of the body, for example, or the professionalization of the treatment of the mentally ill during the late nineteenth and early twentieth centuries- and see how clearly contradictory icons of the patient exist simultaneously within

certain images. Leonardo and Freud thus have much more in common than one would, on first glance, suppose!<sup>64</sup>

Gilman suggests that the imaging of the outward effects of the brain on the body is an important historical marker. In considering the brain from this perspective, one can examine the question of how the treatment of the brain as a physical object is projected onto the patient affected by its dysfunction. So not only does Gilman offer the possibility that the social image of the mentally ill is yet another product of the cartographical rhetoric but that it implies new sociological considerations in the treatment of the patient as the same type of physical object to be scrutinized as the brain.

By extending my reading of both Szasz and Gilman, I would argue that their criticisms suggest that the brain can be perceived in several more rhetorics than science is willing to examine. The discourse of brain science ignores questions of the mind that have troubled philosophers, theologians, and even medical theorists for thousands of years. The human race has always contended that man is more than a corporeal substance, and that he is made of an ethereal matter that is on one the hand perceptible but on the other hand intangible and difficult to comprehend. When neurology attempts to explain the metaphysical nature of man, it does so through the terms of physical entities and activities. It explains emotion, thought, memory, and sensation in terms of chemical signals and electrical stimuli. I would argue that the metaphysical cannot be



**Figure 9:** Charles Bell's "Madness," an image of the mentally ill, from his *Essays on the Anatomy of Expression in Painting* (London: Longman, 1806).

explained by reducing it to the physical. Nevertheless, science has attempted to describe the mind in precisely such terms.

The brain is at the intersection of the physical and metaphysical realms of the human body. Hence, there is more of the brain to be examined than mere physical structure and function. The narrative of progress in brain science tends to be moving in a direction where knowledge of the corporeal attempts to manipulate the ethereal and spiritual side of man. In the not-too-distant future the discourse predicts it will be able to read the biochemical sequences of memory and thought production, perhaps reducing human thought to an objective practice. Once the map of the brain, by scientific standards, is complete, neurologists can theorize that all disorders derived from the brain can be manipulated and cured. The problem with these disorders is that they stem from a part of being that is greater than physical substance. In the manipulation of emotions and thought processes, personal identity is manipulated as well. If this feat is accomplished, then science strips man of any spiritual foundation. In this sense a the progression of scientific knowledge results in the regression of human identity.

I would argue that the circular rhetoric of neurology that I have suggested will prevent brain science from achieving metaphysical control. While the physical and metaphysical realms intersect, one cannot control the other. Since I have argued that the recycling of the cartographic rhetoric has resulted in a halt of progress in the discourse, I am convinced that this lack of progress will eventually catch up with the discourse. This occurrence will force the discourse to examine its subject matter from new perspectives and then perhaps it can advance as an ideology.

Examining the texts of neurology from a literary and philosophical standpoint, I have gained much insight into a field that I intend to enter into in the near future. As I was developing my argument, I found myself unable to describe the discourse without using its own cartographic language. In my first drafts, I also found myself attempting to narrate the historical trajectory as a progression in medicine. Having observed myself write and think in such a manner, I realized, as Foucault would suggest, the incongruencies in the historical narrative of medical progress. When I induced that the texts recycled themselves in the same rhetoric, I came to understand how current medical views are very detached from individuals. A living body is inhabited by a metaphysical entity and this cannot be ignored in medical practice.

What this study has taught me is that as a physician I want to gaze beyond the physical body of the patient lying before me and concern myself both with treating the ailment and with treating the patient's being. In educating myself on the writings of philosophical doctors such as Hippocrates and Descartes, I've come to hold the metaphysical aspects of the human body in higher importance. I've decided that a physician succeeds by synthesizing both physical locations in the body with their metaphysical counterparts elsewhere.

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<sup>1</sup> Peter Machamer, Lindley Darden, and Carl F. Craver. "Thinking About Mechanisms." *Philosophy of Science*. (67 Mar. 2000: 1-25), p. 14.

<sup>2</sup> Michael Foucault. "Truth and Power." *Power*. Ed. James D. Faubion. (New York: New Press, 2000), p. 111.

<sup>3</sup> Foucault, "Truth," p. 113-4.

<sup>4</sup> Foucault, "Truth," p. 114.

<sup>5</sup> Howard Marchitello. *Narrative and Meaning in Early Modern England*. (Cambridge: Cambridge University Press, 1997), p. 93.

- <sup>6</sup> Lois N. Magner. *A History of Medicine*. (New York: Marcel Dekker, 1992), p. 66.
- <sup>7</sup> Stanley Finger. *Origins of Neuroscience: A History of Explorations into Brain Function*. (New York: Oxford University Press, 1994), p. 13.
- <sup>8</sup> Hippocrates. *Medical Works of Hippocrates*. (Oxford: Blackwell Scientific Publications, 1950), pp. 179-80.
- <sup>9</sup> Hippocrates, *Medical*, p. 183.
- <sup>10</sup> Hippocrates, *Medical*, p. 194.
- <sup>11</sup> Hippocrates, *Medical*, p. 195.
- <sup>12</sup> Hippocrates, *Medical*, p. 195.
- <sup>13</sup> Hippocrates, *Medical*, p. 195.
- <sup>14</sup> Galen. *Galen's Selected Works*. (Oxford: Oxford University Press, 1997), p. 33.
- <sup>15</sup> Finger, *Origins*, p. 16.
- <sup>16</sup> Walther Riese. *A History of Neurology*. (New York: MD Publications, 1959), pp. 80-1.
- <sup>17</sup> Arthur J. Brock. *Greek Medicine*. (New York: AMS, 1977), pp. 236-237.
- <sup>18</sup> Riese, *History*, p. 79.
- <sup>19</sup> Magner, *History*, p. 154.
- <sup>20</sup> C.D. O'Malley. *English Medical Humanists*. (Lawrence, KS: University of Kansas Press, 1965), p. 1.
- <sup>21</sup> O'Malley, *English*, p. 2.
- <sup>22</sup> O'Malley, *English*, p. 2-3.
- <sup>23</sup> Magner, *History*, p. 158.
- <sup>24</sup> Andreas Vesalius. *Epitome*. Trans. L.R. Lind. (Cambridge: MIT Press, 1949), p. 35.
- <sup>25</sup> Magner, *History*, p. 158.
- <sup>26</sup> C. Singer, Trans. *Vesalius on the Human Brain*. (London: Oxford University Press, 1952), p. 40.
- <sup>27</sup> Riese, *History*, p. 82.
- <sup>28</sup> C. M. Suanders and Charles D. O'Malley. *The Illustrations from the Works of Andreas Vesalius of Brussels*. (New York: Dover Publications, 1950), p. 188.
- <sup>29</sup> William Harvey. *The Anatomical Exercises*. (New York: Dover, 1995), p. 57.
- <sup>30</sup> Magner, *History*, p. 202.
- <sup>31</sup> Harvey, *Anatomical*, p. 58.
- <sup>32</sup> Harvey, *Anatomical*, pp. 58-9.
- <sup>33</sup> Harvey, *Anatomical*, p. 59.
- <sup>34</sup> Harvey, *Anatomical*, p. 60.
- <sup>35</sup> Bernard Hollander. *In Search of the Soul and the Mechanism of Thought, Emotion and Conduct*. (London: Dutton), p. 182.
- <sup>36</sup> Hollander, *In Search*, p. 150.
- <sup>37</sup> Rene Descartes. *The Passions of the Soul*. Tans. Stephen Voss. (Indianapolis: Hackett, 1989), p. 21.
- <sup>38</sup> Hollander, *In Search*, p. 151.
- <sup>39</sup> Descartes, *Passions*, p. 63.
- <sup>40</sup> Hollander, *In Search*, p. 152.
- <sup>41</sup> Riese, *History*, p. 85.
- <sup>42</sup> F. Josef Gall and J. Spurzheim. *Anatomy and Physiology of the Nervous System in General*. (Paris: F. Schoell, 1819), p. 68.
- <sup>43</sup> Roger Cooter. *The Cultural Meaning of Popular Science: Phrenology and the Organization of Consent in 19<sup>th</sup> Century Britain*. (Cambridge: Cambridge University Press, 1984), p. 15.
- <sup>44</sup> Cooter, *Cultural*, p. 17.
- <sup>45</sup> Foucault. *The Birth of the Clinic: An Archaeology of Medical Perception*. (New York: Vintage Books, 1994), p. 144.
- <sup>46</sup> Hollander, *In Search*, p. 465.
- <sup>47</sup> Herbert Spencer. *The Principles of Psychology*. (New York: Appleton, 1897), p. 395.
- <sup>48</sup> E. Hitzig and G. Fritsch. *Some Papers on the Cerebral Cortex*. Trans. Charles C. Thomas. (Springfield, IL: 1960), p. 81.

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- <sup>49</sup> Machamer, *Mechanisms*, p. 14.
- <sup>50</sup> Machamer, *Mechanisms*, p. 3.
- <sup>51</sup> Machamer, *Mechanisms*, p. 8.
- <sup>52</sup> Machamer, *Mechanisms*, p. 10.
- <sup>53</sup> Machamer, *Mechanisms*, p. 13.
- <sup>54</sup> Machamer, *Mechanisms*, p. 15.
- <sup>55</sup> Machamer, *Mechanisms*, p. 21.
- <sup>56</sup> Machamer, *Mechanisms*, p. 23.
- <sup>57</sup> R. V. Blake, et al. "Accelerated forgetting in patients wit epilepsy: Evidence for an impairment in memory consolidation." *Brain*. (123 2000: 472-483), p. 472.
- <sup>58</sup> Yuri Shkuro, et al. "Interhemispheric Effects of Simulated Lesions in a Neural Model of Single-Word Reading." *Brain and Language*. (72 2000: 343-374), p. 343.
- <sup>59</sup> A. H. Lockwood, et al. "The Functional Anatomy of Gaze-Evoked Tinnitus and Sustained Lateral Gaze." *Neurology*. (56 Feb 2001: 472-80), p. 472.
- <sup>60</sup> Thomas Szasz. *The Meaning of Mind: Language, Morality, and Neuroscience*. (Westport, CN: Praeger, 1996), p. 139.
- <sup>61</sup> Szasz, *Meaning*, p. 140.
- <sup>62</sup> Szasz, *Meaning*, p. 140.
- <sup>63</sup> Sander Gilman. *Disease and Representation*. (Ithaca: Cornell University Press, 1988), p. 3.
- <sup>64</sup> Gilman, *Disease*, p. 3.

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